Review of particle properties

Particle Data Group

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This review of the properties of leptons, mesons, and baryons is an updating of Review of Particle Properties, Particle Data Group [Phys. Letters **50B**, No.1 (1974), and Supplement, Rev. Mod. Phys. 47 (1975) 535]. Data are evaluated, listed, averaged, and summarized in tables. Numerous tables, figures, and formulae of interest to particle physicists are also included. A data booklet is available.

CONTENTS

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I. INTRODUCTION, CREDITS, CONSULTANTS

This review is an updating through December 1975 of our previous review (Particle Data Group, 1974, and Supplement, 1975). In this version, we have attempted to make the text as complete and self-contained as possible.

As usual, the results of our compilation are presented in two sections. The Tables of Particle Properties, usually referred to as simply the Tables, contain a summary of the properties of only those peaks or resonances which in our judgment have a large probability of standing the test of time. This is a conservative judgment, and surely means that some genuine resonances are (temporarily) omitted. See Sec. V below.

The Data Card Listings, on the other hand, are an attempt to give up-to-date information, along with references, on all the reported particles whose existence is either considered confirmed (in which case they are also included in the Tables) or not yet confirmed. The Listings also contain mini-reviews pertaining to questions of interest.

A short survey of the history of some of the constants we compile, as well as some of those compiled by others, has been added to the text as a new feature (Sec. VIII). In general, the reliability of the data has been pretty good; that is, the percentage of the time that our best estimates of various constants have changed by more than one standard deviation over the years is roughly what would be expected from statistical considerations. A history of the Particle Data Group, with a discussion of procedures and problems, has been given by Rosenfeld (1975).

This year we are experimenting with a new statistical procedure in our data averaging. Given in the Tables are our best estimates (and their errors), calculated in the old way. In the Listings, we give simultaneously the old (labeled "AVG") and new (labeled "STUDENT") values. In most cases there is little difference. Details may be found in Sec. VII. User comments are solicited.

A pocket-sized data booklet, containing the Tables and a reprint of the figures and formulae from the first part of the book, is available on request.

For North and South America, Australia, and the Far East, write to Technical Information Division, Lawrence Berkeley Laboratory, Berkeley, California 94720, USA.

For all other areas, write to CERN Scientific Information Service, CH-1211 *Genève 23*, Switzerland.

As usual, we wish to emphasize that we compile the experimental results of others. It is inappropriate to give us the credit for their countless hours of effort. We urge that references be given directly to the original data, and we provide complete references in the Data Card Listings for that purpose.

The responsibilities for the various sections can be broken down as follows:

(1) *Stable particles*: A. Barbaro-Galtieri, N. Barash-Schmidt, and T. G. Trippe.

(2) *Meson resonances*: V. Chaloupka, R. J. Hemingway, M. J. Losty, and M. Roos.

(3) *Baryon resonances*: A. Barbaro-Galtieri, C. Bricman, and R. L. Kelly.

(4) *General, including text*: All authors.

Consultants: To overcome unavoidable gaps in our coverage, both intellectual and geographical, we have solicited the help of consultants:

- Ugo Amaldi (CERN)
- Stanley J. Brodsky (Standford Linear Accelerator Center)
- Denyse M. Chew (Lawrence Berkeley Laboratory)
- Ronald Crawford (University of Glasgow)
- J. Engler (CERN)
- Anatoli Kuznetsov (JINR, Dubna)
- Gerald R. Lynch (Lawrence Berkeley Laboratory)
- F. Mönnig (CERN)
- R. Gordon Moorhouse (University of Glasgow)
- David R. Nygren (Lawrence Berkeley Laboratory)
- Oliver E. Overseth (University of Michigan)
- Sherwood I. Parker (Lawrence Berkeley Laboratory)
- Bernard Sadoulet (Lawrence Berkeley Laboratory)
- Paul Söding (DESY)
- Fumiyo Uchiyama (Lawrence Berkeley Laboratory)

The usefulness of this compilation depends in large part on the interaction between the users and the authors and consultants. We appreciate comments, criticisms, and suggestions for improvements of all stages of data retrieval, processing, and presentation.

II. SELECTION OF DATA

All particles are considered to fall into one of the three groups:

(1) Stable particles, immune to decay via the strong interaction, including the η.

(2) Meson resonances (including all the new high mass particles, whether "stable" or not).

(3) Baryon resonances.

These groups are maintained within the two main parts of the compilation:

(1) Tables of Particle Properties.

(2) Data Card Listings.

The Data Card Listings contain the original information (data, references etc.), weighted averages, comments, and "mini-reviews". Immediately preceding the Data Card Listings is an Illustrative Key thereto. We attempt to give complete Data Card Listings up to our closing date (January 1, 1976) for all journals listed in the Illustrative Key. We also include preprints and unpublished conference reports which have come to our attention, but make no attempt at completeness.

Roughly 40% of our encoded results are not used for averaging. They are set off in parentheses: our reasoning is then often given in a footnote below the data. If the reason is not given, it is one of the following:

- The quantity was presented with no error stated.
- The result comes from a preprint or conference report. It is our experience that such results (and particularly the errors) often change before final publication. Accordingly we keep these new results in parentheses until they are published (or explicitly verified to us by the authors).
- It involves some assumptions that we do not wish to incorporate.

- It is of poor quality, e.g., bad signal-to-noise-ratio.
- The result is inconsistent with others, e.g., because of different methods employed, rendering averaging meaningless.
- It is not independent of other results, e.g., a result from one of several partial-wave analyses all using the same data, again rendering averaging meaningless.

When the data for a particle have received special treatment or when they present special problems, this is noted in a mini-review in the Data Card Listings.

The Tables of Particle Properties represent the output of weighted averages and some critical judgment. The extent to which "blind" averaging has been tempered with judgment is explained in footnotes to the Tables. In general, however, the footnotes are less complete than is the collection of notes and mini-reviews in the Data Card Listings. The reader is therefore encouraged to familiarize himself with the Data Card Listings and, ultimately, with the original experiments.

III. NOMENCLATURE

A. Quantum numbers

The symbols $I^G(J^P)C$ represent:

I = isospin

G = G-parity

J = spin

P = space parity

C = charge conjugation parity .

1. Mesons

The charge conjugation operator C turns particle into antiparticle and has eigenvalues ± 1 only for neutral states; so it is useful to define an extension G which has eigenvalues for charged states too. It is usually[1] defined by

$$G = C \exp(i\pi I_y) \ . \tag{1}$$

A neutral nonstrange state is an eigenstate of $\exp(i\pi I_y)$ with eigenvalue $(-1)^I$. Then we can write the eigenvalue equation for the whole multiplet as

$$G = C_n(-1)^I \ , \tag{2}$$

where C_n (n for neutral) is the eigenvalue C would have if applied to the neutral member of the multiplet. Thus, for a π^0, C has the eigenvalue $+1$, and since $I=1$, $G = -1$. For the charged pion there are no eigenvalues corresponding to C and to the isospin rotation, but Eqs. (1) and (2) still give $G=-1$.

Consider a meson as a bound state of fermion-antifermion, e.g., $\bar{q}q$, with orbital angular momentum l, and with the two fermion spins coupling to give a spin S. Then one can show that the charge-conjugation eigenvalue [defined in Eq. (2)] is

$$C_n = (-1)^{l+S} \ . \tag{3}$$

Equations (2) and (3) combine to give

$$G = (-1)^{l+S+I} \ . \tag{4}$$

The parity is

$$P = -(-1)^l \ . \tag{5}$$

Equations (3) and (5) combine to give

$$C_n P = -(-1)^S \tag{6}$$

so all singlet ($^1S_0$, $^1P_1$, ...) have $C_nP=-1$, and all triplet ($^3S_1$, ...) have $C_nP=+1$. For proofs of the above, see our 1969 text (Particle Data Group, 1969) and Appendix by C. Zemach.

If, instead of $\bar{q}q$, we consider the meson as a state of *boson-antiboson* (e.g., $A2 \to \bar{K}K$), it turns out that some signs cancel, and Eqs. (3) and (4) [not (5)!] apply *unchanged*. Of course the mesons are often spinless so S is zero, but the equations are more general. Eqs. (3) and (4) can be considered as selection rules forbidding many decays.

We now use Eqs. (3) and (4) to introduce the concept of "Abnormal-C" mesons, i.e., mesons that cannot be composed of $\bar{q}q$.

The unitary triplet of quarks is of course defined to have isospin and hypercharge properties such that $\bar{q}q$ can combine (according to the SU(3) relations $\{\bar{3}\}\otimes\{3\} = \{8\}\oplus\{1\}$) so as to form only unitary octets and singlets. The non-observation of "exotic" mesons (i.e., mesons in more complicated supermultiplets) is of course one of the bases of the naive quark model. But it is slightly less obvious that even some *octets* are forbidden by the model, namely those with $(J^P)C_n = (0^\pm)-$, $(1^-)+$, $(2^+)-$, ... Such states are also not observed, and this is an additional success of the naive quark model classification scheme.

In what follows, do not confuse "Abnormal-C" with "Normal" or "Abnormal" J^P, both of which are allowed by the quark model. The series $J^P = 0^+, 1^-, 2^+, \ldots$ is called Normal because $P=(-1)^J$ as for normal spherical harmonics, and $J^P = 0^-, 1^+, \ldots$ is called Abnormal.

The top part of Table I shows all the low angular momentum states that can be formed from $\bar{q}q$. Note that half of the J^P states can be formed by both a triplet and a singlet $\bar{q}q$ state, e.g., $^3P_1$, $^1P_1$ or $^3D_2$, $^1D_2$. Eq. (3) shows that $^3P_1$ and $^1P_1$ have opposite C_n, so the $\bar{q}q$ model allows both. But the states $^3P_0$ and $^3P_2$ have no ^1P counterparts. According to Eq. (6) they have $C_nP=+1$, and with the $\bar{q}q$ model there is no way to form a state with a J^P of $^3P_{0,2}$ (i.e., J^P = Normal) and with $C_nP=-1$. As mentioned, such octets have not shown up. With the help of Table I one can also see that the special state $^1S_0$, $C_nP=+1$, cannot be formed, so has Abnormal C.

2. General remarks

Well-established quantum numbers are underlined in the Tables of Particle Properties (except for stable particles, where most of the quantum numbers are established). We have used flimsy evidence to guess many of the remaining ones, and we have indicated with "?" ones (in the baryon table) for which there is almost no evi-

[1]Most texts define it as in Eq. (1); see, e.g., Gasiorowicz (1966); however, sometimes the rotation is taken about I_x. The difference between the two conventions is mentioned in a footnote in Källen (1964).

TABLE I. $I^G(J^P)$ of non-strange mesons from $\bar{q}q$ model. For the distinction between abnormal J^P and abnormal C, see text following Eq. (6). K mesons share the same values of J^P as the $I=0$ and 1 states shown, but are not eigenstates of G. The middle column, which gathers together $(J^P)_{\mathrm{N\,or\,A}}\,CP$, is a redundant intermediate step intended to make the table easier to read.

Parity	$\bar{q}q$ State CP −	$\bar{q}q$ State CP +	(J^P) CP (Normal or abnormal)	$I^G(J^P)C_n$	Examples and comments
Parity −	$^1S_0$		$(0^-)_A-$	$0^+(0^-)+$	η, η', E ?
				$1^-(0^-)+$	π
		$^3S_1$	$(1^-)_N+$	$0^-(1^-)-$	ω, ϕ
				$1^+(1^-)-$	ρ
Parity +	$^1P_1$		$(1^+)_A-$	$0^-(1^+)-$	
				$1^+(1^+)-$	B
		$^3P_0$	$(0^+)_N+$	$0^+(0^+)+$	ϵ, S*
				$1^-(0^+)+$	δ ?
		$^3P_1$	$(1^+)_A+$	$0^+(1^+)+$	D ?
				$1^-(1^+)+$	A1
		$^3P_2$	$(2^+)_N+$	$0^+(2^+)+$	f, f'
				$1^-(2^+)+$	A2
Parity −	$^1D_2$		$(2^-)_A-$	$0^+(2^-)+$	
				$1^-(2^-)+$	A3
		$^3D_1$	$(1^-)_N+$	same as $^3S_1$	ρ'
		$^3D_2$	$(2^-)_A+$	$0^-(2^-)-$	Regge recurrence of the abnormal-C state
				$1^+(2^-)-$	$(J^P)C_n = (0^-)-$
		$^3D_3$	$(3^-)_N+$	$0^-(3^-)-$	
				$1^+(3^-)-$	g
Parity +	$^1F_3$		$(3^+)_A-$	J > 2	
		$^3F_2$	$(2^+)_N+$	same as $^3P_2$	
		$^3F_3$	$(3^+)_A+$	J > 2	
		$^3F_4$	$(4^+)_N+$	etc.	

ABNORMAL C STATES THAT CANNOT COME FROM $\bar{q}q$ MODEL

Abnormal C states Have no $\bar{q}q$ model	$(0^-)_A+$	$0^-(0^-)-$	All except $J^P = 0^-$ are J^P = normal, CP = −1
		$1^+(0^-)-$	
	$(1^-)_N-$	$0^+(1^-)+$	
		$1^-(1^-)+$	
	$(0^+)_N-$	$0^-(0^+)-$	
		$1^+(0^+)-$	
	$(2^+)_N-$	$0^-(2^+)-$	
		$1^+(2^+)-$	
	$(3^-)_N-$	$0^+(3^-)+$	
		$1^-(3^-)+$	

dence.

As is customary, we define antiparticles as the result of operating with *CPT* on particles, so both share the same spins, masses, and mean lives. Whenever there is a particularly interesting test of *CPT* invariance we include it in the Stable Particles Table.

B. Particle names

If a *meson* has a well-accepted colloquial name, we use it. If not, we name it by a single symbol which specifies its baryon number B (=0 for mesons), its isospin I, its hypercharge Y, and, for a nonstrange meson its G parity. For convenience, we also list the strangeness S, which is related to Y and B by

$$S = Y - B \ .$$

The name conventions for mesons are given in the first part of Table II.

To crowd even more information onto the symbol, we sometimes add a subscript giving J^P. If J^P is not known, but must be "Normal" ($0^+, 1^-, 2^+, \ldots$), e.g., because $K\pi$ decays are seen, we use the subscript N. If such modes are *not* seen (and are not otherwise forbidden), we *guess* that it is because J is "Abnormal", and we use the subscript A.

For *some* pairs of *mesons* with supposedly identical quantum numbers, we also use primes; e.g., η, η'; f, f'.

For *baryons* no attempt has been made to attach a subscript about J and P. The name conventions are given in the second part of Table II. For stable baryons of each I and Y we use the symbol standing alone; for resonances, the mass is in parentheses [i.e., $N(1688)$, $\Lambda(1405)$, $\Sigma(1765)$, etc.]. The J^P assignments are reported in the Baryon Table as $\frac{1}{2}^+, \frac{3}{2}^-, \frac{5}{2}^+$, etc., and also by the symbols P_{11}, D_{13}, F_{15}, which refer to the πp or Kp partial-wave amplitude in which the resonant state occurs (the first subscript refers to the isospin state: $2\times I$ for N and Δ and just I for Z, Λ, and Σ). When two or more baryons have identical quantum numbers we warn the reader by adding primes to the spectroscopic symbol as explained in footnote (a) of the Baryon Table.

TABLE II. Particle name conventions.

Name	I	Y	S	G
		Mesons		
η	0	0	0	+
ω or ϕ [a]	0	0	0	−
ρ	1	0	0	+
π	1	0	0	−
K^+, K^0	$\frac{1}{2}$	+1	+1	
$K^-, \bar{K}^0$	$\frac{1}{2}$	−1	−1	
		Baryons		
N	$\frac{1}{2}$	+1	0	
Δ	$\frac{3}{2}$	+1	0	
Z_0, Z_1	0, 1	+2	+1	
Λ	0	0	−1	
Σ	1	0	−1	
Ξ	$\frac{1}{2}$	−1	−2	
Ω	0	−2	−3	

[a] Since 1973, we have used the symbol ω for those $I^G = 0^-$ mesons that decay mainly into 3π [$\omega(783)$, $\omega(1670)$]; we reserve the symbol ϕ for $\phi(1020)$ and possible future higher-mass $I^G = 0^-$ mesons that decay mainly into $K\bar{K}$.

IV. CONVENTIONS AND PARAMETERS FOR STRONG INTERACTIONS

A. Partial-wave amplitudes and resonance parameters

The vast majority of information concerning baryon resonances comes in the form of partial-wave analyses. In addition data concerning meson resonances ($\pi\pi, K\pi, \pi\pi\pi$) are, with increasing frequency, being subjected to partial-wave analyses. We thus find it natural to introduce the resonance parameters which we compile in terms of a Breit–Wigner approximation for the partial-wave amplitude.

In general the elastic amplitude for a given angular momentum l may be written as

$$T_{11} = \frac{\eta \exp(2i\delta) - 1}{2i} \ , \tag{1}$$

where η is referred to as the absorption parameter ($0 \leq \eta \leq 1$) and δ, as the phase shift. The subscripts 11 on T denote scattering from channel 1 to channel 1 (i.e., $\pi\pi \to \pi\pi$ or $\bar{K}N \to \bar{K}N$).

In Fig. 1 we show an Argand plot of the elastic partial wave amplitude T_{11}. It illustrates geometrically how the real parameters η and δ are related to the real and imaginary parts of T_{11}. Many examples of such Argand plots may be found in the Baryon Data Card Listings.

Consider the so-called non-relativistic Breit–Wigner approximation for T_{11}:

$$T_{11} = \tfrac{1}{2}\Gamma_1/(M - E - \tfrac{1}{2}i\Gamma) \tag{2}$$

where E is the c.m. energy of invariant mass, Γ_1 and Γ are the *elastic* and *total* widths, and M is called the *resonance mass*. Equation (2) is, of course, not the only possible description of a resonant amplitude; it suffices to illustrate the properties of partial-wave amplitudes which we associate with resonance behavior in the absence of any background in the same partial wave (see, e.g., the πN D_{15} and F_{15} waves in the Baryon Data Card Listings). Usually the widths contain barrier-

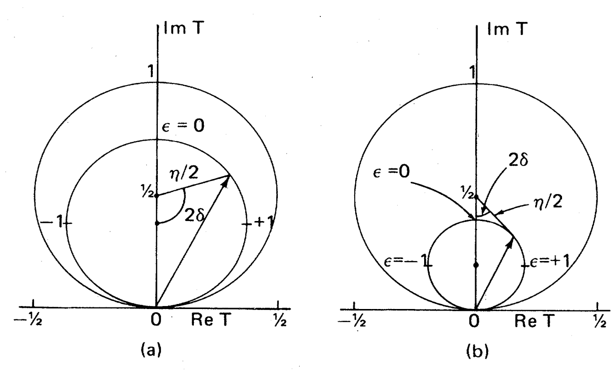

FIG. 1. Argand plots for the partial wave amplitude T_{11}. The outer circles are the unitarity bound ($\eta = 1$). The inner circles correspond to the Breit-Wigner approximation of Eq. (2) for (a) $x_1 = \Gamma_1/\Gamma = 0.75$ and (b) $x_1 = 0.4$. Note: $\epsilon = 2(M - E)/\Gamma$.

penetration factors which can vary rapidly with energy. Near threshold, $\Gamma_1(E)$ should start up as q^{2l+1} (also true for the inelastic width Γ_β). Various E dependences are then used for Γ_1, mostly of the form

$$\Gamma_1(E) \propto \frac{(qR)^{2l+1}}{\text{const.} + \cdots + (qR)^{2l}} , \tag{3}$$

see Jackson (1964), Pišút and Roos (1968), and Barbaro-Galtieri (1968).

The BW-approximation to the amplitude for an inelastic process leading from channel 1 to channel β ($\pi\pi \to \bar{K}K$ or $KN \to \Sigma\pi$, for example), is

$$T_{1\beta} = \tfrac{1}{2}(\Gamma_1\Gamma_\beta)^{1/2}/(M - E - \tfrac{1}{2}i\Gamma) = (x_1 x_\beta)^{1/2}[\tfrac{1}{2}\Gamma/(M - E - \tfrac{1}{2}i\Gamma)] , \tag{4}$$

where

$$\Gamma = \sum_1^N \Gamma_\beta, \quad x_\beta = \Gamma_\beta/\Gamma , \tag{5}$$

and x_1 (called the elasticity) is often written x_e. (Note that in the Data Card Listings we use the symbol P_β to denote x_β.) The channel cross-section $\sigma_{1\beta}$ for the reaction $1 \to \beta$, for spin 0-spin $\frac{1}{2}$ scattering, is

$$\sigma_{1\beta} = 4\pi\lambda\!\!\!^{-2}(J + \tfrac{1}{2})\,|T_{1\beta}|^2 , \tag{6}$$

where $J = l \pm \frac{1}{2}$.

The important features of Eq. (4) which characterize resonant behavior in the Argand diagram ($\text{Im}\,T_{1\beta}$ versus $\text{Re}\,T_{1\beta}$) are:

(1) Energy variation given by circles with diameter $(x_1 x_\beta)^{1/2}$ and maximum amplitude at $E = M$ of

$$T_{1\beta}^{\max} = i(x_1 x_\beta)^{1/2} . \tag{7}$$

(2) A maximum in the speed near resonance, given approximately by

$$\text{“Speed”(res)} = |dT_{1\beta}/dE|_{E=M} = \frac{2(x_1 x_\beta)^{1/2}}{\Gamma(E)} , \tag{8}$$

for slowly varying $\Gamma(E)$. These features may be related to the η, δ representation of T_{11}. Thus when $E = M$, δ is either $90°(x_1 > \frac{1}{2})$ or $0°(x_1 < \frac{1}{2})$ and η dips to its minimum value.

These simple properties can be used to judge the presence or absence of resonance behavior in an Argand plot. However, it must be kept in mind that Eqs. (2) and (4) are only approximations to the “true” amplitude. The simple picture given above can be distorted by various effects:

- the presence of “background” in the same partial wave as the resonance
- two resonances in the same partial wave overlapping in energy
- the resonant energy M being close to an inelastic channel threshold, in which case a K-matrix-like parametrization is more appropriate.

B. SU(3) sign conventions for Λ and Σ resonances

Consider the partial width Γ_β of a resonance decaying into the channel β. We can always define a coupling constant such that

$$\Gamma_\beta \propto G_\beta^2 .$$

In this case the inelastic amplitude in the Breit–Wigner approximation, Eq. (4) will go as

$$T_{1\beta} \propto G_1 G_\beta/(M - E - \tfrac{1}{2}i\Gamma) ,$$

where G_1 is the coupling constant for the elastic channel. In the context of exact SU(3) symmetry the relative signs of the product $G_1 G_\beta$ for different resonances are often useful as a consistency check on SU(3) assignment of Λ and Σ resonances. See Appendix II for further details.

In the Data Card Listings for Λ and Σ resonances, we tabulate measured values for $(x_1 x_\beta)^{1/2} \propto G_1 G_\beta$. Whenever there is an explicit sign, it will be according to the convention advocated by Levi-Setti (1969) and used in the table of SU(3) Isoscalar Factors presented in this review. Thus the signs multiplying the Breit–Wigner amplitudes for $\bar{K}N \to \Sigma(1385) \to \Sigma\pi$, $\Lambda\pi$ and $\bar{K}N \to \Lambda(1405) \to \Sigma\pi$ are simply the product of the phases of the appropriate isoscalar factors. This convention is shown in Fig. 2 from Levi-Setti (1969).

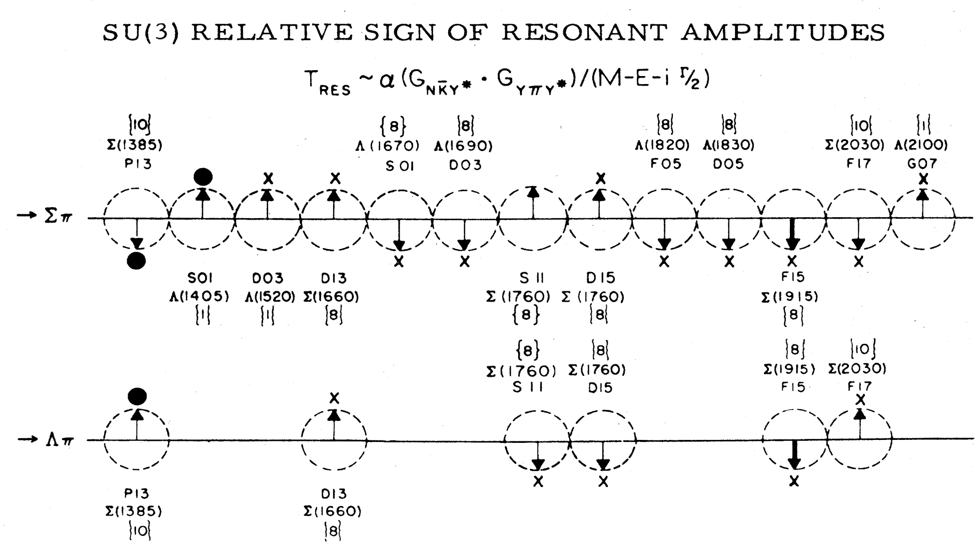

FIG. 2. Plot adapted from Levi-Setti (1969) showing the sign convention adopted here for the Σπ and Λπ amplitudes. Once the signs of one $I = 0$ and one $I = 1$ amplitude are fixed, the others can be measured relative to these two. Arrows here indicate signs predicted by SU(3); × marks indicate the observed phases; ● indicates phase chosen according to sign convention described in text. The Σ(1915) predictions have been changed from Levi-Setti's original figure.

C. Types of partial-wave analyses

Partial-wave analyses (PWA) are classified into three categories in the Data Card Listings: energy-independent partial-wave analyses (IPWA), energy-dependent partial-wave analyses (DPWA), and model-dependent partial-wave analyses (MPWA), in increasing order of the number of explicit supplementary hypotheses that are used to extract the amplitudes from experimental data.

In an IPWA, data at different energies are analyzed separately. Usually each partial wave included in the fit is allowed to vary freely (subject to unitarity constraints) over some large region, and waves whose angular momenta are above some cutoff value are assumed to be negligible. The sharp cutoff in angular momentum resolves continuum ambiguities in the solution (such as the overall phase ambiguity), but there remains a finite number of indistinguishable "best" solutions (i.e., solutions corresponding to identical physical observables) which have been codified by Barrelet (1972). In addition, there are generally some nearby solutions (and their associated Barrelet ambiguities) which have chi-squared values close to the minimum one.

At the end of the analysis a choice is made among these many solutions, usually on the basis of energy continuity. A popular criterion for making this choice is the shortest path technique in which the total "length" of the preferred solution is chosen to be a minimum. The definition of "length" used here is not universal but is usually closely related to the total geometrical length of the lines representing the various partial-wave amplitudes in Argand plots (see the Baryon section of the Data Card Listings for examples of Argand plots). Various other criteria which are also used in some analyses are, e.g., matching with known solutions at low energies, the presence of known resonances in the final results, and limited inelasticity in high partial waves.

In a DPWA, data at different energies are fit simultaneously by using an energy dependent parametrization of the partial-wave amplitudes. The parametrization is usually chosen to include both resonances and nonresonant background of some sort and an attempt is made to keep it as "model independent" as possible. Often the data are grouped into several energy bins which are fit separately rather than trying to fit the whole energy range under consideration simultaneously. One of the main advantages of DPWA over IPWA is that sparse data spread over many different energies can be analyzed, e.g., nearly all $S=-1$ analyses are DPWA. In addition, the built-in energy continuity helps to resolve the ambiguities that plague IPWA and eases the problems associated with resonance parameter extraction. The price one pays for these advantages lies in the danger of systematic error in the amplitudes and poor fits to the data if the parametrization is poorly chosen or insufficiently flexible.

An MPWA also uses an energy-dependent parametrization, but one based on explicit model-dependent theoretical assumptions such as Regge exchanges. This technique is usually applied to reactions where the data are incomplete. There is, of course, no sharp distinction between DPWA and MPWA, and a well chosen MPWA parametrization may actually be less biased than a model-independent but poorly chosen DPWA parametrization.

D. Production of resonances

Hereby, we mean the observation of statistically significant peaks in invariant mass plots or, loosely, in integrated cross sections. Many meson resonances are of this type. We expect most of these peaks to be associated with Breit–Wigner behavior in appropriate Argand plots; thus the ρ meson peak in $\pi\pi$ mass plots is firmly related to the $I=1$, $l=1$ $\pi\pi$ phase shift passing through 90°.

From mass plots we can determine M, Γ, and the approximate branching ratios

$$x_\alpha / x_\beta = \Gamma_\alpha / \Gamma_\beta \ . \tag{9}$$

In the case of total cross sections, the peak above background gives us, using the optical theorem, the product $(J+\frac{1}{2})x_e$:

$$\sigma^{\text{tot}}(E=M) = 4\pi ƛ^2 (J+\tfrac{1}{2}) x_e \ . \tag{10}$$

V. CRITERIA FOR RESONANCES

An experimentalist who sees indications of a resonance in some energy (or mass) region will of course want to know what has been seen in that region in the past; hence, we strive to have the Data Card Listings serve as an archive for all substantial claims or evidences for resonances.

For the Tables of Particle Properties, on the other hand, we wish to be more conservative and to include only those peaks or resonances which we feel have a large chance of survival. An arrow (→) at the left of the Tables of Particle Properties indicates that a questionable candidate has been omitted from the Table, but that it can be found in the corresponding part of the Data Card Listings. One's betting odds for survival are of course subjective; therefore no precise criteria can be defined. In what follows we shall attempt to specify some guide lines.

(a) When energy-independent partial-wave analyses are available (mostly for N^*'s), approximate Breit–Wigner behavior of the amplitude appears to us to be the most satisfactory test for a resonance. We can check that the Argand plot follows roughly a left-hand circle, and that the "speed" of the amplitude also shows a maximum near the resonance energy; further, there should be data well above the resonance, showing that the speed again decreases. Indeed proper behavior of the partial-wave amplitude could accredit a resonance even if its elasticity is too small to make a noticeable peak in the cross section.

Of course even if Argand plots are available, it may still be a matter of opinion as to what behavior constitutes a resonance. Such an example is the $Z_0(1780)$ state seen in KN total cross-section experiments and in partial-wave analysis. The recent partial-wave analyses of Giacomelli (1974) and Martin (1975) find preferred solutions which exhibit a resonance-like loop in the P_{01} wave near 1740 MeV (see Fig. 5 of the $S=+1$

mini-review in the Baryon Data Card Listings). However, Giacomelli *et al.* and Martin point out that, despite the resonant-like *appearance* of the loop, the evidence for resonant *energy dependence* is inconclusive. Thus we omit the $Z_0(1780)$ from the Baryon Table. A similar quandary has existed for some time concerning the $Z_1(1900)$, and it too has been omitted from the Tables.

(b) When there are insufficient data to perform energy-independent analyses, one often resorts to energy-dependent partial-wave analyses (mostly for Y^*'s). In this case Breit–Wigner behavior is an input. We therefore require that resonance solutions be found by several different analyses, preferably in different channels ($\bar{K}N \to \bar{K}N$, $\pi\Sigma$, etc.), before putting the claim in the table.

(c) Partial-wave analyses of three-body final states ($\pi N \to \pi\pi N$) are becoming available. While these analyses are based on the isobar model ($\pi N \to \rho N$, $\pi\Delta$, etc.) and are subject to theoretical objections of varying importance, they provide increasingly reliable information on inelastic decay modes of otherwise established resonances.

(d) Most mesons, Ξ^* peaks, and high mass N^* and Y^* peaks fall into a category for which no partial-wave analyses exist. In general we accept such peaks if they are experimentally reliable, of high statistical significance or if they are observed in several different production processes.

(e) A special category of "diffractive mesons" consists of statistically significant peaks like A_1, A_3 or Q, which are not far above the $\rho\pi$, $f\pi$, or $K^*\pi$ thresholds. The question of a resonance interpretation for these states is complicated, because the behavior near threshold in these channels may be described by the Deck effect. Modern partial-wave analyses can shed considerable light on these problems. See the mini-reviews for details.

Thus, we enter into the tables of Particle Properties only states for which there is experimentally convincing evidence, and we expect that most of these will be confirmed as resonances.

VI. CONVENTIONS AND PARAMETERS FOR WEAK AND ELECTROMAGNETIC DECAYS

A. Muon-decay parameters

The μ-decay parameters describe the momentum spectrum (ρ and η), the asymmetry (ξ and δ), and the helicity (h) of the electron in the process $\mu^\pm \to e^\pm + \nu + \bar{\nu}$. Assuming a local and lepton-conserving interaction, the matrix element may be written as

$$\sum_i \langle \bar{e} | \Gamma_i | \mu \rangle \langle \bar{\nu} | \Gamma_i (C_i + C_i' \gamma_5) | \nu \rangle \ ,$$

where the summation is taken over $i = S, V, T, A, P$. Using the definitions and sign conventions of Kinoshita and Sirlin (1957), we have for the momentum parameters

$$\rho = [3g_A^2 + 3g_V^2 + 6g_T^2]/D \ ,$$

$$\eta = [g_S^2 - g_P^2 + 2g_A^2 - 2g_V^2]/D \ ,$$

for the asymmetry parameters:

$$\xi = \frac{6g_S g_P \cos\phi_{SP} - 8g_A g_V \cos\phi_{AV} + 14 g_T^2 \cos\phi_{TT}}{D} \ ,$$

$$\delta = [-6g_A g_V \cos\phi_{AV} + 6g_T^2 \cos\phi_{TT}]/D\xi \ ,$$

and for the parameter describing the helicity of the electron:

$$h = \frac{2g_S g_P \cos\phi_{SP} - 8g_A g_V \cos\phi_{AV} - 6g_T^2 \cos\phi_{TT}}{D} \ .$$

Here

$$D = g_S^2 + g_P^2 + 4g_V^2 = 6g_T^2 + 4g_A^2 \ ,$$

$$g_i^2 = |C_i|^2 + |C_i'|^2 \ ,$$

and

$$\cos\phi_{ij} = \mathrm{Re}(C_i^* C_j' + C_i' C_j^*) \ .$$

The quantities g_i are defined to be real non-negative numbers, and the ϕ_{ij} are phase angles between the i-type and j-type interactions. Under the assumption of two-component neutrinos $C_i' = -C_i$ and $C_j' = -C_j$, the S, P, and T terms vanish, and ϕ_{AV} is the phase angle between C_A and C_V in the complex plane.

By using the above equations and the experimental determinations of ρ, η, ξ, δ, and h, limits can be placed on g_S/g_V, g_A/g_V, g_T/g_V, g_P/g_V, and ϕ_{AV}. The results, given in the Data Card Listings assume neither two-component neutrinos nor time-reversal invariance. If, however, two-component neutrinos are assumed, then $\sin\phi_{AV}$ is the amplitude of time-reversal violation. Note that most experiments study only the upper end of the spectrum where ρ and η are highly correlated, so they can only report ρ for $\eta \equiv 0$ and η for $\rho \equiv \frac{3}{4}$. The values for ρ and η we use here were obtained by combining measurements of both upper and lower ends of the spectrum and turn out to be nearly uncorrelated.

Note also that the radiative corrections are unambiguous only when $g_S = g_T = g_P = 0$. The same limits on g_A/g_V and ϕ_{AV} are obtained, however, as when g_S, g_T, and g_P are left free.

Current values for the asymmetry parameters as well as $|g_A/g_V|$ and ϕ_{AV} are given in the Addendum to the Stable Particle Table. In addition, upper limits on $|g_S/g_V|$, $|g_T/g_V|$ and $|g_P/g_V|$ are given in the μ section of the Stable Particle Data Card Listings.

B. *K*-decay parameters

1. Dalitz plot for $K \to 3\pi$ decays

The small deviation from uniformity of the Dalitz plot for the 3π decay of the K meson is usually described by a "slope parameter" (Dalitz, 1956). For the τ and τ' decays of the charged K's, and the τ^0 decay mode of the K_L^0, we parametrize the Dalitz plot distribution by the expression

$$|M|^2 \propto 1 + g\,\frac{s_3 - s_0}{m_{\pi^+}^2} + h\left(\frac{s_3 - s_0}{m_{\pi^+}^2}\right)^2 + j\,\frac{s_2 - s_1}{m_{\pi^+}^2} + k\left(\frac{s_2 - s_1}{m_{\pi^+}^2}\right)^2 + \cdots \ , \qquad (1)$$

where $m_{\pi^+}^2$ has been introduced so as to make the coefficients g, h, j, and k dimensionless, and

$$s_i = (P_K - P_i)^2 = (m_K - m_i)^2 - 2m_K T_i \ , \quad i = 1, 2, 3$$

$$s_0 = \frac{1}{3}\sum_i s_i = \tfrac{1}{3}(m_K^2 + m_1^2 + m_2^2 + m_3^2) \ .$$

Here the P_i are 4-vectors, m_i and T_i are the mass and kinetic energy of the ith pion, and the index 3 is used for the odd pion.

The coefficient g is a measure of the slope in the variable s_3 (or T_3) of the Dalitz plot, while h and k measure the quadratic dependence on s_3 and $(s_2 - s_1)$, respectively. The coefficient j is related to the asymmetry of the plot and must be zero if CP invariance holds. Note also that if CP is good, g must be the same for τ^+ and τ^-, and similarly for h and k.

At present there is no compelling experimental evidence for the h, k, or j term (for upper limits on the j term, see Sec. B.3(b) below). Thus we stop the above expansion at the first term and list only g. Since different experiments use different forms for $|M|^2$, in order to compare the experiments we have converted to g whatever coefficients have been measured. See the mini-review in the $K^\pm$ section of the Stable Particle Data Card Listings for details on this point. The results are given in the Addendum to the Stable Particle Table and in the $K^\pm$ and K_L^0 sections of the Stable Particle Data Card Listings.

Relations among $\tau^\pm$, $\tau'^\pm$, and τ^0 are predicted by the $\Delta I = \frac{1}{2}$ rule. See Appendix I for these relations and a discussion of this rule.

2. Form factors in K_{l3} leptonic decays

Assuming that only the vector current contributes to these decays, we write the matrix element as

$$M \propto f_+(t)[(P_K + P_\pi)_\mu \bar{u}_l \gamma_\mu (1+\gamma_5) u_\nu] + f_-(t)[m_l \bar{u}_l (1+\gamma_5)\mu_\nu] \ , \qquad (2)$$

where P_K and P_π are the four momenta of K and π mesons; m_l is the lepton mass; f_+ and f_- are dimensionless form factors which can depend only on $t = (P_K - P_\pi)^2$, the square of the four-momentum transfer to the leptons. f_+ and f_- are relatively real if time reversal invariance holds for these decays. $K_{\mu 3}$ experiments measure f_+ and f_-, while K_{e3} experiments are sensitive only to f_+ because the presence of the lepton mass makes the f_- term negligible.

(a) $K_{\mu 3}$ experiments

Analyses of $K_{\mu 3}$ data frequently assume a linear dependence of f_+ and f_- on t, i.e.

$$f_\pm(t) = f_\pm(0)[1 + \lambda_\pm (t/m_\pi^2)] \ . \qquad (3)$$

Most $K_{\mu 3}$ data are adequately described by Eq. (3) for f_+ and a constant f_- (i.e. $\lambda_- = 0$). There are two equivalent parametrizations commonly used in these analyses:

(1) *λ_+, $\xi(0)$ Parametrization.* Analyses of $K_{\mu 3}$ data often introduce the ratio of the two form factors

$$\xi(t) = f_-(t)/f_+(t) \ .$$

The $K_{\mu 3}$ decay distribution is then described by the two parameters λ_+ and $\xi(0)$ (assuming time reversal invariance and $\lambda_- = 0$). These parameters can be determined by three different methods:

Method A: By studying the Dalitz plot or the pion spectrum of $K_{\mu 3}$ decay. The Dalitz plot density is (See, e.g. Chounet *et al.*, 1972):

$$\rho(E_\pi, E_\mu) \propto f_+^2(t)[A + B\xi(t) + C\xi(t)^2] \ ,$$

where

$$A = m_K(2E_\mu E_\nu - m_K E'_\pi) + m_\mu^2(\tfrac{1}{4}E'_\pi - E_\nu) \ ,$$

$$B = m_\mu^2(E_\nu - \tfrac{1}{2}E'_\pi) \ ,$$

$$C = \tfrac{1}{4} m_\mu^2 E'_\pi \ ,$$

$$E'_\pi = E_\pi^{\max} - E_\pi = \frac{m_K^2 + m_\pi^2 - m_\mu^2}{2m_K} - E_\pi \ .$$

Here E_π, E_μ, and E_ν are respectively the pion, muon, and neutrino energies in the kaon center of mass. The density ρ is fit to the data to determine the values of λ_+, $\xi(0)$, and their correlation.

Method B: By measuring the $K_{\mu 3}/K_{e3}$ branching ratio and comparing it with the theoretical ratio (See, e.g., Fearing *et al.*, 1970) as given in terms of λ^+ and $\xi(0)$, assuming μ-e universality.

$$\Gamma(K_{\mu 3}^\pm)/\Gamma(K_{e3}^\pm) = 0.6457 + 1.4115\lambda_+ + 0.1264\,\xi(0) + 0.0192\,\xi(0)^2 + 0.0080\lambda_+\,\xi(0) \ ,$$

$$\Gamma(K_{\mu 3}^0)/\Gamma(K_{e3}^0) = 0.6452 + 1.3162\lambda_+ + 0.1246\,\xi(0) + 0.0186\,\xi(0)^2 + 0.0064\lambda_+\,\xi(0) \ .$$

This cannot determine λ_+ and $\xi(0)$ simultaneously but simply fixes a relationship between them.

Method C: By measuring the muon polarization in $K_{\mu 3}$ decay. In the rest frame of the K, the μ is expected to be polarized in the direction $\vec{A}$ with $\vec{P} = \vec{A}/|\vec{A}|$, where $\vec{A}$ is given (Cabibbo and Maksymowicz, 1964) by

$$\vec{A} = a_1(\xi)\vec{p}_\mu - a_2(\xi)\left\{\frac{\vec{p}_\mu}{m_\mu}\left[m_K - E_\pi + \frac{\vec{p}_\pi \cdot \vec{p}_\mu}{|\vec{p}_\mu|^2}(E_\mu - m_\mu)\right] + \vec{p}_\pi\right\} + m_K \operatorname{Im}\xi(t)(\vec{p}_\pi \times \vec{p}_\mu) \ .$$

If time-reversal invariance holds, ξ is real, and thus there is no polarization perpendicular to the K-decay plane. Polarization experiments measure the weighted average of $\xi(t)$ over the t range of the experiment, where the weighting accounts for the variation with t of the sensitivity to $\xi(t)$.

(2) *λ_+, λ_0 Parametrization.* Some of the more recent $K_{\mu 3}$ analyses have parametrized in terms of the form factors f_+ and f_0 which are associated with vector and scalar exchange respectively to the lepton pair. f_0 is related to f_+ and f_- by

$$f_0(t) = f_+(t) + [t/(m_K^2 - m_\pi^2)]f_-(t) \ .$$

Here $f_0(0)$ must equal $f_+(0)$ unless $f_-(t)$ diverges at $t = 0$. The earlier assumption that f_+ is linear in t and f_- is constant leads to f_0 linear in t

$$f_0(t) = f_0(0)[1 + \lambda_0(t/m_\pi^2)] \ .$$

With the assumption that $f_0(0)=f_+(0)$, the two parametrizations, $(\lambda_+, \xi(0))$ and (λ_+, λ_0) are equivalent as long as correlation information is retained. (λ_+, λ_0) correlations tend to be less strong than $(\lambda_+, \xi(0))$ correlations.

The experimental results for $\xi(0)$ and its correlation with λ_+ are listed in the $K^\pm$ and K_L^0 sections of the Stable Particle Data Card Listings in subsection XIA, XIB, or XIC depending on whether Method A, B or C discussed above was used. The corresponding values of λ^+ are listed in subsection $L+M$.

Because current experiments tend to use the (λ_+, λ_0) parametrization, we have added a subsection $L0$ for λ_0 results. Wherever possible we have converted $\xi(0)$ results into λ_0 results and vice versa.

(b) K_{e3} experiments

Analysis of K_{e3} data is simpler than that of $K_{\mu 3}$ because the second term of the matrix element assuming a pure vector current (Eq. 2 above) can be neglected. Here f_+ is usually assumed to be linear in t, and the linear coefficient λ_+ of Eq. (3) is determined.

If we remove the assumption of a pure vector current, then the matrix element for the decay, in addition to the terms in Eq. (2), would contain

$$+2m_K(f_S\bar{u}_l(1+\gamma_5)u_\nu$$
$$+(2f_T/m_K)(P_K)_\lambda(P_\pi)_\mu\bar{u}_l\sigma_{\lambda\mu}(1+\gamma_5)u_\nu ,$$

where f_S is the scalar form factor, and f_T is the tensor form factor. In the case of the K_{e3} decays where the f_- term can be neglected, experiments have yielded limits on $|f_S/f_+|$ and $|f_T/f_+|$.

The K_{e3} results for λ_+, $|f_S/f_+|$ and $|f_T/f_+|$ are listed in the subsections $L+M$, FS, and FT respectively of the $K^\pm$ and K_L^0 sections of the Stable Particle Data Card Listings.

See also the *Note on $K_{l3}^\pm$ and K_{l3}^0 Form Factors* in the $K^\pm$ section of the Stable Particle Data Card Listings for additional discussion of the $K_{\mu 3}^0$ parameters, correlations, and conversion between parametrization and also for a comparison of the experimental results.

3. CP violation in K^0 decays

We list parameters for four different reactions in which CP can be tested [for details, see Okun and Rubbia (1967), Steinberger (1969), and Wolfenstein (1969)].

(a) $K_S\to\pi^+\pi^-\pi^0$. The quantity measured here is the ratio of amplitudes

$$A_S(K_S\to\pi^+\pi^-\pi^0)/A_L(K_L\to\pi^+\pi^-\pi^0)\equiv x+iy . \tag{4}$$

If CPT invariance holds and there is no $I=3$ state present, then x can be neglected and CP violation would be observed as a nonzero y. We give the result for Eq. (4) in the K_L^0 section of the Stable Particle Table and under Branching Ratio $R4$ in the K_S^0 section of the Stable Particle Data Card Listings. Our procedure is to assume that $x=0$, and to list $(A_S/A_L)^2$ in the form of a branching ratio.

(b) *Charge asymmetry in $K_L\to 3\pi$ decays.* As mentioned above, the presence of a term in (s_2-s_1) in expression (1) describing the Dalitz plot distribution for $\tau^\pm$, τ^0 decays of K mesons would be an indication of CP violation. Rather than listing values of the (s_2-s_1) coefficient j in Eq. (1), we choose to list $\sigma_\pm$ from the equivalent expression

$$|M|^2\propto 1+\sigma_\pm(2/\sqrt{3})(T_+-T_-)/T_{\pm\,\max}$$
$$+(CP \text{ nonviolating terms}) , \tag{5}$$

where $T_\pm$ are the kinetic energies of the charged pions. We have momentarily abandoned the form involving the Mandelstam variables s_i in favor of Eq. (5) because the latter has been consistently used by experimenters searching for CP violation. We list $\sigma_\pm$ among the CP-violating parameters at the back of the K_L^0 section of the Stable Particle Data Card Listings. Note that only upper limits have been reported for this quantity.

(c) *Asymmetry in the $K_L\to\pi^\mp l^\pm\nu$ decays.* The quantity measured and compiled here is

$$\delta=\frac{\Gamma(K_L\to\pi^-l^+\nu)-\Gamma(K_L\to\pi^+l^-\nu)}{\Gamma(K_L\to\pi^-l^+\nu)+\Gamma(K_L\to\pi^+l^-\nu)} .$$

This asymmetry violates CP invariance. If CPT is good, for a pure K_L^0 beam, δ can be written as

$$\delta=2[(1-|x|^2)/(|1-x|^2)]\mathrm{Re}\epsilon ,$$

where x is the $\Delta S=\Delta Q$-violating parameters defined in section B4, and ϵ is the parameter of the expansion

$$|K_L\rangle=[(1+\epsilon)|K\rangle-(1-\epsilon)|\bar{K}\rangle]/[2(1+|\epsilon|^2)]^{1/2}, \tag{6a}$$

$$|K_S\rangle=[(1+\epsilon)|K\rangle+(1-\epsilon)|\bar{K}\rangle]/[2(1+|\epsilon|^2)]^{1/2} . \tag{6b}$$

We give δ in the Addendum to the Stable Particle Table. In addition, in the K_L^0 CP-violation section of the Stable Particle Data Card Listings, we list δ separately for $K_L^0\to\pi\mu\nu$ and $K_L^0\to\pi e\nu$.

(d) *$K_L\to 2\pi$ decay.* The relevant parameters are

$$\eta_{+-}=A(K_L\to\pi^+\pi^-)/A(K_S\to\pi^+\pi^-)=|\eta_{+-}|\exp(i\phi_{+-}) ,$$
$$\eta_{00}=A(K_L\to\pi^0\pi^0)/A(K_S\to\pi^0\pi^0)=|\eta_{00}|\exp(i\phi_{00}) ,$$

ϵ, defined in Eqs. (6) above, and

$$\epsilon'=\tfrac{1}{2}i\sqrt{2}[\exp i(\delta_2-\delta_0)]\,\mathrm{Im}(A_2/A_0) .$$

Here, A_i and δ_i are the amplitude and phase of $\pi\pi$ scattering at the K mass, defined by

$$\langle I=0|T|K\rangle=\exp(i\delta_0)A_0 ,$$
$$\langle I=2|T|K\rangle=\exp(i\delta_2)A_2 .$$

Wu and Yang (1964) have derived the relationships

$$\eta_{+-}=\epsilon+\epsilon' ,$$
$$\eta_{00}=\epsilon-2\epsilon' .$$

We give η_{+-}, η_{00}, ϕ_{+-}, and ϕ_{00} in the Addendum to the Stable Particle Table. The phases are measured directly, whereas the magnitudes η_{+-} and η_{00} are derived parameters. We use, as far as we can, the directly measured quantities as input and calculate η_{+-} and η_{00} from the values given by our constrained fits. Therefore, if one looks at the Data Card Listings, most of the $|\eta|$ measurements appear in the form of branching ratios, with appropriate comments. We then give the values of η_{+-} and $|\eta_{00}|^2$ in a separate list at the end of the CP-violating parameters section of the K_L^0 section of the Stable Particle Data Card Listings.

4. $\Delta S = \Delta Q$ rule in K^0 decays

The relative amount of $\Delta S \neq \Delta Q$ component present is measured by the parameter x, defined as

$$x = A(\bar{K}^0 \to \pi^- l^+ \nu)/A(K^0 \to \pi^- l^+ \nu) .$$

We list $\mathrm{Re}\{x\}$ and $\mathrm{Im}\{x\}$ for both K_{e3} and $K_{\mu 3}$ at the end of the Stable Particle Data Card Listings and give values in the Addendum to the Stable Particle Table.

C. η-decay parameters

1. C-violation in η-decays

As a test of possible C-violation in electromagnetic interactions, a number of experiments have looked for possible charge asymmetries in the decays $\eta \to \pi^+\pi^-\pi^0$ and $\eta \to \pi^+\pi^-\gamma$. We list the following parameters:

(a) The left-right asymmetry

$$A = (N^+ - N^-)/(N^+ + N^-) ,$$

where $N^{(\pm)}$ means the number of events with the $\pi^{(\pm)}$ energy greater than the $\pi^{(\mp)}$ energy in the η rest frame.

(b) The sextant asymmetry

$$A_s = \frac{N_1 + N_3 + N_5 - N_2 - N_4 - N_6}{N_1 + N_2 + N_3 + N_4 + N_5 + N_6}$$

for the decay $\eta \to \pi^+\pi^-\pi^0$. The numbers refer to the sextants of the Dalitz plot [see, for example, Layter (1972)]. A_s is sensitive to an $I=0$ C-violating asymmetry.

(c) The quadrant asymmetry A_q, defined in a similar way as A_s, but with each sector of the Dalitz plot now containing $\pi/2$ rather than $\pi/3$ radians. A_q is sensitive to an $I=2$ C-violating final state.

(d) The d-wave contribution to the C-violating amplitude in the decay $\eta \to \pi^+\pi^-\gamma$. The upper limit for this contribution is measured by the parameter β, defined by

$$dN/d|\cos\theta| \propto \sin^2\theta(1 + \beta\cos^2\theta) ,$$

where θ is the angle between the π^+ and the γ in the dipion center of mass. A term proportional to $\cos^2\theta$ could also be due to p- and f-wave interference.

We list A for the decay modes $\eta \to \pi^+\pi^-\pi^0$ and $\eta \to \pi^+\pi^-\gamma$, A_s and A_q for the decay $\eta \to \pi^+\pi^-\pi^0$, and β for the decay $\eta \to \pi^+\pi^-\gamma$ in the η section of the Stable Particle Data Card Listings.

2. Dalitz plot for $\eta \to \pi^+\pi^-\pi^0$

The Dalitz plot for the decay $\eta \to \pi^+\pi^-\pi^0$ may be fit by the distribution

$$|M(x,y)|^2 \propto 1 + ay + by^2 + cx + dx^2 + exy .$$

Here,

$$x = \sqrt{3}\ (T_+ - T_-)/Q ,$$

$$y = (3T_0/Q) - 1 ,$$

T_+, T_-, T_0 are the kinetic energies of the π^+, π^-, and π^0 in the η rest system, and $Q = m_\eta - m_{\pi^+} - m_{\pi^-} - m_{\pi^0}$. The coefficient of the term linear in x is sensitive to C-violation due to an $I=0$ or $I=2$ final state. We list papers presenting determinations of the parameters a, b, c, and d in the η section of the Stable Particle Data Card Listings. However, we do not tabulate values of these parameters because the assumptions made by different authors are not compatible and do not allow comparison of the numerical values.

3. Dalitz plot for $\eta \to \pi^+\pi^-\gamma$

The Dalitz plot for the decay $\eta \to \pi^+\pi^-\gamma$ may be fit to the expression

$$|M|^2 \propto 1 + 2\alpha z ,$$

where

$$z = \frac{2}{3}\sum_{i=1}^{3}\left[\frac{3}{m_\eta - 3m_\pi}\left(E_i - \frac{1}{3}m_\eta\right)\right]^2 = \frac{\rho^2}{\rho^2_{\max}} .$$

Here E_i is the energy of the ith pion in the η rest frame, and ρ is the distance to the center of the Dalitz plot. We list the parameter α in the η section of the Stable Particle Data Card Listings.

D. Baryon-decay parameters

1. A/V ratio for baryon leptonic decays

Consider the decay

$$B_i \to B_f + l + \nu .$$

Assuming V,A theory, neglecting "induced" scalar, "induced" pseudoscalar, and axial weak-magnetism terms, and neglecting the q^2 dependence of the form factors, the baryon part of the matrix element for these decays may be written (Goldberger and Treiman, 1958) as

$$\langle B_f|\gamma_\lambda(g_V - g_A\gamma_5) + (g_W/m_{B_i})\sigma^{\lambda\nu}q_\nu|B_i\rangle ,$$

where B_i and B_f represent initial and final baryons, g_A and g_V the axial and vector coupling constant, g_W the weak magnetism coupling constant, and q_ν the sum of the lepton momenta. Here the Pauli representation is used for the γ matrices. The definition of g_A/g_V is

$$g_A/g_V = |g_A/g_V|\exp(i\delta) ,$$

where δ is $0 + n\pi$ if time-reversal invariance holds (see Jackson *et al.*, 1957).

In neutron beta decay the measurements are consistent with time reversal, so g_A/g_V is nearly real and has been considered to be such in all the baryon leptonic decays. Notice that by using the above definition of the matrix element with the Pauli representations, the value of g_A/g_V in neutron beta decay is negative.

Due to statistical limitation the weak magnetism form factor g_W is usually assumed from CVC and SU(3), so only g_A and g_V are determined experimentally. This determination is accomplished in a variety of ways:

(a) The lepton-neutrino angular correlation provides a measure of the absolute value of g_A/g_V (for relevant formulas, see, e.g., Albright, 1959).

(b) The up-down asymmetry of the lepton from polarized baryon decays provides a measure of g_A/g_V with its sign (for relevant formulas, see, e.g. Albright, 1959).

(c) The lepton spectrum, given enough statistics, provides a measure of g_A/g_V with its sign (for relevant formulas, see, e.g., Bender, 1968).

(d) The polarization of the decay baryon, from polarized or unpolarized initial baryon, also provides g_A/g_V with its sign (for formulas, see, e.g., Willis and Thompson, 1968).

We compile the ratio g_A/g_V with its sign, for those decays for which it has been measured. For the neutron beta decay we compile also the phase δ.

All the coupling constants and decay rates for baryon leptonic decays are related by Cabbibo's theory (Cabbibbo, 1964). A recent fit to this theory has been done by Roos (1974).

2. Asymmetry parameters in nonleptonic hyperon decays

The transition matrix for the hyperon decay may be written as

$$M = s + p(\vec{\sigma}\cdot\vec{q}) \;, \qquad (7)$$

where s and p are the parity-changing and the parity conserving amplitudes, respectively; $\vec{\sigma}$ is the Pauli spin operator, and $\vec{q}$ is a unit vector along the direction of the decay baryon in the hyperon rest frame.

The asymmetry parameters are defined by the relations

$$\alpha = 2\,\mathrm{Re}(s^*p)/(|s|^2+|p|^2) \;,$$

$$\beta = 2\,\mathrm{Im}(s^*p)/(|s|^2+|p|^2) \;,$$

$$\gamma = (|s|^2-|p|^2)/(|s|^2+|p|^2) \;.$$

With the transition matrix (7), the angular distribution of the decay baryon, in the hyperon rest system, is of the form

$$I = 1+\alpha\vec{P}_Y\cdot\vec{q} \;,$$

where $\vec{P}_Y = \langle Y|\sigma|Y\rangle$ is the hyperon polarization.

In the notation of Lee and Yang (1957) the polarization $\vec{P}_B$ of the decay baryon is[2]

$$\vec{P}_B = \frac{(\alpha+\vec{P}_Y\cdot\vec{q})\vec{q}+\beta(\vec{P}_Y\times\vec{q})+\gamma\vec{q}\times(\vec{P}_Y\times\vec{q})}{1+\alpha\vec{P}_Y\cdot\vec{q}}$$

where $\vec{P}_B$ is defined in that rest system of the baryon obtained by a Lorentz transformation along $\vec{q}$ from the hyperon rest system in which $\vec{q}$ and $\vec{P}_Y$ are defined. Note that α is the helicity of the decay baryon for unpolarized hyperons.

The three parameters α, β, and γ satisfy the relation

$$\alpha^2+\beta^2+\gamma^2 = 1 \;.$$

It is then convenient to describe hyperon nonleptonic decays in terms of the two independent parameters α and the angle ϕ defined by

$$\beta = (1-\alpha^2)^{1/2}\sin\phi \;,$$

$$\gamma = (1-\alpha^2)^{1/2}\cos\phi \;,$$

which has a more nearly Gaussian distribution than β or γ. Evidently

$$-\tfrac{1}{2}\pi \le \phi \le \tfrac{1}{2}\pi \quad \text{for } \gamma>0 \;.$$

$$+\tfrac{1}{2}\pi \le \phi \le \tfrac{3}{2}\pi \quad \text{for } \gamma<0 \;.$$

In discussing time-reversal invariance, the quantity of interest is Δ, defined by

$$\alpha = 2|s||p|\cos\Delta/(|s|^2+|p|^2) \;,$$

$$\beta = -2|s||p|\sin\Delta/(|s|^2+|p|^2) \;;$$

that is, Δ is the phase angle of s relative to p. Evidently

$$-\tfrac{1}{2}\pi \le \Delta \le \tfrac{1}{2}\pi \quad \text{for } \alpha>0 \;,$$

$$+\tfrac{1}{2}\pi \le \Delta \le \tfrac{3}{2}\pi \quad \text{for } \alpha<0 \;.$$

Under the assumption of time-reversal invariance, the angle Δ must satisfy the relation

$$\Delta = \delta_s - \delta_p \;,$$

modulo π, where δ_s and δ_p are the pion-baryon scattering phase shifts at the appropriate energy and for the appropriate isospin state. For Λ decay, assuming the validity of the $|\Delta I| = \frac{1}{2}$ rule,

$$\Delta = \delta_s - \delta_p = (6.8 \pm 2.0)\ \mathrm{deg.}^3$$

In the Stable Particle Data Card Listings we give α and ϕ for each decay since they are the most closely related to the experiments and are essentially uncorrelated. Whenever necessary we have changed the signs of the reported values, so as to agree with our conventions. In the Stable Particle Table we give α, ϕ, and Δ with errors; and for convenience we also give the central value of γ, without an error.

VII. STATISTICAL PROCEDURES

We divide this discussion on obtaining averages and errors into two sections:

A. the unconstrained case, or "simple averaging", and
B. the constrained case.

In what follows, the term "error" means one standard deviation (1σ); that is, for central value $\bar{x}$ and error $\delta\bar{x}$, the range $\bar{x} \pm \delta\bar{x}$ constitutes a 68.3% confidence interval.

A. Unconstrained averaging

We first describe the standard procedure which we have used for several years to determine averages and errors. We will then discuss a second method, newly proposed, which we feel offers a less conservative, and possibly more accurate, estimate of errors.

1. Standard procedure—Gaussian distribution with scale factor

We begin by assuming that measurements of a given quantity obey a Gaussian distribution, and thus we calculate a weighted average and error

[2]Note that Lee and Yang (1957) contains a misprint. The minus sign in the definition of β should be replaced by a 2. In addition, our unit vector $\vec{q}$ is the direction of the baryon, whereas their unit vector $\vec{p}$ is the direction of the pion.

[3]This value for $\delta_s - \delta_p$ is derived from the phase-shift analyses by Roper *et al.* (1965). The error is our estimation of the uncertainty.

$$\bar{x} \pm \delta\bar{x} = \left(\sum_i w_i x_i \Big/ \sum_i w_i\right) \pm \left[1 \Big/ \left(\sum_i w_i\right)\right]^{-1/2}, \quad w_i = [1/(\delta x_i)^2] , \tag{1}$$

where x_i and δx_i are the value and error, respectively, reported by the ith experiment, and the sums run over N experiments. We also calculate χ^2 and compare it with its expectation value of $N-1$.

If $\chi^2/(N-1)$ is less than or equal to 1, and there are no known problems with the data, we accept the above results.

If $\chi^2/(N-1)$ is ridiculously large, or if there is prior knowledge of extremely large inconsistencies between experiments, we may choose not to average the data at all. Or, in some cases, we may quote the calculated average, but then give an "educated guess" as to the error; such a guess is a generally quite conservative estimate designed to take into account known problems with the data.

Finally, if $\chi^2/(N-1)$ is greater than 1, but not to such a large extent, we still average the data, but then try to make up for this fact in two ways:

(i) We plot an ideogram to guide the reader in deciding which data he might reject before making his own selected average. An example of such an ideogram is given in Fig. 3 below. Each experiment appearing in the plot is represented by a Gaussian with central value x_i, error δx_i, and area proportional to $1/\delta x_i$. The choice of area is a somewhat arbitrary one; it is based on the assumption that an experimenter will work to reduce his systematic errors until they are slightly smaller (but seldom much smaller) than his statistical errors. Thus as a bubble-chamber physicist gets more events, he will use them both to reduce his statistical errors and to study his biases. Our confidence that a significant systematic error has not been made in his experiment, as compared with other contradictory experiments, then tends to go up as $1/\delta x_i$.

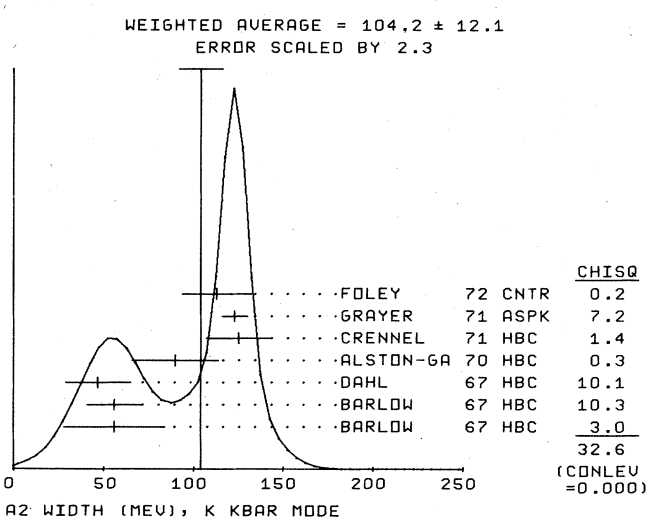

FIG. 3. Ideogram of measurements of the A_2 width, as determined from the $K\bar{K}$ mode. The vertical line indicates the position of the weighted average, while the horizontal bar atop the line gives the error in the average after scaling by the SCALE factor. Only those experiments indicated by + error flags were precise enough to be accepted in the calculation of the SCALE factor; the column on the far right gives the χ^2 contribution of each of these experiments. The less precise experiments were included in the calculation of the weighted average, but not SCALE; they have ⊥ error flags.

But why not assign a weight $1/\delta x_i^2$, as is done when computing a weighted average? We feel that this is equivalent to assuming that large systematic errors are as infrequent as large statistical fluctuations, and that this is unrealistic.

We want to emphasize the difference between least-squares averaging (where the weighting factor is the inverse square of the error) and the ideograms prepared for visual display. The former arithmetic is of course best if one has statistically distributed input, and yields a narrow Gaussian distribution centered at the weighted mean. The ideogram (often multipeaked and certainly not Gaussian) is based on the opposite hypothesis that some of the input is systematically in error. The idea behind least-squares averaging is that experiments 1, 2, 3, etc., are *all* valid (so we should multiply their probabilities); our *ideograms* are based on the assumption that 1 *or* 2 *or* 3, etc., is valid, "hedged" with $1/\delta x_i$ betting odds; we then add their probabilities. Both approaches cannot simultaneously be right; we leave it to the reader to choose. A glance at the ideogram will show, however, that the discrepancy is often not severe for reasonably distributed input.

(ii) The second way in which we try to take account of $\chi^2/(N-1)$ being greater than 1 is to scale up our quoted error $\delta\bar{x}$ in Eq. (1) by a factor

$$\mathrm{SCALE} = [\chi^2/(N-1)]^{1/2} . \tag{2}$$

Our reasoning is as follows. Since we don't know which one or more of the experiments are wrong, we assume that all experimentalists underestimated their errors by the same scale factor (2). If we scale up all input errors by this factor, χ^2 returns to $N-1$, and of course the output error scales up by the same factor.

If all the experiments have errors of about the same size, the above (straightforward) procedure for calculating SCALE is carried out. If, however, we are to combine experiments with widely varying errors, we must modify the procedure slightly. This is because it is the more precise experiments that most influence not only the average value $\bar{x}$, but also the error $\delta\bar{x}$. Now, on the average, the low-precision experiments each contribute about unity to *both* the numerator and the denominator of SCALE, hence the χ^2 contribution of the sensitive experiments is diluted, i.e., reduced. Therefore, we evaluate SCALE by using *only* experiments for which the error are not much greater than those of the more precise experiments. Explicitly, to calculate SCALE we use only the most sensitive experiments, i.e., those with errors less than δ_0, where the ceiling δ_0 is (arbitrarily) chosen to be

$$\delta_0 = 3N^{1/2}\delta\bar{x} .$$

Here $\delta\bar{x}$ is the unscaled error of the mean of all the experiments. Note that if each experiment had the same error δx_i, then $\delta\bar{x}$ would be $\delta x_i/N^{1/2}$, so each individual experiment would be well under the ceiling on SCALE.

This scaling approach has the property that if there are two values with comparable errors separated by much more than their stated errors (with or without a number of other experiments of lower accuracy), the error on the mean value $\delta\bar{x}$ is increased so that it is approximately half the interval between the two discrepant values.

We wish to emphasize the fact that our scaling procedures for *errors* in no way affect central values. In addition, if one wishes to recover the unscaled error $\delta\bar{x}$, he need only divide the given error by the SCALE factor for that error.

2. A second procedure—Student's distribution

The newly proposed method of averaging data, described in detail in Roos *et al.* (1975), relies upon an empirical determination of the distribution of the residuals for the ensemble of data appearing in the Review. The residual for the ith measurement of a quantity with average value $\bar{x}$ is defined as

$$h_i = (x_i - \bar{x})/\delta x_i .$$

Roos *et al.* select several different subsamples of the data, and show that the residuals for *each* subsample have approximately the same properties; in particular, their first few even moments are similar. Since the distributions have longer tails than a Gaussian, the authors choose to represent them by a distribution function having such a property, namely the Student distribution

$$S_n(h/c) = K\left[1 + \frac{(h/c)^2}{n}\right]^{-(n+1)/2} . \tag{3}$$

Here K is a normalization constant, and n and c are parameters which the authors then fit to the combined sample of data. The resulting empirical distribution is

$$S_{10}(h/1.11) = 0.351\left[1 + \frac{(h/1.11)^2}{10}\right]^{-11/2} . \tag{4}$$

Note that the shape of S_{10} is somewhere between that of a Gaussian ($=S_\infty$) and that of a Breit–Wigner ($=S_1$).

The proposed method of averaging the data for a given quantity then consists of finding the value of $\bar{x}$ which maximizes the log-likelihood function

$$\mathrm{Log}\mathcal{L}(\{x_i\}\,|\,\bar{x}) = \sum_i S_{10}\left(\frac{x_i - \bar{x}}{1.11\,\delta x_i}\right) ; \tag{5}$$

the sum here is again taken over all N measurements of x. The error $\delta\bar{x}$ is determined by finding the variation in $\bar{x}$ needed to decrease the log-likelihood by 1/2:

$$\log\mathcal{L}(\{x_i\}\,|\,\bar{x}) - \log\mathcal{L}(\{x_i\}\,|\,\bar{x} \pm \delta\bar{x}) = \tfrac{1}{2} . \tag{6}$$

3. Comparison of procedures

Both of the procedures described above adopt a partially empirical approach to the problem that measured values for the quantities tabulated in this Review do not exhibit the Gaussian behavior naively expected. (This problem, it should be noted, persists even when careful attempts are made to resolve difficulties and inconsistencies in the data prior to averaging.)

The first approach operates on a quantity-by-quantity basis and adjusts the error in each case so that no scaled $\chi^2/(N-1)$ is greater than 1. This is obviously rather conservative, since even if the data obeyed a Gaussian distribution, about half of the quantities would be expected to have $\chi^2/(N-1) > 1$.

The second approach, on the other hand, assumes that (provided we first eliminate quantities with obvious, known problems) all quantities have the same theoretical distribution function, namely the fairly long-tailed $S_{10}(h/1.11)$. With this supposition, if a *particular* quantity has a large χ^2, it is assumed to be just a happenstance, occasioned by a random fluctuation into the long tails, and no special scaling for this quantity is done. This procedure thus results in generally smaller, or less conservative, error estimates for quantities having $\chi^2/(N-1) > 1$. (However, it should be noted that, because of the overall scale of 1.11 appearing in the empirical Student's distribution, the errors for quantities with $\chi^2/(N-1) \leq 1$ are actually increased by about 10%.) Table III shows some comparisons of sample results from the two procedures, using data from the 1974 edition of the Review. Shifts in both $\bar{x}$ and $\delta\bar{x}$ can be observed, especially where SCALE > 1.

Since the new procedure is a significant departure from the past, we have adopted the following approach for this year: in the Data Card Listings we give the average-and-error for each quantity calculated both ways; the standard way is labeled at the left with the code "AVG," while the proposed newer way is labeled

TABLE III. Comparison of procedures.

Particle property	Pure Gaussian $\bar{x} \pm \delta\bar{x}$	Standard method: Gaussian + scale factor $\bar{x} \pm \delta\bar{x}$	SCALE	Proposed method: Student's distribution $\bar{x} \pm \delta\bar{x}$
ρ^0 mass (MeV)	770.32 ± 0.65	770.32 ± 0.91	1.4	770.37 ± 0.82
η' mass (MeV)	957.59 ± 0.24	957.59 ± 0.24	1.0	957.58 ± 0.28
ϕ mass (MeV)	1019.69 ± 0.15	1019.69 ± 0.28	1.9	1019.83 ± 0.20
$K^*(1420)$ mass (MeV)	1421.3 ± 2.3	1421.3 ± 2.3	1.0	1421.3 ± 2.6
K_L^0 mean life (10^{-8} sec)	5.158 ± 0.042	5.158 ± 0.042	1.0	5.158 ± 0.046
Σ^+ mean life (10^{-10} sec)	0.8004 ± 0.0058	0.8004 ± 0.0058	1.0	0.8004 ± 0.0064
Σ^- mean life (10^{-10} sec)	1.482 ± 0.011	1.482 ± 0.017	1.5	1.479 ± 0.013
$K^\pm \to \pi^\pm\pi^+\pi^-$ (%)	5.521 ± 0.075	5.521 ± 0.098	1.3	5.533 ± 0.089
$\Lambda \to p\pi^-$ (%)	63.99 ± 0.49	63.99 ± 0.49	1.0	63.98 ± 0.55

"STUDENT." In the Tables of Particle Properties, we continue to use the standard procedure—Gaussian with SCALE factor. As in the past, a SCALE factor greater than 1 is indicated by the appearance of "$S = \ldots$" next to the value and error.

We heartily invite your comments on the proposed Student's distribution method. They will assist us in deciding on procedures for future editions.

B. Constrained fits

Except for trivial cases, all branching ratios and rate measurements are analyzed by computer program AHR. This program makes a simultaneous least-squares fit to all the data, and outputs the partial-decay fractions $\overline{P}_i$, width Γ, partial widths Γ_i, and their error matrix.

The original version of AHR was written by J. Peter Berge. It is documented separately, and we wish here only to give the simplest nontrivial example that permits us to comment on the error matrix and the scale factor.

Assume that a state has only three partial-decay fractions, P_1, P_2, and P_3 ($\sum P_i = 1$), which have been measured in four different ratios, $R_1, \ldots, R_4$, where, e.g., $R_1 = P_1/P_2, R_2 = P_1/P_3$, etc.[4] Further assume that *each* ratio has been measured by N experiments (we designate each experiment with a subscript x, e.g., R_{1x}). Then AHR finds the best values of P_1, P_2, and P_3 by minimizing χ^2, namely

$$\chi^2 = \sum_{r=1}^{4} \left[\sum_{x=1}^{N} \left(\frac{R_{rx} - R_r(P_1, P_2, P_3)}{\delta R_{rx}} \right)^2 \right]. \tag{7}$$

In addition to the fitted values $\overline{P}_i$, the program calculates an error matrix $\langle \delta\overline{P}_i \delta\overline{P}_j \rangle$. We tabulate the diagonal elements $\delta\overline{P}_i = \langle \delta\overline{P}_i \delta\overline{P}_i \rangle^{1/2}$ [except that some errors are scaled according to Eq. (2) as discussed below]. In the listings we give the complete error matrix; we also calculate the fitted value of each ratio, for comparison with the input data, and list it below the relevant input, along with a simple unconstrained average of the same input.

Two further comments on the example above:

(1) There was no connection between measurements of the width and the branching ratios. But often we also have information on partial widths Γ_i as well as total width Γ. In this case AHR must introduce Γ as a parameter into the fit, along with the relations $\Gamma_i = \Gamma P_i$, $\sum \Gamma_i = \Gamma$. When appropriate, we tabulate the Γ_i along with the P_i, and give error matrices in the listings.

(2) Note that we do *not* allow for correlations between input data. We *do* try to pick those ratios and widths which are as independent and as close to the original data as possible.

In *asymmetric* errors, we use a continuous function of $\delta(P)^+$ and $\delta(P)^-$ in the fitting. When no errors are reported, we merely list the data for inspection.

Hyperon-decay parameters

The program AHR handles any type of input, α, Φ, Δ, β, or γ, according to the definitions of Sec. VI. If for a particular hyperon decay there are data for more than two of the decay parameters, they are analyzed by using the constraint

$$\alpha^2 + \beta^2 + \gamma^2 = 1 .$$

Inconsistent constrained data

According to our simple example, which led to Eq. (7), the double sum for χ^2 is summed over experiments $x = 1$ to N, leaving a single sum over ratios

$$\chi^2 = \sum_r \chi_r^2 .$$

Even before fitting, some of the χ_r^2 may be too large. But if we scaled them before fitting, then the scaling would move the central value, contrary to our policy. So we do not scale until after the first fit; then, knowing the fitted χ_r^2 and its expectation value $\langle \chi_r^2 \rangle$ we form SCALE factors (just as before), i.e.,

$$(\mathrm{SCALE})_r^2 = \chi_r^2 / \langle \chi_r^2 \rangle ,$$

and if any $(\mathrm{SCALE})_r$ is greater than 1, all N of the measurements of that particular ratio are equally penalized by having their errors increased by SCALE. Program AHR then recycles on all the data, those with errors unchanged as well as those with errors increased. We then get new values, $\delta\overline{P}_i'$ for the errors in the partial decay modes.

Because of the constraint ($\sum P_i = 1$) some SCALE factors may still be greater than 1 even after this second pass. If this is so, the whole procedure (i.e., increasing errors by the new SCALE factors and recycling through AHR) is repeated.

At the end of AHR's final pass we have *two* measures of the errors for the $\overline{P}_i$. One is, of course, the $\delta\overline{P}_i'$, i.e., the errors in the final fitted values $\overline{P}_i'$ which include the effects of scaling the input errors. The other measure of the errors is $(\overline{P}_i - \overline{P}_i')$, i.e., the *shift* in the central values of the ith mode between the first (unscaled) fit and the final (scaled) fit. In practice we find that on the average these two measures of the uncertainty are about equal. Rather than selecting just one or the other, our tabulated errors are given by the combination

$$(\delta\overline{P}_i)_{\mathrm{tab}} = [\delta\overline{P}_i'^2 + (\overline{P}_i - \overline{P}_i')^2]^{1/2} ,$$

where $\overline{P}_i$ is the fitted value of the ith partial-decay mode before scaling, $\overline{P}_i'$ is its value after scaling, and $\delta\overline{P}_i'$ is the error in $\overline{P}_i'$. The SCALE factors we finally list in such cases are defined by

$$(\mathrm{SCALE})_i = (\delta\overline{P}_i)_{\mathrm{tab}} / \delta\overline{P}_i .$$

However, in line with our policy of not letting SCALE affect the central values, we give the values of $\overline{P}_i$ obtained from the original (unscaled) fits. [The differences between the $\overline{P}_i$ calculated with either the scaled or the unscaled errors are, of course, always within the tabulated errors, $(\delta\overline{P}_i)_{\mathrm{tab}}$.]

VIII. A LOOK AT HISTORY

It may be said that one can estimate the age of a high energy physicist by asking him or her the mass of the

[4]We can handle any R of the form $R = \sum \alpha_i P_i / \sum \beta_i P_i'$, where α_i and β_i are constants, usually 1 or 0.

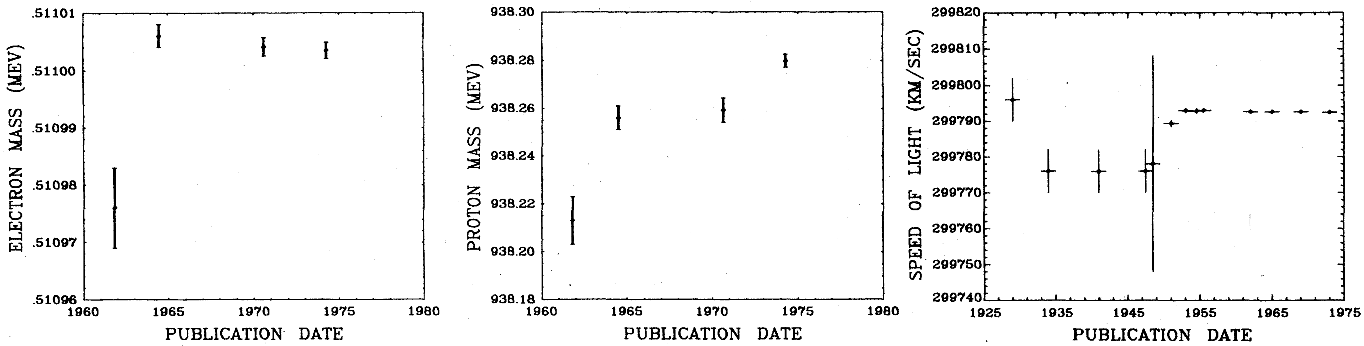

FIG. 4. The "generally accepted values" of the proton mass, the electron mass, and the speed of light, as a function of the publication data of the compilation used (not done by Particle Data Group). Data for the speed of light plot courtesy of E. R. Cohen, Rockwell International Science Center. See the Stable Particle Data Card Listings for references on proton and electron masses.

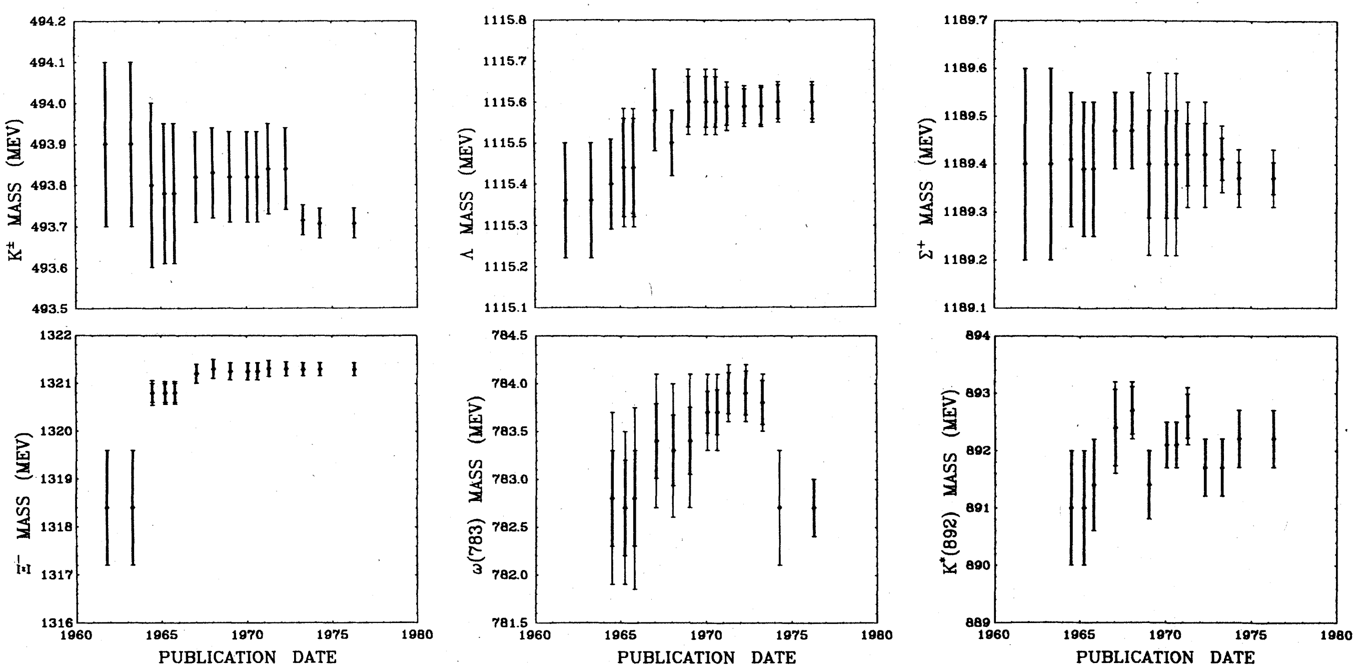

FIG. 5. Particle Data Group averages of the masses of various particles, as a function of date of publication of Review of Particle Properties (Adapted, with permission, from *Annual Review of Nuclear Science,* Volume 25.

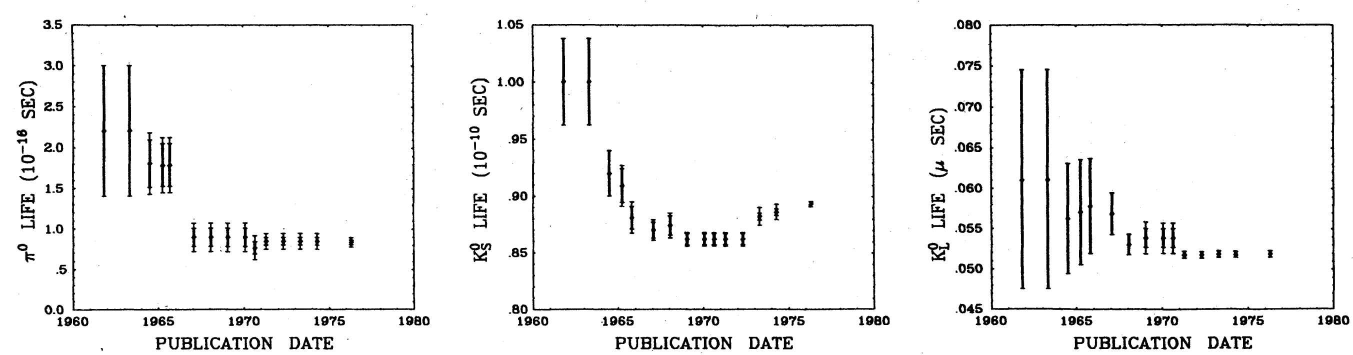

FIG. 6. Particle Data Group averages of the lifetimes of various particles, as a function of publication date of RPP.

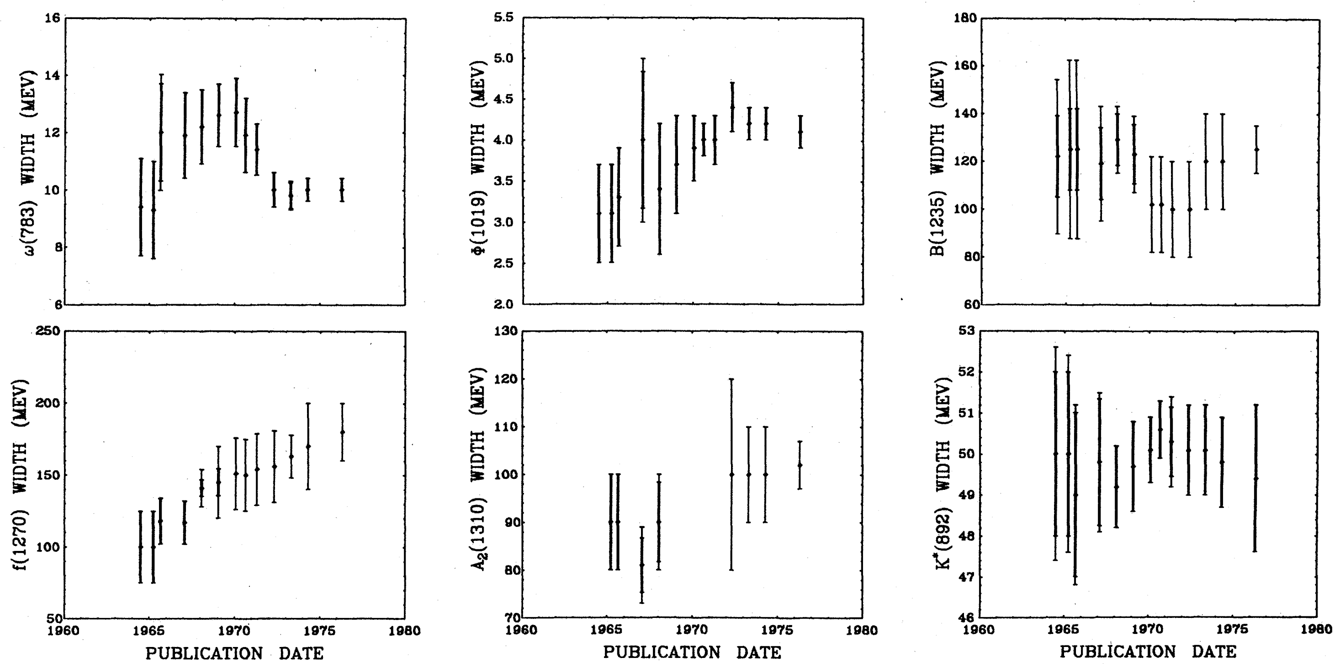

FIG. 7. Particle Data Group averages of the widths of various resonances, as a function of date of publication of RPP. The gap in the A_2 data indicates the years when the A_2 was thought to be split.

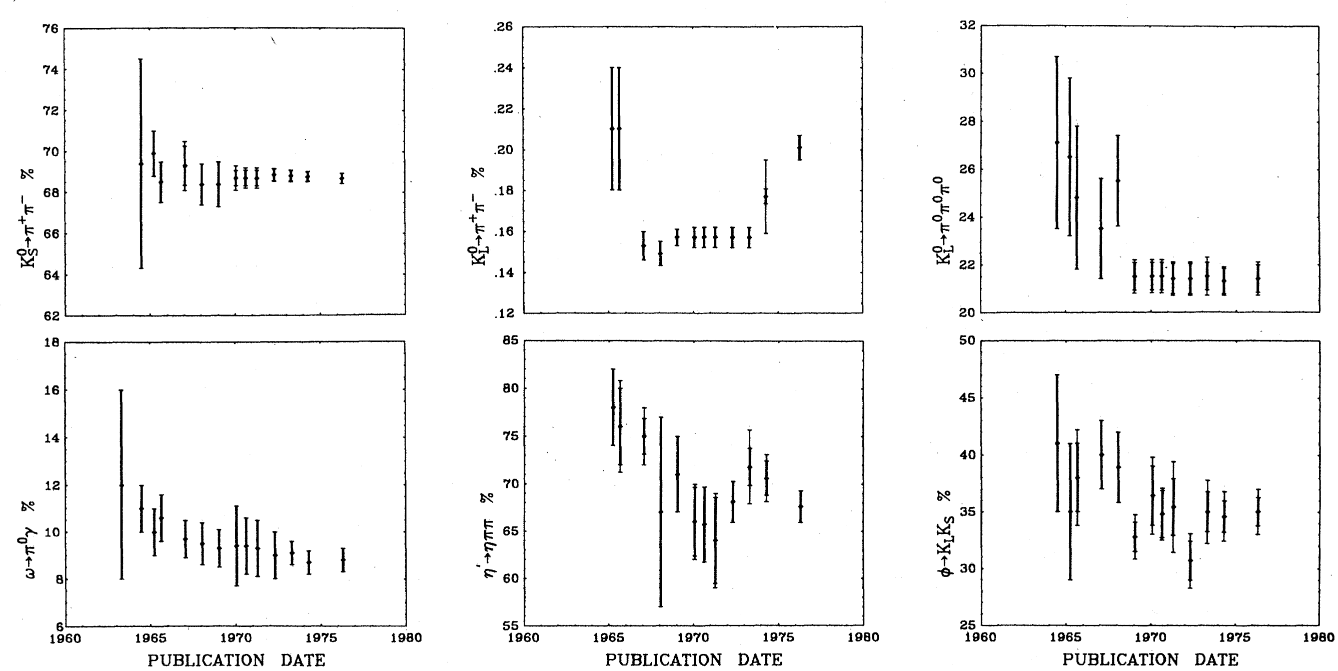

FIG. 8. Particle Data Group averages of various branching fractions, as a function of date of publication of RPP.

Λ^0. If the answer is 1115.44 MeV, he probably was deep into his graduate training in 1965.

A history of the values of physical constants has more than whimsical value. In Fig. 4 we show how the generally accepted values for the speed of light and a couple of other constants have changed with time. The "generally accepted value" is usually an average over several experiments, performed by a compiler (in Fig. 4, the compiler is other than the Particle Data Group in all cases, although we do of course quote the complied results). The x axis on all these figures is the date of publication of the value shown. Clearly there is a general progression toward better understanding—at least as measured by the size of the error bars. However, the size of the error bars do not tell the full story, as we can see by the frequency with which the "best" value has changed by more than one standard deviation. Changes in these values can come from several sources—a new experimental measurement, re-evaluation of an old measurement (which can come about if a previously unrecognized source of bias is discovered and corrected, or if a new value for one of the input constants, e.g. the electric change, is available), or a change in the averaging procedure.

In Fig. 5 we show the history of some masses (including the Λ^0, for radioactive Λ^0 dating of your colleagues), based on averages which we ourselves have performed. All of these were originally presented in Rosenfeld (1975). The publication date refers to the publication of the Review of Particle Properties.

In Fig. 6 we show the best estimates for the lifetimes of some of the particles stable against strong decay. These and subsequent figures have been compiled since publication of Rosenfeld (1975). In Fig. 7 we show the widths of some of the resonances, and in Fig. 8, the values of some of the branching fractions. All values are taken from the Tables. Before 1964, very few branching fractions were listed in the Tables. In all cases, a representative sample is chosen. In each figure, the heavy inner error bar represents the statistical error computed in the averaging procedure, and the thin outer error bars, when present, indicate the increase in the error due to the scale factor. The scale factor is described in the preceding section. It represents an attempt to quantify the increase in the uncertainty which is present in the case of experiments which disagree by more than a certain amount. In the case where the error represents an "educated guess," rather than a calculation, the inner error bar is absent.

On the whole, the number of times the values have changed by more than one standard deviation over the years is remarkably few. Even those branching fractions which involve rare decays and which are therefore presumably difficult to measure (Fig. 8) are, for the most part, within one or two standard deviations in 1974 of their value in any year since 1960. This is in spite of the vast amount of new experimental input, and indicates the general reliability of the results.

Of course, the data points for the different years are hardly independent of each other, but those differing by several years frequently have quite different experimental input. The relative lack of change is a comment both on the experiments and on the averaging procedures. We, of course, are responsible only for the averages (but not on Fig. 4). These averages entail considerable exercise of judgment: there are conflicting experiments, experiments with impossibly small errors, "preliminary" results, and so forth. Statistical procedures will tell us that two experiments do not agree; they do not give a clue as to which (if either) is a good representation of the truth. Major decisions, and their motivations, are usually discussed on a case-by-case basis in the Data Card Listings; general comments may be found in Sec. II and in Rosenfeld (1975). Note that, occasionally, the error bars increase from one publication to the next, in these figures. This is usually the result of decision making by the compiler, e.g., to cease using a particular result.

We show these figures not only to demonstrate that there is not much change in these averages in the usual case, but also to show that there exist cases with relatively large changes. There is a psychological danger in preparing tables of "right" answers. The old joke about the experimenter who fights the systematics until he or she get the "right" answer (read "agrees with previous experiments"), and then publishes, contains a germ of truth (presumably, those who compile and average experimental results are also not immune to this disease). A result can disagree with the average of all previous experiments by five standard deviations, and still be right! Hence, perhaps it is of value to show that large changes can (and do) sometimes occur.

In summary, with the addition of Figs. 7–8, not available at the time of publication of Rosenfeld (1975), we find we can reiterate his conclusions. Namely, that the combination of careful work by experimenters and by compilers (which involved excluding around 40% of the data from the averages, adjusting impossibly small errors, etc.), and the frequent use of the conservative scale factor, has produced averages whose reliability is remarkably good.

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TABLES OF PARTICLE PROPERTIES

April 1976

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R. J. Hemingway, R. L. Kelly, M. J. Losty, A. Rittenberg,
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(Closing date for data: Jan. 1, 1976)

Stable Particle Table

For additional parameters, see Addendum to this table.

Quantities in italics have changed by more than one (old) standard deviation since April 1974.

Particle	$I^G(J^P)C_n$	Mass (MeV) Mass^2 (GeV)^2	Mean Life (sec) $c\tau$ (cm)	Partial decay mode: Mode	Partial decay mode: Fraction[a]	Partial decay mode: p or p_{max}[b] (MeV/c)
γ	$0,1(1^-)-$	$0(<7\times10^{-22})$	stable	stable		
ν	$J=\frac{1}{2}$	ν_e: $0(<0.00006)$	stable	stable		
		ν_μ: $0(<0.65)$				
e	$J=\frac{1}{2}$	0.5110034	stable ($>5\times10^{21}$y)	stable		
		±.0000014				
μ	$J=\frac{1}{2}$	105.65948	*2.197134×10^{-6}*	$e\nu\bar{\nu}$	100 %	53
		±.00035	*±.000077*	$e\gamma\gamma$	(<4)$\times10^{-6}$	53
		m^2= 0.01116	$c\tau$=6.5868×10^4	3e	(<6)$\times10^{-9}$	53
		$m_\mu - m_{\pi^\pm}$ = −33.909		$e\gamma$	(<2.2)$\times10^{-8}$	53
		±.006		$e^+\bar{\nu}_e\nu_\mu$	(<25)%	53
$\pi^\pm$	$1^-(0^-)$	139.5688	2.6030×10^{-8}	$\mu\nu$	100 %	30
		±.0064	±.0023	$e\nu$	(1.267±0.023)$\times10^{-4}$	70
		m^2= 0.0195	$c\tau$=780.4	$\mu\nu\gamma$	[c](1.24±0.25)$\times10^{-4}$	30
			$(\tau^+ - \tau^-)/\bar{\tau}$=	$\pi^0 e\nu$	(1.02±0.07)$\times10^{-8}$	5
			(0.05±0.07)%	$e\nu\gamma$	[c](3.0 ±0.5)$\times10^{-8}$	70
			(test of CPT)	$e\nu e^+e^-$	(<3.4)$\times10^{-8}$	70
π^0	$1^-(0^-)+$	134.9645	0.828×10^{-16}	$\gamma\gamma$	(98.85±0.05)%	67
		±.0074	±.057 S=1.8*	γe^+e^-	(1.15±0.05)%	67
		m^2= 0.182	$c\tau$=2.5×10^{-6}	$\gamma\gamma\gamma$	(<5)$\times10^{-6}$	67
		$m_{\pi^\pm} - m_{\pi^0}$ = 4.6043		$e^+e^-e^+e^-$	[d](3.32)$\times10^{-5}$	67
		±.0037		$\gamma\gamma\gamma\gamma$	(<6)$\times10^{-5}$	67
				e^+e^-	(<2)$\times10^{-6}$	67

Stable Particle Table *(cont'd)*

Particle	$I^G(J^P)C_n$	Mass (MeV) Mass^2 (GeV)^2	Mean life (sec) $c\tau$ (cm)	Partial decay mode: Mode	Fraction[a]	p or p_{max}[b] (MeV/c)
$K^\pm$	$\frac{1}{2}(0^-)$	493.707	1.2371×10^{-8}	$\mu\nu$	(63.61±0.16)%	236
		±0.037	±.0026 S=1.9*	$\pi\pi^0$	(21.05±0.14)%	205
		m^2=0.244	$c\tau$=370.9	$\pi\pi^-\pi^+$	(5.59±0.03)% S=1.1*	125
			$(\tau^+-\tau^-)/\bar{\tau}$=	$\pi\pi^0\pi^0$	(1.73±0.05)% S=1.4*	133
			(.11±.09)%	$\mu\pi^0\nu$	(3.20±0.09)% S=1.7*	215
			(test of CPT)	$e\pi^0\nu$	(4.82±0.05)% S=1.1*	228
			S=1.2*	$\mu\nu\gamma$	[c](5.8 ±3.5)$\times10^{-3}$	236
				$e\pi^0\pi^0\nu$	(1.8 $^{+2.4}_{-0.6}$)$\times10^{-5}$	207
		$m_{K^\pm}-m_{K^0}$=−3.99		$\pi\pi^\mp e^\pm\nu$	(3.7 ±0.2)$\times10^{-5}$	203
		±0.13		$\pi\pi^\pm e^\mp\nu$	(<5)$\times10^{-7}$	203
		S=1.1*		$\pi\pi^\mp\mu^\pm\nu$	(0.9 ±0.4)$\times10^{-5}$	151
				$\pi\pi^\pm\mu^\mp\nu$	(<3.0)$\times10^{-6}$	151
				$e\nu$	(1.54±0.09)$\times10^{-5}$	247
				$e\nu\gamma$	[c](1.62±0.47)$\times10^{-5}$	247
				$\pi\pi^0\gamma$	[e,c](2.71±0.19)$\times10^{-4}$	205
				$\pi\pi^+\pi^-\gamma$	[c](1.0 ±0.4)$\times10^{-4}$	125
				$\mu\pi^0\nu\gamma$	[c](<6)$\times10^{-5}$	215
				$e\pi^0\nu\gamma$	[c](3.7 ±1.4)$\times10^{-4}$	228
				πe^+e^-	(2.6 ±0.5)$\times10^{-7}$	227
				$\pi^\mp e^\pm e^\pm$	(<1.5)$\times10^{-5}$	227
				$\pi\mu^+\mu^-$	(<2.4)$\times10^{-6}$	172
				$\pi\gamma\gamma$	[c](<3.5)$\times10^{-5}$	227
				$\pi\gamma\gamma\gamma$	[c](<3.0)$\times10^{-4}$	227
				$\pi\nu\bar{\nu}$	(<0.6)$\times10^{-6}$	227
				$\pi\gamma$	(<4)$\times10^{-6}$	227
				$e\pi^\mp\mu^\pm$	(<2.8)$\times10^{-8}$	214
				$e\pi^\pm\mu^\mp$	(<1.4)$\times10^{-8}$	214
				$\mu\nu\nu\bar{\nu}$	(<6)$\times10^{-6}$	236
K^0	$\frac{1}{2}(0^-)$	497.70	50% K_{Short}, 50% K_{Long}			
		±0.13				
		S=1.1*				
		m^2=0.248				
K^0_S	$\frac{1}{2}(0^-)$		0.8930×10^{-10} (f)	$\pi^+\pi^-$	(68.67±0.25)% S=1.1*	206
			±.0023	$\pi^0\pi^0$	(31.33±0.25)% S=1.1*	209
			$c\tau$=2.68	$\mu^+\mu^-$	(<3.2)$\times10^{-7}$	225
				e^+e^-	(<3.4)$\times10^{-4}$	249
				$\pi^+\pi^-\gamma$	[c](2.0 ±0.4)$\times10^{-3}$	206
				$\gamma\gamma$	(<0.4)$\times10^{-3}$	249
K^0_L	$\frac{1}{2}(0^-)$		5.181×10^{-8}	$\pi^0\pi^0\pi^0$	(21.4 ±0.7)% S=1.2*	139
			±.040	$\pi^+\pi^-\pi^0$	(12.25±0.18)% S=1.1*	133
			$c\tau$=1553	$\pi\mu\nu$	(27.1 ±0.5)%	216
				$\pi e\nu$	[g](39.0 ±0.5)% S=1.1*	229
				$\pi e\nu\gamma$	[g,c](1.3 ±0.8)%	229
		$m_{K_L}-m_{K_S}$= *0.5349×10^{10}* ħ sec^{-1}		$\pi^+\pi^-$	[f](*0.201±0.006*)%	206
		±0.0022		$\pi^0\pi^0$	(0.094±0.019)% S=1.5*	209
				$\pi^+\pi^-\gamma$	[c](6.0 ±2.0)$\times10^{-5}$	206
				$\pi^0\gamma\gamma$	(<2.4)$\times10^{-4}$	231
				$\gamma\gamma$	(4.9 ±0.5)$\times10^{-4}$	249
				$e\mu$	(<2.0)$\times10^{-9}$	238
				$\mu^+\mu^-$	[h](1.0 ±0.3)$\times10^{-8}$	225
				$\mu^+\mu^-\gamma$	(<7.8)$\times10^{-6}$	225
				$\mu^+\mu^-\pi^0$	(<5.7)$\times10^{-5}$	177
				e^+e^-	(<2.0)$\times10^{-9}$	249
				$e^+e^-\gamma$	(<2.8)$\times10^{-5}$	249
				$\pi^+\pi^-e^+e^-$	(<7.2)$\times10^{-6}$	206
				$\pi^0\pi^\pm e^\mp\nu$	(<2.2)$\times10^{-3}$	207
η	$0^+(0^-)+$	548.8	$^e\Gamma$=(*0.85±0.12*)keV$^{(i)}$	$\gamma\gamma$	(38.0 ±1.0)% S=1.2*	274
		±0.6	Neutral decays	$\pi^0\gamma\gamma$	[i](3.1 ±1.1)% S=1.2*	258
		S=1.4*	(71.0±0.7)%	$3\pi^0$	(29.9 ±1.1)% S=1.1*	180
		m^2=0.301	S=1.1*	$\pi^+\pi^-\pi^0$	(23.6 ±0.6)% S=1.1*	175
				$\pi^+\pi^-\gamma$	(*4.89±0.13*)% S=1.1*	236
				$e^+e^-\gamma$	(*0.50±0.12*)%	274
				$\pi^0e^+e^-$	(<0.04)%	258
				$\pi^+\pi^-$	(<0.15)%	236
			Charged decays	$\pi^+\pi^-e^+e^-$	(0.1 ±0.1)%	236
			(29.0±0.7)%	$\pi^+\pi^-\pi^0\gamma$	(<6)$\times10^{-4}$	175
			S=1.1*	$\pi^+\pi^-\gamma\gamma$	(<0.2)%	236
				$\mu^+\mu^-$	(2.2 ±0.8)$\times10^{-5}$	253
				$\mu^+\mu^-\pi^0$	(<5)$\times10^{-4}$	211

Stable Particle Table *(cont'd)*

Particle	$I^G(J^P)C_n$	Mass (MeV) Mass^2 (GeV)^2	Mean Life (sec) $c\tau$ (cm)	Partial decay mode: Mode	Fraction[a]	p or p_{max}[b] (MeV/c)
p	$\frac{1}{2}(\frac{1}{2}^+)$	938.2796	stable (>2×10^{30}y)			
		±0.0027				
		m^2= 0.8804				
n	$\frac{1}{2}(\frac{1}{2}^+)$	939.5731	918±14	$pe^-\nu$	100 %	1
		±0.0027	$c\tau$=2.75×10^{13}			
		m^2= 0.8828				
		m_p-m_n=−1.29343				
		±0.00004				
Λ	$0(\frac{1}{2}^+)$	1115.60	2.578×10^{-10}	$p\pi^-$	(64.2 ± 0.5)%	100
		±0.05	±.021 S=1.6*	$n\pi^0$	(35.8 ± 0.5)%	104
		S=1.2*	$c\tau$=7.73	$pe^-\nu$	(8.13±0.29)×10^{-4}	163
		m^2= 1.245		$p\mu^-\nu$	(1.57±0.35)×10^{-4}	131
				$p\pi^-\gamma$	c(0.85±0.14)×10^{-3}	100
Σ^+	$1(\frac{1}{2}^+)$	1189.37	0.800×10^{-10}	$p\pi^0$	(51.6 ±0.7)%	189
		±0.06	±.006	$n\pi^+$	(48.4 ±0.7)%	185
		S=1.8*	$c\tau$=2.40	$p\gamma$	(1.24±0.18)×10^{-3} S=1.4*	225
		m^2= 1.415		$n\pi^+\gamma$	c(0.93±0.10)×10^{-3}	185
				$\Lambda e^+\nu$	(2.02±0.47)×10^{-5}	71
		$m_{\Sigma^+}-m_{\Sigma^-}$= −7.98	$\frac{\Gamma(\Sigma^+\to\ell^+n\nu)}{\Gamma(\Sigma^-\to\ell^-n\nu)}$<.043 ←	$n\mu^+\nu$	(<3.0)×10^{-5}	202
		±.08		$ne^+\nu$	(<0.5)×10^{-5}	224
		S=1.2*		pe^+e^-	(<7)×10^{-6}	225
Σ^0	$1(\frac{1}{2}^+)$	1192.47	<1.0×10^{-14}	$\Lambda\gamma$	100 %	74
		±0.08	$c\tau$<3×10^{-4}	Λe^+e^-	d(5.45)×10^{-3}	74
		m^2= 1.422		$\Lambda\gamma\gamma$	(<3)%	74
Σ^-	$1(\frac{1}{2}^+)$	1197.35	1.482×10^{-10}	$n\pi^-$	100 %	193
		±0.06	±.017 S=1.5*	$ne^-\nu$	(1.08±0.04)×10^{-3}	230
		m^2= 1.434	$c\tau$=4.44	$n\mu^-\nu$	(0.45±0.04)×10^{-3}	210
				$\Lambda e^-\nu$	(0.60±0.06)×10^{-4}	79
		$m_{\Sigma^0}-m_{\Sigma^-}$= −4.88		$n\pi^-\gamma$	c(4.6 ±0.6)×10^{-4}	193
		±.06				
Ξ^0	$\frac{1}{2}(\frac{1}{2}^+)$(j)	1314.9	2.96×10^{-10}	$\Lambda\pi^0$	100 %	135
		±0.6	±.12	$\Lambda\gamma$	(0.5 ±0.5)%	184
		m^2= 1.729	$c\tau$=8.87	$\Sigma^0\gamma$	(<7)%	117
				$p\pi^-$	(<3.6)×10^{-5}	299
				$pe^-\nu$	(<1.3)×10^{-3}	323
				$\Sigma^+e^-\nu$	(<1.1)×10^{-3}	120
				$\Sigma^-e^+\nu$	(<0.9)×10^{-3}	112
		$m_{\Xi^0}-m_{\Xi^-}$=−6.4		$\Sigma^+\mu^-\nu$	(<1.1)×10^{-3}	64
		±.6		$\Sigma^-\mu^+\nu$	(<0.9)×10^{-3}	49
				$p\mu^-\nu$	(<1.3)×10^{-3}	309
Ξ^-	$\frac{1}{2}(\frac{1}{2}^+)$(j)	1321.29	1.652×10^{-10}	$\Lambda\pi^-$	100 %	139
		±0.14	±.023 S=1.1*	$\Lambda e^-\nu$	k(0.69±0.18)×10^{-3}	190
		m^2= 1.746	$c\tau$=4.95	$\Sigma^0e^-\nu$	(<0.5)×10^{-3}	123
				$\Lambda\mu^-\nu$	(3.5 ±3.5)×10^{-4}	163
				$\Sigma^0\mu^-\nu$	(<0.8)×10^{-3}	70
				$n\pi^-$	(<1.1)×10^{-3}	303
				$ne^-\nu$	(<3.2)×10^{-3}	327
				$n\mu^-\nu$	(<1.5)%	313
				$\Sigma^-\gamma$	(<1.2)×10^{-3}	118
				$p\pi^-\pi^-$	(<4)×10^{-4}	223
				$p\pi^-e^-\nu$	(<4)×10^{-4}	304
				$p\pi^-\mu^-\nu$	(<4)×10^{-4}	250
				$\Xi^0e^-\nu$	(<2.3)×10^{-4}	6
Ω^-	$0(\frac{3}{2}^+)$(j)	1672.2	$1.3^{+0.3}_{-0.2}$×10^{-10}	$\Xi^0\pi^-$	Total of 43 events seen	293
		±.4		$\Xi^-\pi^0$		290
		m^2= 2.796	$c\tau$=4.0	ΛK^-		211

ADDENDUM TO

Stable Particle Table

e	$1.001\ 159\ 6567 \pm .000\ 000\ 0035\ \frac{e\hbar}{2m_e c}$	
μ	*1.001 166 897 ±.000 000 027* $\frac{e\hbar}{2m_\mu c}$	**μ Decay parameters** (ℓ) $\rho = 0.752\pm0.003$ $\eta = -0.12\pm0.21$ $\xi = 0.972\pm0.013$ $\delta = 0.755\pm0.009$ $h = 1.00\pm0.13$ $\lvert g_A/g_V\rvert = 0.86^{+0.33}_{-0.11}$ $\phi = 180°\pm15°$

$K^\pm$

Mode	Partial rate (sec^{-1})	
$\mu\nu$	$(51.42\pm0.17)\times10^6$	S=1.2*
$\pi\pi^0$	$(17.02\pm0.12)\times10^6$	S=1.1*
$\pi\pi^+\pi^-$	$(4.52\pm0.02)\times10^6$	S=1.1*
$\pi\pi^0\pi^0$	$(1.40\pm0.04)\times10^6$	S=1.4*
$\mu\pi^0\nu$	$(2.58\pm0.07)\times10^6$	S=1.7*
$e\pi^0\nu$	$(3.90\pm0.04)\times10^6$	S=1.1*

K^0_S

Mode	Partial rate (sec^{-1})	
$\pi^+\pi^-$	n(*0.7689±.0035*)$\times10^{10}$	
$\pi^0\pi^0$	n(0.3509±.0030)$\times10^{10}$	S=1.1*

K^0_L

Mode	Partial rate (sec^{-1})	
$\pi^0\pi^0\pi^0$	$(4.13\pm0.14)\times10^6$	S=1.2*
$\pi^+\pi^-\pi^0$	$(2.36\pm0.04)\times10^6$	S=1.1*
$\pi\mu\nu$	$(5.23\pm0.10)\times10^6$	
$\pi e\nu$	$(7.52\pm0.11)\times10^6$	
$\pi^+\pi^-$	f,n(*3.88 ±0.11*)$\times10^4$	
$\pi^0\pi^0$	n(1.81 ±0.37)$\times10^4$	S=1.5*

$\Delta I = \frac{1}{2}$ rule for $K \to 3\pi$ (m)

$K^+\to\pi^+\pi^+\pi^-$ g=−0.214±.005 S=1.7*
$K^-\to\pi^-\pi^-\pi^+$ g=−0.214±.007 S=2.7*
$K^\pm\to\pi^0\pi^0\pi^\pm$ g= *0.550±.020* S=1.6*
$K^0_L\to\pi^+\pi^-\pi^0$ g= *0.646±.014* S=2.5*

Form factors for $K_{\ell 3}$ decays (For ξ, λ^μ_+, and λ^μ_0 see Data Card Listings, especially note in $K^\pm$ section.)

K^+_{e3} $\lambda^e_+=0.029\pm.004$ K^0_{e3} $\lambda^e_+=0.0288\pm.0028$ S=1.4*

CP violation parameters (o,n,f)

$\lvert\eta_{+-}\rvert=(2.272\pm.023)\times10^{-3}$ $\lvert\eta_{00}\rvert=(2.32\pm.09)\times10^{-3}$ S=1.1*
$\phi_{+-}=(45.0\pm1.2)°$ $\phi_{00}=(48\pm13)°$
$\lvert\eta_{+-0}\rvert^2<0.12$ $\lvert\eta_{000}\rvert^2<0.28$ $\delta=(0.330\pm.012)\times10^{-2}$

$\Delta S = -\Delta Q$

Re x=0.008±.020 S=1.4* Im x = −0.003±.027 S=1.2*

η

Mode	Left–right asymmetry	Sextant asymmetry	Quadrant asymmetry
$\pi^+\pi^-\pi^0$	(0.12±.17)%	(0.19±0.16)%	(−0.17±0.17)%
$\pi^+\pi^-\gamma$	(0.88±.40)%		β=0.047±0.062

	Magnetic moment ($e\hbar/2m_pc$)	Decay parameters (p)	Measured		Derived			
			α	ϕ(degree)	γ	Δ(degree)	g_A/g_V	g_V/g_A
p	2.7928456 ±.0000011							
n	−1.913148 ±.000066	$pe^-\nu$					−1.250±.009 δ=(181.1±1.3)°	
Λ	−0.67 ±.06	$p\pi^-$	0.647±0.013	(−6.5±3.5)°	0.76	$(7.6^{+4.0}_{-4.1})°$		
		$n\pi^0$	0.651±0.045					
		$pe\nu$					−0.66±0.05 S=1.2*	
Σ^+	2.62 ±.41	$p\pi^0$	−0.979±0.016	(36±34)°	0.17	(187±6)°		
		$n\pi^+$	+0.066±0.016	(167±20)°	−0.97	$(-73^{+136}_{-10})°$		
		$p\gamma$	$-1.03^{+.52}_{-.42}$	S=1.1*				
Σ^-	−1.48 ±.37	$n\pi^-$	−0.069±0.008	(10±15)°	0.98	$(249^{+12}_{-115})°$		
		$ne^-\nu$					±(0.435±0.035)	
		$\Lambda e^-\nu$						0.24±0.23 S=1.3*
Ξ^0		$\Lambda\pi^0$	−0.44±0.08 S=1.3*	(21±12)°	0.84	$(216^{+13}_{-19})°$		
Ξ^-	−1.85 ±.75	$\Lambda\pi^-$	−0.392±0.021	(2±6)° S=1.1*	0.92	(185±13)°		
Ω^-		ΛK^-	$-0.66^{+0.36}_{-0.30}$					

Stable Particle Table *(cont'd)*

*S = Scale factor = $\sqrt{\chi^2/(N-1)}$, where N ≈ number of experiments. S should be ≈ 1. If S > 1, we have enlarged the error of the mean, $\delta\bar{x}$; i.e., $\delta\bar{x} \rightarrow S\delta\bar{x}$. This convention is still inadequate, since if S >> 1 the experiments are probably inconsistent, and therefore the real uncertainty is probably even greater than $S\delta x$. See text, and ideograms in Stable Particle Data Card Listings.

a. Quoted upper limits correspond to a 90% confidence level.
b. In decays with more than two bodies, p_{max} is the maximum momentum that any particle can have.
c. See Stable Particle Data Card Listings for energy limits used in this measurement.
d. Theoretical value; see also Stable Particle Data Card Listings.
e. The direct emission branching fraction is $(1.56\pm.35)\times10^{-5}$.
f. The $\tau(K_S^0)$ and $|\eta_{+-}|$ averages (and the related $K_L^0 \rightarrow \pi^+\pi^-$ branching fraction and rate averages) contain only post-1971 results. The pre-1971 averages were $|\eta_{+-}| = (1.95\pm0.03)\times10^{-3}$ and $\tau(K_S^0) = (0.862\pm0.006)\times10^{-10}$ sec. See notes on $|\eta_{+-}|$ and $\tau(K_S^0)$ discrepancies in Stable Particle Data Card Listings.
g. The branching fraction for $K_L^0 \rightarrow \pi e\nu$ includes the radiative events $K_L^0 \rightarrow \pi e\nu\gamma$.
h. This is above the contradictory result of Clark et al. ($<0.3\times10^{-8}$). See note in Stable Particle Data Card Listings.
i. See note in Stable Particle Data Card Listings.
j. P for Ξ and J^P for Ω^- not yet measured. Values reported are SU(3) predictions.
k. Assumes rate for $\Xi^- \rightarrow \Sigma^0 e^-\nu$ small compared with $\Xi^- \rightarrow \Lambda e^-\nu$.
ℓ. $|g_A/g_V|$ defined by $g_A^2 = |C_A|^2+|C'_A|^2$, $g_V^2 = |C_V|^2+|C'_V|^2$, and $\Sigma\langle\bar{e}|\Gamma_i|\mu\rangle\langle\bar{\nu}|\Gamma_i(C_i+C'_i\gamma_5)|\nu\rangle$;
ϕ defined by $\cos\phi = -\mathrm{Re}(C_A^*C'_V+C'_AC_V^*)/g_Ag_V$ [for more details, see text Section VI A].
m. The definition of the slope parameter of the Dalitz plot is as follows [see also text Section VI B.1]:

$$|M|^2 = 1 + g\left(\frac{s_3-s_0}{m_{\pi^+}^2}\right) .$$

n. The $K_S^0 \rightarrow \pi\pi$ and $K_L^0 \rightarrow \pi\pi$ rates (and branching fractions) are from independent fits and do not include results of K_L^0–K_S^0 interference experiments. The $|\eta_{+-}|$ and $|\eta_{00}|$ values given in the addendum are these rates combined with the $|\eta_{+-}|$ and $|\eta_{00}|$ results from interference experiments.
o. The definition for the CP violation parameters is as follows [see also text Section VI B.3]:

$$\eta_{+-} = |\eta_{+-}|e^{i\phi_{+-}} = \frac{A(K_L^0 \rightarrow \pi^+\pi^-)}{A(K_S^0 \rightarrow \pi^+\pi^-)} \qquad \eta_{00} = |\eta_{00}|e^{i\phi_{00}} = \frac{A(K_L^0 \rightarrow \pi^0\pi^0)}{A(K_S^0 \rightarrow \pi^0\pi^0)}$$

$$\delta = \frac{\Gamma(K_L^0\rightarrow\ell^+)-\Gamma(K_L^0\rightarrow\ell^-)}{\Gamma(K_L^0\rightarrow\ell^+)+\Gamma(K_L^0\rightarrow\ell^-)}, \qquad |\eta_{+-0}|^2 = \frac{\Gamma(K_S^0\rightarrow\pi^+\pi^-\pi^0)}{\Gamma(K_L^0\rightarrow\pi^+\pi^-\pi^0)}, \qquad |\eta_{000}|^2 = \frac{\Gamma(K_S^0\rightarrow\pi^0\pi^0\pi^0)}{\Gamma(K_L^0\rightarrow\pi^0\pi^0\pi^0)} .$$

p. The definition of these quantites is as follows [for more details on sign convention, see text Section VI B]:

$\alpha = \frac{2\lvert s\rvert\lvert p\rvert\cos\Delta}{\lvert s\rvert^2+\lvert p\rvert^2}$	$\beta = \sqrt{1-\alpha^2}\sin\phi$	g_A/g_V defined by $\langle B_f\lvert\gamma_\lambda(g_V-g_A\gamma_5)\rvert B_i\rangle$
$\beta = \frac{-2\lvert s\rvert\lvert p\rvert\sin\Delta}{\lvert s\rvert^2+\lvert p\rvert^2}$	$\gamma = \sqrt{1-\alpha^2}\cos\phi$	δ defined by $g_A/g_V = \lvert g_A/g_V\rvert e^{i\delta}$

Meson Table

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In addition to the entries in the Meson Table, the Meson Data Card Listings contain all substantial claims for meson resonances. See Contents of Meson Data Card Listings[i].

Quantities in italics have changed by more than one (old) standard deviation since April 1974.

Name (G \ I: 0, 1; −: ω/φ, π; +: η, ρ)	$I^G(J^P)C_n$ ⊢ estab.	Mass M (MeV)	Full Width Γ (MeV)	M^2 $\pm\Gamma M$[a] $(GeV)^2$	Partial decay mode: Mode	Fraction (%) [Upper limits are 1σ (%)]	p or p_{max}[b] (MeV/c)
$\pi^\pm$ π^0	$1^-(0^-)+$	139.57 134.96	0.0 7.8 eV ±.9 eV	0.019479 0.018215	See Stable Particle Table		
η	$0^+(0^-)+$	548.8 ±0.6	2.63 keV ±.58 keV	0.301 ±.000	Neutral Charged	71.1 28.9	See Stable Particle Table
ρ(770)	$1^+(1^-)-$	773§ ±3§	152§ ±3§	0.598 ±.117	ππ πγ e^+e^- $\mu^+\mu^-$	≈100 0.024 ±.007 0.0043±.0005 (d) 0.0067±.0012 (d)	360 374 386 372
M and Γ from neutral mode.					For upper limits, see footnote (e)		
ω(783)	$0^-(1^-)-$	782.7 ±0.3	10.0 ±.4	0.613 ±.008	$\pi^+\pi^-\pi^0$ $\pi^+\pi^-$ $\pi^0\gamma$ e^+e^-	89.9±0.6 S=1.2* 1.3±0.3 S=1.5* 8.8±0.5 0.0076±.0017 S=1.9*	327 366 380 391
					For upper limits, see footnote (f)		
→→ η′(958)	$0^+(0^-)+$	957.6 ±0.3	< 1	0.917 <.001	ηππ $\rho^0\gamma$ γγ	*67.6±1.7* *30.4±1.7* S=1.1* 2.0±0.3	231 167 479
					For upper limits, see footnote (g)		
δ(970)	$1^-(0^+)+$	976[h]§ ±10§	50[h]§ ±20§	0.953 ±.049	ηπ	seen	315
Possibly coupled to the I = 1 $K\bar{K}$ system¶.							
→ $S^*(993)$	$0^+(0^+)+$	∿ 993[c] ±5	40[c] ±8	0.986 ±.040	$K\bar{K}$ ππ	near threshold	53 476
See note on ππ S wave¶.							
Φ(1020)	$0^-(1^-)-$	1019.7 ±0.3 S=1.6*	4.1 ±.2	1.040 ±.004	K^+K^- K_LK_S $\pi^+\pi^-\pi^0$ (incl. ρπ) ηγ $\pi^0\gamma$ e^+e^- $\mu^+\mu^-$	46.6±2.3 S=1.6* 35.0±2.0 S=1.6* 16.4±1.5 S=1.1* 2.0±0.4 0.14±0.05 .032±.002 S=1.4* .025±.003	128 111 462 362 501 510 499
					For upper limits, see footnote (i)		
→→→ $A_1(1100)$	$1^-(1^+)+$	∿ 1100	∿ 300	1.21 ±.33	ρπ	∿ 100	251
Broad enhancement in the $J^P=1^+$ ρπ partial wave; not an established resonance¶.							
→→ ε(1200)	$0^+(0^+)+$	1100 to 1300	∿ 600		ππ		
Existence of pole not established. See note on ππ S wave¶.							
B(1235)	$1^+(1^+)-$	1228§ ±10§	125§ ±10§	1.51 ±.15	ωπ [D/S amplitude ratio = .25±.06]	only mode seen	345
					For upper limits, see footnote (j)		
f(1270)	$0^+(2^+)+$	1271§ ±5§	180§ ±20§	1.62 ±.23	ππ $2\pi^+2\pi^-$ $K\bar{K}$ $\pi^+\pi^-2\pi^0$	81±1§ *2.8±0.3* 2.7±0.6 S=1.1* seen	620 557 395 560
					For upper limits, see footnote (ℓ)		
D(1285)	$0^+(A\ )+$	1286§ ±10§	30§ ±20§	1.65 ±.04	$K\bar{K}\pi$ ηππ †[δπ $2\pi^+2\pi^-$ (prob. $\rho^0\pi^+\pi^-$)	seen seen seen] seen	305 484 245 565
	$J^P = 0^-, 1^+, 2^-$, with 1^+ favoured						

Meson Table *(cont'd)*

Name	$I^G(J^P)C_n$ estab.	Mass M (MeV)	Full Width Γ (MeV)	$M^2 \pm \Gamma M$[a] $(GeV)^2$	Partial decay mode: Mode	Fraction (%) [Upper limits are 1σ (%)]		p or p_{max}[b] (MeV/c)
$A_2(1310)$	$1^-(2^+)+$	1310 ± 5§	102 ± 5§	$1.72 \pm .13$	ρπ	70.9±1.8	S=1.1*	411
					ηπ	15.0±1.2		529
					ωππ	9.3±1.9	S=1.2*	354
					$\bar{K}K$	4.7±0.5		428
					η′π	<1		279
E(1420)	$0^+(A\ )+$	1416 ± 10§	60 ± 20§	$2.01 \pm .08$	$K\bar{K}\pi$	∿ 40		421
					†[$K^*\bar{K} + \bar{K}^*K$	∿ 20]		130
					ηππ	∿ 60		564
					†[δπ	possibly seen]		352
Not a well established resonance.								
f′(1514)	$0^+(2^+)+$	1516 ± 3	40 ± 10	$2.30 \pm .06$	$K\bar{K}$	only mode seen		572
					For upper limits, see footnote (k)			
$F_1(1540)$	$1\ (A\ )$	1540 ± 5	40 ± 15	$2.37 \pm .06$	$K^*\bar{K} + \bar{K}^*K$	seen		321
					3π	possibly seen		737
Not a well established resonance.								
ρ′(1600)	$1^+(1^-)-$	∿ 1600	200-800	2.56	4π	dominant		738
					†[$\rho\pi^+\pi^-$	seen with $\pi^+\pi^-$ in S-wave]		573
					ππ	possibly seen		788
					$K\bar{K}$	< 8		629
Not a well established resonance.¶								
$A_3(1640)$	$1^-(2^-)+$	∿ 1640	∿ 300	$2.69 \pm .49$	fπ			304
Broad enhancement in the $J^P = 2^-$ fπ partial wave; not a well established resonance.¶								
ω(1675)	$0^-(3^-)-$	1667 ± 10§	150 ± 20§	$2.78 \pm .25$	ρπ	seen		646
					3π	possibly seen		806
					5π	possibly seen		778
					†[ωππ	possibly seen]		615
g(1680)¶	$1^+(3^-)-$	1690 ± 20§	180 ± 30§	$2.86 \pm .30$	2π	24±1		833
					4π (incl. ππρ, ρρ, $A_2\pi$, ωπ)	large		787
					$K\bar{K}$	small		683
J^P, M and Γ from the 2π mode.					$K\bar{K}\pi$ (incl. $K^*\bar{K}$)	small		624
h(2040)	$0^+(4^+)+$	2040 ± 20	193 ± 50	$4.16 \pm .39$	ππ	seen		1010
					$K\bar{K}$	seen		890
See note (l) for possible heavier states.								
K^+	$1/2(0^-)$	493.71		0.244	See Stable Particle Table			
K^0		497.70		0.248				
$K^*(892)$	$1/2(1^-)$	892.2 ± 0.5	49.4 ± 1.8	$0.796 \pm .044$	Kπ	≈ 100		288
					Kππ	< 0.2		216
M and Γ from charged mode; $m^0 - m^\pm = 4.1 \pm 0.6$ MeV.					Kγ	0.15±0.07		309
κ(1250)	$1/2(0^+)$	1250 ± 100§	∿ 450	$1.56 \pm .56$	Kπ			
See note on Kπ S wave¶.								
Q region	$1/2(A\ )$	1200 to 1400			Kππ	only mode seen		
					†[$K^*\pi$	large]		
$J^P = 1^+$ is dominant contribution;					†[Kρ	seen]		
not a well established resonance¶.					†[$K(\pi\pi)_{\ell=0}$	possibly seen]		
$K^*(1420)$	$1/2(2^+)$	1421 ± 3§	108 ± 10§	$2.02 \pm .15$	Kπ	56.1±2.6		616
					$K^*\pi$	30.9±2.1		415
					Kρ	*6.6±1.7*		316
		See note (m).			Kω	4.5±1.7		305
					Kη	2.0±2.0		482

Meson Table *(cont'd)*

Name	$I^G(J^P)C_n$ (estab.)	Mass M (MeV)	Full Width Γ (MeV)	M^2 $\pm\Gamma M$[(a)] $(GeV)^2$	Partial decay mode: Mode	Partial decay mode: Fraction (%) [Upper limits are 1σ (%)]	p or p_{max}[(b)] (MeV/c)
L(1770)	1/2(A)	1765 ±10[§]	140 ±50[§]	3.11 ±.25	Kππ	dominant	788
					Kπππ	seen	757
					†[K^*(1420)π and other subreactions[¶]]		
Not a well established resonance[¶].							
See note (1) for possible heavier states.							
J/ψ(3100)	$0^-(1^-)-$	3098 ± 3	0.067 ±.012	9.6 ±.0	e^+e^-	7 ± 1	1549
					$\mu^+\mu^-$	7 ± 1	1545
					hadrons	86 ± 2	
					†[identified hadron modes	~ 12] ¶	
					†[γ X(2750)	possibly seen]¶	328
ψ(3700)	$0^-(1^-)-$	3684 ± 4	0.228 ±.056	13.6 ± .0	e^+e^-	0.9 ± .2	1842
					$\mu^+\mu^-$	0.9 ± .2	1839
					hadrons	98.1 ± .3	
					†[J/ψ $\pi^+\pi^-$	33 ± 3]	474
					†[J/ψ $\pi^0\pi^0$	17 ± 2]	478
					†[J/ψ η	4.2 ± .7]	189
					†[γP_c, $P_c \to$ J/ψ γ	3.6 ± .7]¶	
					†[γχ(3410)	seen]¶	264
					†[γχ(3530)	seen]¶	151
					†[other identified hadron modes	~ 0.5] ¶	
ψ(4100)	$(1^-)-$	~ 4100	~ 200	16.8 ± .8			
Broad enhancement in the e^+e^- total cross section; probably not a single resonance.[¶]							
ψ(4400)	$(1^-)-$	4414 ± 7	33 ±10	19.5 ± .1	e^+e^-	.0013 ± .0003	2207

→X(2750)
→P_c(3300 or 3500)
→χ(3410)
→χ(3530)

States observed in radiative decays of J/ψ(3100) and ψ(3700). See Meson Data Card Listings for a compilation and discussion of the experimental data.

(1) Contents of Meson Data Card Listings

Non-strange (Y = 0) entry	$I^G(J^P)C_n$	entry	$I^G(J^P)C_n$	entry	$I^G(J^P)C_n$	Strange (|Y| = 1) entry	$I(J^P)$
π	$1^-(0^-)+$	A_1 (1100)	$1^-(1^+)+$	ρ′ (1600)	$1^+(1^-)-$	K	$1/2(0^-)$
η	$0^+(0^-)+$	→ M (1150)		A_3 (1640)	$1^-(2^-)+$	K^*(892)	$1/2(1^-)$
ρ (770)	$1^+(1^-)-$	→ $A_{1.5}$(1170)		ω (1675)	$0^-(3^-)-$	κ (1250)	$1/2(0^+)$
ω (783)	$0^-(1^-)-$	ε (1200)	$0^+(0^+)+$	g (1680)	$1^+(3^-)-$	Q	1/2(A)
→ M (940)		B (1235)	$1^+(1^+)-$	→ X (1690)	-	K^*(1420)	$1/2(2^+)$
→ M (953)		→ ρ′ (1250)	$1^+(1^-)-$	→ X (1795)	1	→ K_N(1700)	1/2
η′ (958)	$0^+(0^-)+$	f (1270)	$0^+(2^+)+$	→ A_4 (1900)	1^-	L (1770)	1/2(A)
δ (970)	$1^-(0^+)+$	D (1285)	0^+(A)+	→ S (1930)	1	→ K_N(1800)	$1/2(3^-)$
→ H (990)		A_2 (1310)	$1^-(2^+)+$	h (2040)	$0^+(4^+)+$	→ K^*(2200)	
S^* (993)	$0^+(0^+)+$	E (1420)	0^+(A)+	→ ρ (2100)			
φ (1020)	$0^-(1^-)-$	→ X (1430)	0	→ T (2200)	1		
→ M (1033)		→ X (1440)	1	→ U (2360)	1		
→ B_1(1040)		f′ (1514)	$0^+(2^+)+$	→ $N\bar{N}$(2375)	0	→ Exotics	
→ η_N(1080)	0^+(N)+	F_1 (1540)	1 (A)	→ X(2500-3600)			

New heavy mesons

J/ψ(3100) ψ(3700) ψ(4100) ψ(4400) →X(2750) →P_c(3300 or 3500) →χ(3410) →χ(3530)

Meson Table *(cont'd)*

→ Indicates an entry in Meson Data Card Listings not entered in the Meson Table. We do not regard these as established resonances.

¶ See Meson Data Card Listings.

* Quoted error includes scale factor $S = \sqrt{\chi^2/(N-1)}$. See footnote to Stable Particle Table.

† Square brackets indicate a subreaction of the previous (unbracketed) decay mode(s).

§ This is only an educated guess; the error given is larger than the error of the average of the published values. (See Meson Data Card Listings for the latter.)

(a) ΓM is approximately the half-width of the resonance when plotted against M^2.

(b) For decay modes into ≥ 3 particles, p_{max} is the maximum momentum that any of the particles in the final state can have. The momenta have been calculated by using the averaged central mass values, without taking into account the widths of the resonances.

(c) From pole position $(M - i\Gamma/2)$.

(d) The e^+e^- branching ratio is from $e^+e^- \to \pi^+\pi^-$ experiments only. The $\omega\rho$ interference is then due to $\omega\rho$ mixing only, and is expected to be small. See note in Meson Data Card Listings. The $\mu^+\mu^-$ branching ratio is compiled from 3 experiments; each possibly with substantial $\omega\rho$ interference. The error reflects this uncertainty; see notes in Meson Data Card Listings. If $e\mu$ universality holds, $\Gamma(\rho^0 \to \mu^+\mu^-) = \Gamma(\rho^0 \to e^+e^-) \times 0.99785$.

(e) Empirical limits on fractions for other decay modes of $\rho(770)$ are $\pi^\pm\eta < 0.8\%$, $\pi^+\pi^+\pi^-\pi^- < 0.15\%$, $\pi^\pm\pi^+\pi^-\pi^0 < 0.2\%$.

(f) Empirical limits on fractions for other decay modes of $\omega(783)$ are $\pi^+\pi^-\gamma < 5\%$, $\pi^0\pi^0\gamma < 1\%$, η + neutral(s) < 1.5%, $\mu^+\mu^- < 0.02\%$, $\pi^0\mu^+\mu^- < 0.2\%$, $\eta\gamma < 0.5\%$.

(g) Empirical limits on fractions for other decay modes of $\eta'(958)$: $\pi^+\pi^- < 2\%$, $\pi^+\pi^-\pi^0 < 5\%$, $\pi^+\pi^+\pi^-\pi^- < 1\%$, $\pi^+\pi^+\pi^-\pi^-\pi^0 < 1\%$, $6\pi < 1\%$, $\pi^+\pi^-e^+e^- < 0.6\%$, $\pi^0e^+e^- < 1.3\%$, $\eta e^+e^- < 1.1\%$, $\pi^0\rho^0 < 4\%$, $\gamma\omega < 5\%$.

(h) The mass and width are from the $\eta\pi$ mode only. If the $K\bar{K}$ channel is strongly coupled, the width may be 120 MeV or more.

(i) Empirical limits on fractions for other decay modes of $\phi(1020)$ are $\pi^+\pi^- < 0.03\%$, $\pi^+\pi^-\gamma < 0.7\%$, $\omega\gamma < 5\%$, $\rho\gamma < 2\%$, $2\pi^+2\pi^-\pi^0 < 1\%$.

(j) Empirical limits on fractions for other decay modes of B(1235): $\pi\pi < 15\%$, $K\bar{K} < 2\%$, $4\pi < 50\%$, $\phi\pi < 1.5\%$, $\eta\pi < 25\%$, $(\bar{K}K)^\pm\pi^0 < 8\%$, $K_SK_S\pi^\pm < 2\%$, $K_SK_L\pi^\pm < 6\%$.

(k) Empirical limits on fractions for other decay modes of f'(1514) are $\pi^+\pi^- < 20\%$, $\eta\eta < 50\%$, $\eta\pi\pi < 30\%$, $K\bar{K}\pi + K^*\bar{K} < 35\%$, $2\pi^+2\pi^- < 32\%$.

(ℓ) Empirical limits on fractions for other decay modes of f(1270) are $\eta\pi\pi < 1\%$, $K^0K^-\pi^+$ + c.c. < 1% $\eta\eta < 2\%$.

(m) The tabulated mass of 1421 MeV comes from the $K\pi$ mode; the $K\pi\pi$ mode can be contaminated with diffractively produced $Q^\pm$.

Established Nonets, and octet-singlet mixing angles from Appendix IIB, Eq. (2'). Of the two isosinglets, the "mainly octet" one is written first, followed by a semicolon.

$(J^P)C_n$	Nonet members	$\theta_{lin.}$	$\theta_{quadr.}$
$(0^-)+$	π, K, η; η'	-24 ± 1°	-11 ± 1°
$(1^-)-$	ρ, K^*, ϕ; ω	37 ± 1°	40 ± 1°
$(2^+)+$	A_2, $K^*(1420)$, f'; f	29 ± 2°	31 ± 2°

Baryon Table

April 1976

The following short list gives the status of all the Baryon States in the Data Card Listings. In addition to the status, the name, the nominal mass, and the quantum numbers (where known) are shown. States with three- or four-star status are included in the main Baryon Table; the others have been omitted because the evidence for the existence of the effect and/or for its interpretation as a resonance is open to considerable question.

N(939)	P11	****
N(1470)	P11	****
N(1520)	D13	****
N(1535)	S11	****
N(1670)	D15	****
N(1688)	F15	****
N(1700)	S11	****
N(1700)	D13	**
N(1780)	P11	***
N(1810)	P13	***
N(1990)	F17	**
N(2000)	F15	*
N(2040)	D13	**
N(2100)	S11	*
N(2100)	D15	*
N(2190)	G17	***
N(2220)	H19	***
N(2650)		***
N(3030)		***
N(3245)		*
N(3690)		*
N(3755)		*

Δ(1232)	P33	****
Δ(1650)	S31	****
Δ(1670)	D33	***
Δ(1690)	P33	*
Δ(1890)	F35	***
Δ(1900)	S31	*
Δ(1910)	P31	***
Δ(1950)	F37	****
Δ(1960)	D35	**
Δ(2160)		**
Δ(2420)	H311	***
Δ(2850)		***
Δ(3230)		***
Z0(1780)	P01	*
Z0(1865)	D03	*
Z1(1900)	P13	*
Z1(2150)		*
Z1(2500)		*

Λ(1116)	P01	****
Λ(1330)		Dead
Λ(1405)	S01	****
Λ(1520)	D03	****
Λ(1600)	P01	*
Λ(1670)	S01	****
Λ(1690)	D03	****
Λ(1800)	P01	**
Λ(1800)	G09	*
Λ(1815)	F05	****
Λ(1830)	D05	****
Λ(1860)	P03	***
Λ(1870)	S01	**
Λ(2010)		**
Λ(2020)	F07	*
Λ(2100)	G07	****
Λ(2110)	F05	**
Λ(2350)		****
Λ(2585)		***

Σ(1193)	P11	****
Σ(1385)	P13	****
Σ(1440)		Dead
Σ(1480)		*
Σ(1580)	D13	**
Σ(1620)	S11	**
Σ(1660)	P11	**
Σ(1670)	D13	****
Σ(1670)		**
Σ(1690)		**
Σ(1750)	S11	***
Σ(1765)	D15	****
Σ(1770)	P11	*
Σ(1840)	P13	*
Σ(1880)	P11	**
Σ(1915)	F15	****
Σ(1940)	D13	***
Σ(2000)	S11	*
Σ(2030)	F17	****
Σ(2070)	F15	*
Σ(2080)	P13	**
Σ(2100)	G17	*
Σ(2250)		****
Σ(2455)		***
Σ(2620)		***
Σ(3000)		**

Ξ(1317)	P11	****
Ξ(1530)	P13	****
Ξ(1630)		**
Ξ(1820)		***
Ξ(1940)		***
Ξ(2030)		**
Ξ(2250)		*
Ξ(2500)		**
Ω(1672)	P03	****

**** Good, clear, and unmistakable. *** Good, but in need of clarification or not absolutely certain.
** Needs confirmation. * Weak.

[See notes on N's and Δ's, on possible Z^*'s, and on Y^*'s and Ξ^*'s at the beginning of those sections in the Baryon Data Card Listings; also see notes on individual resonances in the Baryon Data Card Listings.]

Particle[a]	I (J^P)[a] estab.	π or K Beam[b] p_{beam} (GeV/c) $\sigma = 4\pi\lambda\!\!\!^{-2}$ (mb)	Mass M^c (MeV)	Full Width Γ^c (MeV)	M^2 $\pm\Gamma M^b$ (GeV^2)	Partial decay mode: Mode	Fraction %	p or p_{max}[d] (MeV/c)
p n	$1/2(1/2^+)$		938.3 939.6		0.880 0.883	See Stable Particle Table		
N(1470)[g]	$1/2(1/2^+)$ P'_{11}	p = 0.66 σ = 27.8	1390 to 1470	180 to 220 (200)	2.16 ±0.29	Nπ	~60	420
						Nη	~18	d
						Nππ	~25	368
						[Nε	~ 7][e]	d
						[Δπ	~19][e]	177
						[Nρ	< 9][e]	d
						pγ[f]	0.07-0.14	435
						nγ[f]	< 0.05	435
N(1520)[g]	$1/2(3/2^-)$ D'_{13}	p = 0.74 σ = 23.5	1510 to 1530	110 to 150 (125)	2.31 ±0.19	Nπ	~55	456
						Nππ	~45	410
						[Nε	< 5][e]	d
						[Nρ	~15][e]	d
						[Δπ	~25][e]	228
						Nη	< 1	d
						pγ[f]	0.4-0.7	471
						nγ[f]	0.3-0.6	471
N(1535)[g]	$1/2(1/2^-)$ S'_{11}	p = 0.76 σ = 22.5	1500 to 1530	50 to 120 (100)	2.36 ±0.15	Nπ	~30	467
						Nη	~65	182
						Nππ	~ 5	422
						[Nρ	~ 3][e]	d
						[Nε	~ 2][e]	d
						[Δπ	~ 1][e]	243
						pγ[f]	<0.4	481
						nγ[f]	<0.4	481

Baryon Table *(cont'd)*

Particle[a]	I (J^P)[a] —— estab.	π or K Beam[b] p_{beam} (GeV/c) $\sigma = 4\pi ƛ^2$ (mb)	Mass M^c (MeV)	Full Width Γ^c (MeV)	M^2 $\pm\Gamma M^b$ (GeV^2)	Partial decay mode: Mode	Fraction %	p or p_{max}[d] (MeV/c)
N(1670)[g]	1/2(5/2⁻)D'_{15} ——	p = 1.00 σ = 15.6	1660 to 1685	145 to 165 (155)	2.79 ±0.26	Nπ Nππ [Δπ ΛK Nη pγ[f] nγ[f]	~45 ~55 ~50][e] <0.3 <0.5 <0.03 <0.14	560 525 360 200 368 572 572
N(1688)[g]	1/2(5/2⁺)F'_{15} ——	p = 1.03 σ = 14.9	1670 to 1690	120 to 145 (140)	2.85 ±0.24	Nπ Nππ [Nε [Nρ [Δπ Nη pγ[f] nγ[f]	~ 60 ~ 40 ~14][e] ~14][e] ~ 11][e] < 0.3 0.1-0.4 < 0.03	572 538 340 d 375 388 583 583
N(1700)[g]	1/2(1/2⁻)S''_{11} ——	p = 1.05 σ = 14.3	1660 to 1690	100 to 200 (150)	2.89 ±0.26	Nπ Nππ [Nε [Nρ [Δπ ΛK ΣK pγ[f] nγ[f]	~ 55 ~ 30 ~ 10][e] ~ 7][e] ~ 4][e] ~ 4 ~ 2 < 0.1 < 0.15	580 547 355 d 385 250 109 591 591
N(1780)	1/2(1/2⁺)P''_{11} ——	p = 1.20 σ = 12.2	1700 to 1800	100 to 250 (200)	3.17 ±0.36	Nπ Nππ [Nε [Nρ [Δπ ΛK ΣK Nη pγ[f] nγ[f]	~20 >40 15-40][e] 20-50][e] 10-20][e] ~ 7 ~10 2-20[h] < 0.15 < 0.13	633 603 440 249 448 353 267 476 643 643
N(1810)	1/2(3/2⁺)P_{13} ——	p = 1.26 σ = 11.5	1700 to 1850	100 to 300 (200)	3.28 ±0.36	Nπ Nππ [Nρ ΛK ΣK Nη pγ[f] nγ[f]	~20 ~70 ~70][e] ~ 5 ~ 2 < 5 < 0.2 < 0.2	652 624 297 386 307 503 661 661
N(2190)	1/2(7/2⁻)G_{17} ——	p = 2.07 σ = 6.21	2100 to 2250	150 to 300 (250)	4.80 ±0.55	Nπ ΛK ΣK	15-35 <0.2 <0.2	888 710 664
N(2220)	1/2(9/2⁺)H_{19} ——	p = 2.14 σ = 5.97	2200 to 2250	250 to 350 (300)	4.93 ±0.67	Nπ	~20	905
N(2650)	1/2(?⁻) ——	p = 3.26 σ = 3.67	~2650	~350 (350)	7.02 ±0.93	Nπ	(J+1/2)x < 0.4[j]	1154
N(3030)	1/2(?) ——	p = 4.41 σ = 2.62	~3030	~400 (400)	9.18 ±1.21	Nπ	(J+1/2)x < 0.1[j]	1366
Δ(1232)[g]	3/2(3/2⁺)P'_{33} ——	p = 0.30 σ = 94.3	1230 to 1234	110 to 120 (115)	1.52 ±0.14	Nπ $N\pi^+\pi^-$ pγ[f]	~99.4 ~0 0.58-0.66	227 80 259
	Δ(++) Pole position:[k]	$M-i\Gamma/2 = (1211.0\pm0.8) - i(49.9\pm0.6)$						
	Δ(0) Pole position:[k]	$M-i\Gamma/2 = (1210.9\pm1.0) - i(53.1\pm1.0)$						
Δ(1650)[g]	3/2(1/2⁻)S'_{31} ——	p=0.96 σ =16.4	1615 to 1695	140 to 200 (140)	2.72 ±0.23	Nπ Nππ [Nρ [Δπ pγ[f]	~35 ~65 10-25][e] ~50][e] < 0.25	547 511 d 344 558

Baryon Table *(cont'd)*

Particle[a]	I $(J^P)^a$ estab.	π or K Beam[b] p_{beam} (GeV/c) $\sigma = 4\pi ƛ^2$ (mb)	Mass M^c (MeV)	Full Width Γ^c (MeV)	M^2 $\pm\Gamma M^b$ (GeV^2)	Partial decay mode: Mode	Fraction %	p or p_{max}[d] (MeV/c)
Δ(1670)[g]	$3/2(3/2^-)D_{33}$	p = 1.00 σ =15.6	1650 to 1720	190 to 260 (200)	2.79 ±0.33	Nπ Nππ [Nρ [Δπ pγ[f]	~15 ~85 30-60][e] ~45][e] 0.05-0.3	560 525 d 361 572
Δ(1890)[g]	$3/2(5/2^+)F_{35}$	p = 1.42 σ = 9.88	1860 to 1900	150 to 300 (250)	3.57 ±0.47	Nπ Nππ [Nρ [Δπ ΣK pγ[f]	~15 ~80 ~60][e] 10-30][e] <3 <0.1	704 677 403 531 400 712
Δ(1910)[g]	$3/2(1/2^+)P_{31}$	p = 1.46 σ = 9.54	1780 to 1950	160 to 230 (200)	3.65 ±0.38	Nπ Nππ [Nρ [Δπ ΣK pγ[f]	15-35 ? small][e] small][e] 2-20 <0.1	716 691 429 545 420 725
Δ(1950)[g]	$3/2(7/2^+)F_{37}$	p = 1.54 σ = 8.90	1910 to 1940	200 to 240 (220)	3.80 ±0.43	Nπ Nππ [Nρ [Δπ ΣK pγ[f]	~40 > 25 ~10][e] ~20][e] <1 0.09-0.15	741 716 471 574 460 749
Δ(2420)[g]	$3/2(11/2^+)H_{3\ 11}$	p = 2.64 σ = 4.68	2380 to 2450	300 to 500 (300)	5.86 ±0.73	Nπ	10-15	1023
Δ(2850)	$3/2(\ ?^+\ )$	p = 3.85 σ = 3.05	2800 to 2900	~400 (400)	8.12 ±1.14	Nπ	(J+1/2)x ~0.25[j]	1266
Δ(3230)	$3/2(\ ?\ )$	p = 5.08 σ = 2.25	3200 to 3350	~440 (440)	10.43 ±1.42	Nπ	(J+1/2)x ~0.05[j]	1475
Z*	Evidence for states with strangeness +1 is controversial. See the Baryon Data Card listings for discussion and display of data.							
Λ	$0(1/2^+)$		1115.6		1.245	See Stable Particle Table		
Λ(1405)	$0(1/2^-)S'_{01}$	below K^-p threshold	1405 ±5[ℓ]	40±10[ℓ] (40)	1.97 ±0.06	Σπ	100	142
Λ(1520)	$0(3/2^-)D'_{03}$	p = 0.389 σ = 84.5	1519 ±2[ℓ]	15 ±2[ℓ] (15)	2.31 ±0.02	$N\bar{K}$ Σπ Λππ Σππ	46±1 42±1 10± 1 0.9±0.1	234 258 250 140
Λ(1670)	$0(1/2^-)S''_{01}$	p = 0.74 σ = 28.5	1660 to 1680	20 to 60 (40)	2.79 ±0.07	$N\bar{K}$ Λη Σπ	15-35 15-35 20-60	410 64 393
Λ(1690)	$0(3/2^-)D''_{03}$	p = 0.78 σ = 26.1	1690 ±10[ℓ]	30 to 80 (60)	2.86 ±0.10	$N\bar{K}$ Σπ Λππ Σππ	20-30 15-40 ~25 ~20	429 409 415 352
Λ(1815)	$0(5/2^+)F'_{05}$	p = 1.05 σ = 16.7	1820 ±5[ℓ]	70 to 100 (85)	3.29 ±0.15	$N\bar{K}$ Σπ Σ(1385)π	~60 ~12 15-20	542 508 362
Λ(1830)	$0(5/2^-)D_{05}$	p = 1.09 σ = 15.8	1810 to 1840	60 to 110 (95)	3.35 ±0.17	$N\bar{K}$ Σπ Λη	<10 35-75 <4	554 519 367
Λ(1860)	$0(1/2^+)P_{03}$	p = 1.14 σ = 14.7	1860 to 1910	40 to 110 (80)	3.46 ±0.15	$N\bar{K}$ Σπ	15-35 5-10	576 534
Λ(2100)	$0(7/2^-)G_{07}$	p = 1.68 σ = 8.68	2100 to 2120	150 to 300 (250)	4.41 ±0.53	$N\bar{K}$ Σπ Λη ΞK Λω	~30 ~5 <3 <3 <8	748 699 617 483 443

Baryon Table *(cont'd)*

Particle[a]	I (J^P)[a] estab.	π or K Beam[b] p_{beam} (GeV/c) $\sigma = 4\pi\lambda^2$ (mb)	Mass M^c (MeV)	Full Width Γ^c (MeV)	M^2 $\pm\Gamma M^b$ (GeV^2)	Mode	Fraction %	p or p_{max} (MeV/c) [d]
Λ(2350)	0(?)	p = 2.29 σ = 5.85	2340 to 2360	100 to 200 (120)	5.52 ±0.28	$N\bar{K}$ Σπ	(J+1/2)x ~0.9[j] seen	913 865
Λ(2585)	0(?)	p = 2.91 σ = 4.37	~2585	~300 (300)	6.68 ±0.78	$N\bar{K}$	(J+1/2)x ~1.0[j]	1058
Σ	1(1/2$^+$)		(+)1189.4 (0)1192.5 (-)1197.4		1.415 1.422 1.434	See Stable Particle Table		
Σ(1385)	1(3/2$^+$)P'_{13}	below K^-p threshold	(+)1382.5±0.5 S=1.2[m] (-)1386.6±1.2 S=2.3[m]	(+)35±2 S=1.9[m] (-)42±4 S=3.2[m] (35)	1.92 ±0.05	Λπ Σπ	88±2 12±2	208 117
Σ(1670)[n]	1(3/2$^-$)D''_{13}	p = 0.74 σ = 28.5	1670 ±10[ℓ]	35 to 70 (50)	2.79 ±0.08	$N\bar{K}$ Σπ Λπ	10-25 20-60 < 20	410 387 447
Σ(1750)	1(1/2$^-$)S''_{11}	p = 0.91 σ = 20.7	1700 to 1790	50 to 120 (75)	3.06 ±0.13	$N\bar{K}$ Λπ Σπ Ση	10-40 5-20 <8 15-55	483 507 450 54
Σ(1765)	1(5/2$^-$)D_{15}	p = 0.94 σ = 19.6	1723 ±7[ℓ]	110 to 150 (130)	3.12 ±0.23	$N\bar{K}$ Λπ Λ(1520)π Σ(1385)π Σπ	~41 ~14 ~16 ~10 ~1	496 518 187 315 461
Σ(1915)[g]	1(5/2$^+$)F'_{15}	p = 1.25 σ = 13.0	1905 to 1930	70 to 140 (100)	3.67 ±0.19	$N\bar{K}$ Λπ Σπ	5-15 20 ?	612 619 568
Σ(1940)[i]	1(3/2$^-$)D'''_{13}	p = 1.32 σ = 12.0	1900 to 1960	110 to 280 (220)	3.76 ±0.43	$N\bar{K}$ Λπ Σπ	<20 ~4 ~7	678 680 589
Σ(2030)[g]	1(7/2$^+$)F_{17}	p = 1.52 σ = 9.93	2020 to 2040	120 to 200 (180)	4.12 ±0.37	$N\bar{K}$ Λπ Σπ ΞK	~20 ~20 5-10 < 2	700 700 652 412
Σ(2250)	1(?)	p = 2.04 σ = 6.76	2200 to 2300	50 to 200 (150)	5.06 ±0.34	$N\bar{K}$ Λπ Σπ	(J+1/2)x ~0.3[j] seen seen	849 841 801
Σ(2455)	1(?)	p = 2.57 σ = 5.09	~2455	~120 (120)	6.03 ±0.29	$N\bar{K}$	(J+1/2)x ~0.2[j]	979
Σ(2620)	1(?)	p = 2.95 σ = 4.30	~2600	~200 (200)	6.86 ±0.52	$N\bar{K}$	(J+1/2)x ~0.3[j]	1064
Ξ	1/2(1/2$^+$)		(0)1314.9 (-)1321.3		1.729 1.746	See Stable Particle Table		
Ξ(1530)[o]	1/2(3/2$^+$)P_{13}		(0)1531.8±0.3 S=1.3[m] (-)1535.1±0.6	(0) 9.1±0.5 (-)10.1±1.9 (10)	2.34 ±0.02	Ξπ	100	144
Ξ(1820)[o,p]	1/2(?)		1800 to 1850	12 to 100 (60)	3.31 ±0.11	$\Lambda\bar{K}$ $\Sigma\bar{K}$ Ξπ Ξ(1530)π	seen seen seen seen	396 306 413 234
Ξ(1940)[o,q]	1/2(?)		1900 to 1970	30 to 140 (90)	3.76 ±0.17	Ξπ Ξ(1530)π	seen seen	499 336
Ω^-	0(3/2$^+$)		1672.2		2.796	See Stable Particle Table		

Baryon Table *(cont'd)*

→ For convenience all Baryon States for which information exists in the Baryon Data Card Listings are listed at the beginning of the Baryon Table. States with only a one or two star (*) rating in that list have been omitted from the main Baryon Table; each omitted state is indicated by an arrow in the left-hand margin of the Table. In the Listings there is an arrow under the name of each state omitted from the Table.

a. The names of the Baryon States in Col. 1 [such as N(1470)] contain a nominal mass which is a rounded average of the reported values in the Data Card Listings. The convention for using primes in the spectroscopic notation for the quantum numbers in Col. 2 [such as P'_{11}] is as follows: no prime is attached when the Data Card Listings include only one resonance in the given partial wave; when there is more than one resonance the first has been designated with a prime, the second with a double prime, etc. The name and the quantum numbers for each state are also given in large print at the beginning of the Data Card Listings for that state.

b. The numbers in Col. 3 and Col. 6 are calculated using the nominal mass (see a. above) for M and the nominal width (see c. below) for Γ.

c. For M and Γ of most baryons we report here an interval instead of an average. Averages are appropriate if each result is based on independent measurements, but inappropriate where the spread in parameters arises because different models or procedures have been applied to a common set of data. A single value with an approximation sign (~) indicates that there is not enough data to give a meaningful interval. A nominal width is included in parentheses in Col. 5; this nominal width is used to calculate the value of ΓM given in Col. 6.

d. For two body decay modes we give the momentum, p, of the decay products in the decaying baryon rest frame. For decay modes into ≥ 3 particles we give the maximum momentum, p_{max}, that any of the particles in the final state can have in this frame. The momenta are calculated using the nominal mass (see a. above) of the decaying baryon, and of any isobars in the final state. Some decays which would be energetically forbidden for the nominal masses actually occur because of the finite widths of the decaying Baryon and/or isobars in the final state. In these cases, the decay momentum is omitted from Col. 9 and replaced with a reference to this footnote.

e. Square brackets around an isobar decay mode indicate that it is a sub-reaction of the previous unbracketed decay mode. In the case of N^* and Δ decays into isobar modes we have used the isobar model results of LONGACRE 75 in addition to other data from the listings (where available) to estimate the branching fractions.

f. The tabulated radiative fractions involve a sum over two helicities (1/2, 3/2). In the case of I = 1/2 resonances, there are two distinct isospin couplings, whence γp and γn. For conventions and further details, see the Mini-Review preceding the Baryon Data Card Listings.

g. Only information coming from partial-wave analyses has been used here. For the production experiments results see the Baryon Data Card Listings.

h. The range given here does not include the branching ratio of approximately 80% reported by FELTESSE 75.

i. There may be more than one state in this region. The only analysis which reports an elastic coupling (LEA 73) also finds unusually low mass and width values. The inelastic branching fractions quoted here are based on an elasticity of 10%, which is a compromise between LEA 73 and RLIC 76.

j. This state has been seen only in an energy-dependent fit to total, channel, or fixed angle cross-section data. J is not known; x is Γ_{el}/Γ .

k. See note on determination of resonance parameters in the Baryon Data Card Listings. Values of mass and width are dependent upon resonance shape used to fit the data. The pole position is much less dependent upon the parametrization used. The pole positions given here are taken from results (in the Data Card Listings) of fits to the phase shifts of CARTER 73 without Coulomb corrections.

ℓ. The error given here is only an educated guess; it is larger than the error of the average of the published values (see the Baryon Data Card Listings for the latter).

m. Quoted error includes an S (scale) factor. See first footnote to Stable Particle Table.

n. In this energy region the situation is still confused. In addition to the effect at ~ 1670 MeV seen in both production and formation experiments, recent formation experiments have found evidence for fairly narrow S_{11} and/or P_{11} states at 1620-1660 MeV. A narrow bump in the I = 1 $\bar{K}N$ total cross section has also been seen recently at ~ 1590 MeV. It is not clear how many states really exist here. No one has reported a strong coupling of any of these states to $\bar{K}N$ but there is much disagreement about branching ratios into πΛ and πΣ. See the mini-reviews preceding the Σ(1620) and Σ(1670) Data Card Listings for more information.

o. Only Ξ(1530) is firmly established; information on the other states comes from experiments that have poor statistics due to the fact that the cross sections for S = - 2 states are very low. For Ξ states, because of the meager statistics, we lower our standards and tabulate resonant effects if they have at least a four-standard-deviation statistical significance and if they are seen by more than one group. See the Baryon Data Card Listings for the other states.

p. All four decay modes shown have been seen. Branching ratios are not quoted because there may be more than one state here.

q. This bump has been seen in both final states shown; it is not clear if one, or more, states are present.

PHYSICAL AND NUMERICAL CONSTANTS*

PHYSICAL CONSTANTS

		Uncert. (ppm)
N	$= 6.0220943(63) \times 10^{23}$ mole^{-1}	1.05
V_m	$= 22413.83(70)$ cm^3 mole^{-1} = molar volume of ideal gas at STP	31
c	$= 2.99792458(1.2) \times 10^{10}$ cm sec^{-1}	0.004
e	$= 4.803242(14) \times 10^{-10}$ esu $= 1.6021892(46) \times 10^{-19}$ coulomb	2.9; 2.9
1 MeV	$= 1.6021892(46) \times 10^{-6}$ erg	2.9
$\hbar = h/2\pi$	$= 6.582173(17) \times 10^{-22}$ MeV sec $= 1.0545887(57) \times 10^{-27}$ erg sec	2.6; 5.4
$\hbar c$	$= 1.9732858(51) \times 10^{-11}$ MeV cm $= 197.32858(51)$ MeV Fermi	2.6; 2.6
	$= 0.6240078(16)$ GeV mb$^{1/2}$	2.6
α	$= e^2/\hbar c = 1/137.035982(30)$	0.22
$k_{\text{Boltzmann}}$	$= 1.380662(44) \times 10^{-16}$ erg °K^{-1}	32
	$= 8.61735(28) \times 10^{-11}$ MeV °K^{-1} = 1 eV/11604.50(36) °K	32; 32
m_e	$= 0.5110034(14)$ MeV $= 9.109534(47) \times 10^{-31}$ kg	2.8; 5.1
m_p	$= 938.2796(27)$ MeV $= 1836.15152(70)\, m_e = 6.72270(31)\, m_{\pi^\pm}$	2.8; 0.38; 46
	$= 1.007276470(11)$ amu	0.011
1 amu	$= 1/12\, m_{C12} = 931.5016(26)$ MeV	2.8
m_d	$= 1875.628(5)$ MeV	3
r_e	$= e^2/m_e c^2 = 2.8179380(70)$ fermi (1 fermi $= 10^{-13}$ cm)	2.5
$\lambda\!\!\!^{-}_e$	$= \hbar/m_e c = r_e \alpha^{-1} = 3.8615905(64) \times 10^{-11}$ cm	1.6
$a_{\infty\text{Bohr}}$	$= \hbar^2/m_e e^2 = r_e \alpha^{-2} = 0.52917706(44)$Å (1Å $= 10^{-8}$ cm)	0.82
σ_{Thomson}	$= (8/3)\pi r_e^2 = 0.6652448(33) \times 10^{-24}$ cm.^{2} (10^{-24} cm^2 = 1 barn)	4.9
μ_{Bohr}	$= e\hbar/2m_e c = 0.57883785(95) \times 10^{-14}$ MeV gauss^{-1}	1.6
μ_p	$= e\hbar/2m_p c = 3.1524515(53) \times 10^{-18}$ MeV gauss^{-1}	1.7
μ_p/μ_{Bohr}	$= 1.520993136(21)$	0.014
$1/2\omega^e_{\text{cyclotron}}$	$= e/2m_e c = 8.794023(25) \times 10^6$ rad sec^{-1} gauss^{-1}	2.8
$1/2\omega^p_{\text{cyclotron}}$	$= e/2m_p c = 4.789378(13) \times 10^3$ rad sec^{-1} gauss^{-1}	2.8

Hydrogen-like atom (nonrelativistic, μ = reduced mass):

$$\frac{v}{c})_{rms} = \frac{ze^2}{n\hbar c}; \quad E_n = \frac{\mu}{2} v^2 = \frac{\mu z^2 e^4}{2(n\hbar)^2}; \quad a_n = \frac{n^2\hbar^2}{\mu z e^2}$$

$R_\infty = m_e e^4/2\hbar^2 = m_e c^2 \alpha^2/2 = 13.605804(36)$ eV (Rydberg)		2.6
$= m_e c \alpha^2/2\hbar = 109737.3143(10)$ cm^{-1}		0.009

$pc = 0.3\, H\rho$ (MeV, kilogauss, cm)

1 year (sidereal)	$= 365.256$ days $= 3.1558 \times 10^7$ sec($\approx \pi \times 10^7$ sec)
density of dry air	$= 1.205$ mg cm^{-3} (at 20°C, 760 mm)
acceleration by gravity	$= 980.62$ cm sec^{-2} (sea level, 45°)
gravitational constant	$= 6.6732(31) \times 10^{-8}$ cm^{3}g^{-1} sec^{-2}
1 calorie (thermochemical)	= 4.184 joules
1 atmosphere	$= 1033.2275$ dynes cm^{-2} = 1.01325 bar
1 eV per particle	$= 11604.50(36)$ °K (from $E = kT$)

NUMERICAL CONSTANTS

π	= 3.1415927	1 rad	= 57.2957795 deg	$\sqrt{\pi}$	= 1.7724539
e	= 2.7182818	$1/e$	= 0.3678794	$\sqrt{2}$	= 1.4142136
ln2	= 0.6931472	ln10	= 2.3025851	$\sqrt{3}$	= 1.7320508
$\log_{10}2$	= 0.3010300	$\log_{10}e$	= 0.4342945	$\sqrt{10}$	= 3.1622777

*Prepared by Stanley J. Brodsky, based mainly on the adjustment of the fundamental physical constants by E. R. Cohen and B. N. Taylor, J. Phys. Chem. Ref. Data 2, 663 (1973), plus current values for N, α, μ_p/μ_{Bohr}, R_∞ [see B. N. Taylor and E. R. Cohen, Proceedings of the Fifth International Conference on Atom Masses and Fundamental Constants (AMCO-5), Paris, 1975]. The figures in parentheses correspond to the one-standard-deviation uncertainty in the last digits of the main number. (Updated April 1976.)

CLEBSCH-GORDAN COEFFICIENTS, SPHERICAL HARMONICS, AND d FUNCTIONS

Note: A $\sqrt{\ }$ is to be understood over every coefficient; e.g., for -8/15 read $-\sqrt{8/15}$.

Notation:

	J J ...
	M M ...
m_1 m_2	Coefficients
m_1 m_2	
. .	

$$Y_1^0 = \sqrt{\frac{3}{4\pi}}\cos\theta$$

$$Y_1^1 = -\sqrt{\frac{3}{8\pi}}\sin\theta\, e^{i\phi}$$

$$Y_2^0 = \sqrt{\frac{5}{4\pi}}\left(\frac{3}{2}\cos^2\theta - \frac{1}{2}\right)$$

$$Y_2^1 = -\sqrt{\frac{15}{8\pi}}\sin\theta\cos\theta\, e^{i\phi}$$

$$Y_2^2 = \frac{1}{4}\sqrt{\frac{15}{2\pi}}\sin^2\theta\, e^{2i\phi}$$

$$Y_\ell^{-m} = (-1)^m Y_\ell^{m*}$$

$$d^\ell_{m,0} = \sqrt{\frac{4\pi}{2\ell+1}}\, Y_\ell^m e^{-im\phi}$$

$$\langle j_1 j_2 m_1 m_2 | j_1 j_2 J M\rangle = (-1)^{J-j_1-j_2}\langle j_2 j_1 m_2 m_1 | j_2 j_1 J M\rangle$$

1/2 × 1/2

	1
	+1
+1/2 +1/2	1

	1	0
	0	0
+1/2 -1/2	1/2	1/2
-1/2 +1/2	1/2	-1/2

	1
	-1
-1/2 -1/2	1

1 × 1/2

	3/2
	+3/2
+1 +1/2	1

	3/2	1/2
	+1/2	+1/2
+1 -1/2	1/3	2/3
0 +1/2	2/3	-1/3

	3/2	1/2
	-1/2	-1/2
0 -1/2	2/3	1/3
-1 +1/2	1/3	-2/3

	3/2
	-3/2
-1 -1/2	1

2 × 1

	3
	+3
+2 +1	1

	3	2
	+2	+2
+2 0	1/3	2/3
+1 +1	2/3	-1/3

	3	2	1
	+1	+1	+1
+2 -1	1/15	1/3	3/5
+1 0	8/15	1/6	-3/10
0 +1	6/15	-1/2	1/10

	3	2	1
	0	0	0
+1 -1	1/5	1/2	3/10
0 0	3/5	0	-2/5
-1 +1	1/5	-1/2	3/10

	3	2	1
	-1	-1	-1
0 -1	6/15	1/2	1/10
-1 0	8/15	-1/6	-3/10
-2 +1	1/15	-1/3	3/5

	3	2
	-2	-2
-1 -1	2/3	1/3
-2 0	1/3	-2/3

	3
	-3
-2 -1	1

1 × 1

	2
	+2
+1 +1	1

	2	1
	+1	+1
+1 0	1/2	1/2
0 +1	1/2	-1/2

	2	1	0
	0	0	0
+1 -1	1/6	1/2	1/3
0 0	2/3	0	-1/3
-1 +1	1/6	-1/2	1/3

	2	1
	-1	-1
0 -1	1/2	1/2
-1 0	1/2	-1/2

	2
	-2
-1 -1	1

2 × 1/2

	5/2
	+5/2
+2 1/2	1

	5/2	3/2
	3/2	+3/2
+2 -1/2	1/5	4/5
+1 +1/2	4/5	-1/5

	5/2	3/2
	+1/2	+1/2
+1 -1/2	2/5	3/5
0 +1/2	3/5	-2/5

	5/2	3/2
	-1/2	-1/2
0 -1/2	3/5	2/5
-1 +1/2	2/5	-3/5

	5/2	3/2
	-3/2	-3/2
-1 -1/2	4/5	1/5
-2 +1/2	1/5	-4/5

	5/2
	-5/2
-2 -1/2	1

3/2 × 1/2

	2
	+2
+3/2 +1/2	1

	2	1
	+1	+1
+3/2 -1/2	1/4	3/4
+1/2 +1/2	3/4	-1/4

	2	1
	0	0
+1/2 -1/2	1/2	1/2
-1/2 +1/2	1/2	-1/2

	2	1
	-1	-1
-1/2 -1/2	3/4	1/4
-3/2 +1/2	1/4	-3/4

	2
	-2
-3/2 -1/2	1

3/2 × 1

	5/2
	+5/2
+3/2 +1	1

	5/2	3/2
	+3/2	+3/2
+3/2 0	2/5	3/5
+1/2 +1	3/5	-2/5

	5/2	3/2	1/2
	+1/2	+1/2	+1/2
+3/2 -1	1/10	2/5	1/2
+1/2 0	3/5	1/15	-1/3
-1/2 +1	3/10	-8/15	1/6

	5/2	3/2	1/2
	-1/2	-1/2	-1/2
+1/2 -1	3/10	8/15	1/6
-1/2 0	3/5	-1/15	-1/3
-3/2 +1	1/10	-2/5	1/2

	5/2	3/2
	-3/2	-3/2
-1/2 -1	3/5	2/5
-3/2 0	2/5	-3/5

	5/2
	-5/2
-3/2 -1	1

$$d^j_{m',m} = (-1)^{m-m'} d^j_{m,m'} = d^j_{-m,-m'}$$

3/2 × 3/2

	3
	+3
+3/2 +3/2	1

	3	2
	+2	+2
+3/2 +1/2	1/2	1/2
+1/2 +3/2	1/2	-1/2

	3	2	1
	+1	+1	+1
+3/2 -1/2	1/5	1/2	3/10
+1/2 +1/2	3/5	0	-2/5
-1/2 +3/2	1/5	-1/2	3/10

	3	2	1	0
	0	0	0	0
+3/2 -3/2	1/20	1/4	9/20	1/4
+1/2 -1/2	9/20	1/4	-1/20	-1/4
-1/2 +1/2	9/20	-1/4	-1/20	1/4
-3/2 +3/2	1/20	-1/4	9/20	-1/4

	3	2	1
	-1	-1	-1
+1/2 -3/2	1/5	1/2	3/10
-1/2 -1/2	3/5	0	-2/5
-3/2 +1/2	1/5	-1/2	3/10

	3	2
	-2	-2
-1/2 -3/2	1/2	1/2
-3/2 -1/2	1/2	-1/2

	3
	-3
-3/2 -3/2	1

$$d^{1/2}_{1/2,1/2} = \cos\frac{\theta}{2} \qquad d^{1/2}_{1/2,-1/2} = -\sin\frac{\theta}{2}$$

$$d^1_{1,1} = \frac{1+\cos\theta}{2} \qquad d^1_{1,0} = -\frac{\sin\theta}{\sqrt{2}}$$

$$d^1_{1,-1} = \frac{1-\cos\theta}{2} \qquad d^1_{0,0} = \cos\theta$$

2 × 3/2

	7/2
	+7/2
+2 +3/2	1

	7/2	5/2
	+5/2	+5/2
+2 +1/2	3/7	4/7
+1 +3/2	4/7	-3/7

	7/2	5/2	3/2
	+3/2	+3/2	+3/2
+2 -1/2	1/7	16/35	2/5
+1 1/2	4/7	1/35	-2/5
0 3/2	2/7	-18/35	1/5

	7/2	5/2	3/2	1/2
	+1/2	+1/2	+1/2	+1/2
+2 -3/2	1/35	6/35	2/5	2/5
+1 -1/2	12/35	5/14	0	-3/10
0 1/2	18/35	-3/35	-1/5	1/5
-1 3/2	4/35	-27/70	2/5	-1/10

	7/2	5/2	3/2	1/2
	-1/2	-1/2	-1/2	-1/2
+1 -3/2	4/35	27/70	2/5	1/10
0 -1/2	18/35	3/35	-1/5	-1/5
-1 1/2	12/35	-5/14	0	3/10
-2 3/2	1/35	-6/35	2/5	-2/5

	7/2	5/2	3/2
	-3/2	-3/2	-3/2
0 -3/2	2/7	18/35	1/5
-1 -1/2	4/7	-1/35	-2/5
-2 1/2	1/7	-16/35	2/5

	7/2	5/2
	-5/2	-5/2
-1 -3/2	4/7	3/7
-2 -1/2	3/7	-4/7

	7/2
	-7/2
-2 -3/2	1

2 × 2

	4
	4
+2 +2	1

	4	3
	+3	+3
+2 +1	1/2	1/2
+1 +2	1/2	-1/2

	4	3	2
	+2	+2	+2
+2 0	3/14	1/2	2/7
+1 1	4/7	0	-3/7
0 2	3/14	-1/2	2/7

	4	3	2	1
	+1	+1	+1	+1
+2 -1	1/14	3/10	3/7	1/5
+1 0	3/7	1/5	-1/14	-3/10
0 1	3/7	-1/5	-1/14	3/10
-1 2	1/14	-3/10	3/7	-1/5

	4	3	2	1	0
	0	0	0	0	0
+2 -2	1/70	1/10	2/7	2/5	1/5
+1 -1	8/35	2/5	1/14	-1/10	-1/5
0 0	18/35	0	-2/7	0	1/5
-1 1	8/35	-2/5	1/14	1/10	-1/5
-2 2	1/70	-1/10	2/7	-2/5	1/5

	4	3	2	1
	-1	-1	-1	-1
+1 -2	1/14	3/10	3/7	1/5
0 -1	3/7	1/5	-1/14	-3/10
-1 0	3/7	-1/5	-1/14	3/10
-2 1	1/14	-3/10	3/7	-1/5

	4	3	2
	-2	-2	-2
0 -2	3/14	1/2	2/7
-1 -1	4/7	0	-3/7
-2 0	3/14	-1/2	2/7

	4	3
	-3	-3
-1 -2	1/2	1/2
-2 -1	1/2	-1/2

	4
	-4
-2 -2	1

$$d^{3/2}_{3/2,3/2} = \frac{1+\cos\theta}{2}\cos\frac{\theta}{2}$$

$$d^{3/2}_{3/2,1/2} = -\sqrt{3}\,\frac{1+\cos\theta}{2}\sin\frac{\theta}{2}$$

$$d^{3/2}_{3/2,-1/2} = \sqrt{3}\,\frac{1-\cos\theta}{2}\cos\frac{\theta}{2}$$

$$d^{3/2}_{3/2,-3/2} = -\frac{1-\cos\theta}{2}\sin\frac{\theta}{2}$$

$$d^{3/2}_{1/2,1/2} = \frac{3\cos\theta-1}{2}\cos\frac{\theta}{2}$$

$$d^{3/2}_{1/2,-1/2} = -\frac{3\cos\theta+1}{2}\sin\frac{\theta}{2}$$

$$d^2_{2,2} = \left(\frac{1+\cos\theta}{2}\right)^2$$

$$d^2_{2,1} = -\frac{1+\cos\theta}{2}\sin\theta$$

$$d^2_{2,0} = \frac{\sqrt{6}}{4}\sin^2\theta$$

$$d^2_{2,-1} = -\frac{1-\cos\theta}{2}\sin\theta$$

$$d^2_{2,-2} = \left(\frac{1-\cos\theta}{2}\right)^2$$

$$d^2_{1,1} = \frac{1+\cos\theta}{2}(2\cos\theta-1)$$

$$d^2_{1,0} = -\sqrt{\frac{3}{2}}\sin\theta\cos\theta$$

$$d^2_{1,-1} = \frac{1-\cos\theta}{2}(2\cos\theta+1)$$

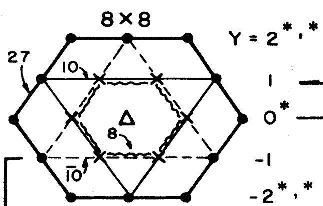
$$d^2_{0,0} = \left(\frac{3}{2}\cos^2\theta - \frac{1}{2}\right)$$

Sign convention is that of Wigner (Group Theory, Academic Press, New York, 1959), also used by Condon and Shortley (The Theory of Atomic Spectra, Cambridge Univ. Press, New York, 1953), Rose (Elementary Theory of Angular Momentum, Wiley, New York, 1957), and Cohen (Tables of the Clebsch-Gordan Coefficients, North American Rockwell Science Center, Thousand Oaks, Calif., 1974). The signs and numbers in the current tables have been calculated by computer programs written independently by Cohen and at LBL. (Table extended April 1974.)

SU(3) ISOSCALAR FACTORS

Adapted from J. J. de Swart, Rev. Mod. Phys. 35, 916 (1963)
The convention used here is: baryon first, meson second.

{8} ⊗ {8} = {27} ⊕ {10} ⊕ {10*} ⊕ {8}₁ ⊕ {8}₂ ⊕ {1}.



Multiplicity of 27;
● = 1, × = 2, Δ = 3

* Five single-coefficient tables are omitted. The one involving a {10*} has a negative coefficient, i.e. (NK|10*) = -1. The others, involving {27} and {10}, are all +1.

$Y = 1 \quad I = 1/2$ N

ξ_1	$\underset{+}{27}$	$\underset{+}{8_D}$	$\underset{-}{8_F}$	$\underset{-}{10^*}$
Nπ	$\sqrt{5}/10$	$3\sqrt{5}/10$	1/2	−1/2
ΣK	$-\sqrt{5}/10$	$-3\sqrt{5}/10$	1/2	−1/2
Nη	$3\sqrt{5}/10$	$-\sqrt{5}/10$	1/2	1/2
ΛK	$3\sqrt{5}/10$	$-\sqrt{5}/10$	−1/2	−1/2

$Y = 1 \quad I = 3/2$ Δ

ξ_1	$\underset{+}{27}$	$\underset{-}{10}$
Nπ	$\sqrt{2}/2$	$-\sqrt{2}/2$
ΣK	$\sqrt{2}/2$	$\sqrt{2}/2$

$Y = 0 \quad I = 0$ Λ

ξ_1	$\underset{+}{27}$	$\underset{+}{8_D}$	$\underset{+}{1}$	$\underset{-}{8_F}$
N$\bar{K}$	$\sqrt{15}/10$	$\sqrt{10}/10$	1/2	$\sqrt{2}/2$
ΞK	$-\sqrt{15}/10$	$-\sqrt{10}/10$	−1/2	$\sqrt{2}/2$
Σπ	$-\sqrt{10}/20$	$-\sqrt{15}/5$	$\sqrt{6}/4$	0
Λη	$3\sqrt{30}/20$	$-\sqrt{5}/5$	$-\sqrt{2}/4$	0

$Y = 0 \quad I = 1$ Σ

ξ_1	$\underset{+}{27}$	$\underset{+}{8_D}$	$\underset{-}{8_F}$	$\underset{-}{10}$	$\underset{-}{10^*}$
N$\bar{K}$	$\sqrt{5}/5$	$-\sqrt{30}/10$	$\sqrt{6}/6$	$-\sqrt{6}/6$	$\sqrt{6}/6$
ΞK	$\sqrt{5}/5$	$-\sqrt{30}/10$	$-\sqrt{6}/6$	$\sqrt{6}/6$	$-\sqrt{6}/6$
Σπ	0	0	$\sqrt{6}/3$	$\sqrt{6}/6$	$-\sqrt{6}/6$
Ση	$\sqrt{30}/10$	$\sqrt{5}/5$	0	1/2	1/2
Λπ	$\sqrt{30}/10$	$\sqrt{5}/5$	0	−1/2	−1/2

$Y = -1 \quad I = 1/2$ Ξ

ξ_1	$\underset{+}{27}$	$\underset{+}{8_D}$	$\underset{-}{8_F}$	$\underset{-}{10}$
Ξπ	$-\sqrt{5}/10$	$-3\sqrt{5}/10$	1/2	1/2
Σ$\bar{K}$	$\sqrt{5}/10$	$3\sqrt{5}/10$	1/2	1/2
Ξη	$3\sqrt{5}/10$	$-\sqrt{5}/10$	−1/2	1/2
Λ$\bar{K}$	$3\sqrt{5}/10$	$-\sqrt{5}/10$	1/2	−1/2

$Y = -1 \quad I = 3/2$

ξ_1	$\underset{+}{27}$	$\underset{-}{10^*}$
Ξπ	$\sqrt{2}/2$	$-\sqrt{2}/2$
Σ$\bar{K}$	$\sqrt{2}/2$	$\sqrt{2}/2$

The phase factor $\xi_1 = \pm 1$, from de Swart's Table I, enters in his symmetry formula (14.3):

$$\langle \mu_1 \mu_2 | \mu \rangle = \xi_1 (-1)^{I_1 + I_2 - I} \langle \mu_2 \mu_1 | \mu \rangle .$$

This factor is irrelevant if you are doing your own self-consistent calculations; it enters when you try to check someone else who chose $\mu_2 \otimes \mu_1$ instead of $\mu_1 \otimes \mu_2$.

{10} ⊗ {8} = {35} ⊕ {27} ⊕ {10} ⊕ {8}.

* Four single coefficient tables are omitted; only the {27} is -1; the three with {35} are +1.

$Y = 1 \quad I = 1/2$ N.

ξ_1	$\underset{-}{27}$	$\underset{+}{8}$
Δπ	$-\sqrt{5}/5$	$-2\sqrt{5}/5$
ΣK	$-2\sqrt{5}/5$	$\sqrt{5}/5$

$Y = 1 \quad I = 3/2$ Δ

ξ_1	$\underset{+}{35}$	$\underset{-}{27}$	$\underset{-}{10}$
Δπ	1/4	$-\sqrt{5}/4$	$\sqrt{10}/4$
Δη	$\sqrt{5}/4$	3/4	$\sqrt{2}/4$
ΣK	$\sqrt{10}/4$	$-\sqrt{2}/4$	− 1/2

$Y = 0 \quad I = 0$ Λ

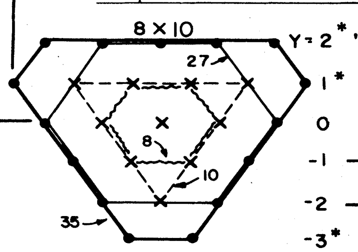
ξ_1	$\underset{-}{27}$	$\underset{+}{8}$
Σπ	$-\sqrt{10}/5$	$-\sqrt{15}/5$
ΞK	$-\sqrt{15}/5$	$\sqrt{10}/5$

$Y = 0 \quad I = 1$ Σ

ξ_1	$\underset{+}{35}$	$\underset{-}{27}$	$\underset{-}{10}$	$\underset{+}{8}$
Σπ	$\sqrt{3}/6$	$-3\sqrt{5}/10$	$\sqrt{3}/3$	$-\sqrt{30}/15$
Ση	$\sqrt{2}/2$	$\sqrt{30}/10$	0	$-\sqrt{5}/5$
ΞK	$\sqrt{3}/3$	$-\sqrt{5}/5$	$-\sqrt{3}/3$	$\sqrt{30}/15$
Δ$\bar{K}$	$\sqrt{3}/6$	$\sqrt{5}/10$	$\sqrt{3}/3$	$2\sqrt{30}/15$

$Y = 0 \quad I = 2$

ξ_1	$\underset{+}{35}$	$\underset{-}{27}$
Σπ	$\sqrt{3}/2$	−1/2
Δ$\bar{K}$	1/2	$\sqrt{3}/2$



Multiplicity of 35;
● = 1, × = 2

$Y = -1 \quad I = 1/2$ Ξ

ξ_1	$\underset{+}{35}$	$\underset{-}{27}$	$\underset{-}{10}$	$\underset{+}{8}$
Ξπ	1/4	$-7\sqrt{5}/20$	$\sqrt{2}/4$	$-\sqrt{5}/5$
Ξη	3/4	$3\sqrt{5}/20$	$-\sqrt{2}/4$	$-\sqrt{5}/5$
ΩK	$\sqrt{2}/4$	$-3\sqrt{10}/20$	− 1/2	$\sqrt{10}/5$
Σ$\bar{K}$	1/2	$\sqrt{5}/10$	$\sqrt{2}/2$	$\sqrt{5}/5$

$Y = -1 \quad I = 3/2$

ξ_1	$\underset{+}{35}$	$\underset{-}{27}$
Ξπ	$\sqrt{2}/2$	$-\sqrt{2}/2$
Σ$\bar{K}$	$\sqrt{2}/2$	$\sqrt{2}/2$

$Y = -2 \quad I = 0$ Ω^-

ξ_1	$\underset{+}{35}$	$\underset{-}{10}$
Ωη	$\sqrt{2}/2$	$-\sqrt{2}/2$
Ξ$\bar{K}$	$\sqrt{2}/2$	$\sqrt{2}/2$

$Y = -2 \quad I = 1$

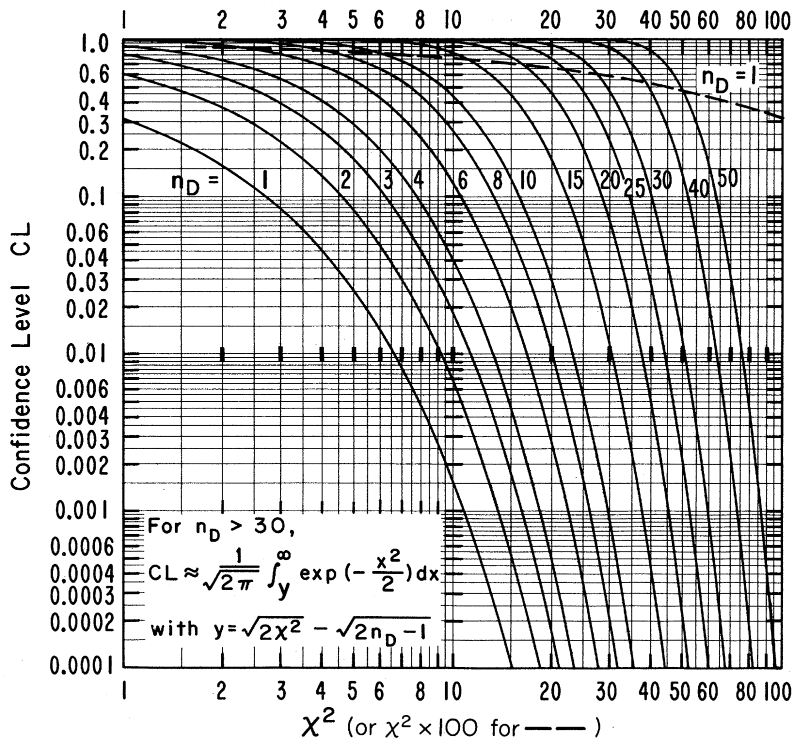
ξ_1	$\underset{+}{35}$	$\underset{-}{27}$
Ωπ	1/2	$-\sqrt{3}/2$
Ξ$\bar{K}$	$\sqrt{3}/2$	1/2

PROBABILITY AND STATISTICS

A. PROBABILITY DISTRIBUTIONS AND CONFIDENCE LEVELS

We give here properties of the three probability distributions most commonly used in high energy physics: Normal (or Gaussian), Chi-squared, and Poisson. We warn the reader that there is no universal convention for the term "confidence level" as used by physicists; thus, explicit definitions are given for each distribution, and we have attempted to choose definitions that correspond to common usage. It is explained below how confidence levels for all three distributions can be extracted from the following figure.

χ^2 Confidence Level vs. χ^2 for n_D Degrees of Freedom



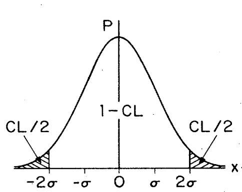
A.1. Normal Distribution

The normal distribution with mean $\bar{x}$ and standard deviation σ (variance σ^2) is:

$$P(x)dx = \frac{1}{\sqrt{2\pi}\sigma} e^{-(x-\bar{x})^2/2\sigma^2} dx. \tag{1}$$

The confidence level associated with an observed deviation from the mean, δ, is the probability that $|x-\bar{x}| > \delta$, i. e.,

$$CL = 2\int_{\bar{x}+\delta}^{\infty} dx\, P(x) \tag{2}$$



[The small figure in Eq. (2) is drawn with $\delta = 2\sigma$.] CL is given by the ordinate of the $n_D = 1$ curve in the figure at $\chi^2 = (\delta/\sigma)^2$. The confidence level for $\delta = 1\sigma$ is 31.7%; 2σ, 4.6%; 3σ, 0.3%. The central confidence interval, 1-CL, (which is also sometimes called confidence level) for $\delta = 1\sigma$ is 68.3%; 2σ, 95.4%; 3σ, 99.7%. The odds against exceeding δ, (1-CL)/CL, for $\delta = 1\sigma$ are 2.15:1; 2σ, 21:1; 3σ, 370:1; 4σ, 16,000:1; 5σ, 1,700,000:1. Relations between σ and other measures of the width: probable error (CL = 0.5 deviation) = 0.67σ; mean absolute deviation = 0.80σ; RMS deviation = σ; half width at half maximum = 1.18σ.

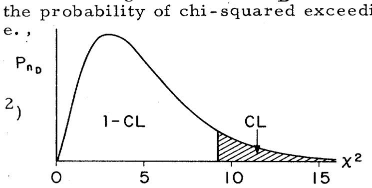
A.2. Chi-squared Distribution

The chi-squared distribution for n_D degrees of freedom is:

$$P_{n_D}(\chi^2)\, d\chi^2 = \frac{1}{2^h \Gamma(h)} (\chi^2)^{h-1} e^{-\chi^2/2} d\chi^2 \quad (\chi^2 \geq 0), \tag{3}$$

where h (for "half") = $n_D/2$. The mean and variance are n_D and $2n_D$, respectively. In evaluating Eq. (3) one may use Stirling's approximation: $\Gamma(h) = (h-1)! \approx 2.507\, e^{-h}\, h^{(h-1/2)} \times (1 + 0.0833/h)$ which is accurate to ± 0.1% for all $h \geq 1/2$. The confidence level associated with a given value of n_D and an observed value of χ^2 is the probability of chi-squared exceeding the observed value, i. e.,

$$CL = \int_{\chi^2}^{\infty} d\chi^2\, P_{n_D}(\chi^2) \tag{4}$$



[The small figure in Eq. (4) is drawn with $n_D = 5$ and CL = 10%.] CL is plotted as a function of χ^2 for several values of n_D in the above figure. For large n_D, χ^2 becomes normally distributed about n_D. Thus,

$$y_1 = (\chi^2 - n_D)/\sqrt{2n_D} \tag{5}$$

becomes normally distributed with unit standard deviation. A better approximation, due to Fisher,[1] is that χ, not χ^2, becomes normally distributed, specifically

$$y_2 = \sqrt{2\chi^2} - \sqrt{2n_D - 1} \tag{6}$$

approaches normality with unit standard deviation. For small CL's in particular, y_2 is much more accurate than y_1. Thus, for $n_D = 50$ and $\chi^2 = 80$, the true CL = 0.45%, but y_1 is 3.0 corresponding to a CL of 0.13%, while y_2 is 2.7 corresponding to a CL of 0.35%.

PROBABILITY AND STATISTICS (Cont'd)

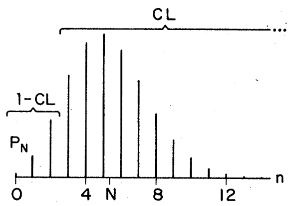
A.3. Poisson Distribution

The Poisson distribution with mean $\bar{n}$ is:

$$P_{\bar{n}}(n) = \frac{e^{-(\bar{n})}(\bar{n})^n}{n!} \quad (n = 0, 1, 2, \cdots) . \tag{7}$$

The variance is equal to the mean. Confidence levels for Poisson distributions are usually defined in terms of quantities called "upper limits" as follows: The confidence level associated with a given upper limit N and an observed value n_0 of n is the probability that $n > n_0$ if $\bar{n} = N$, i.e.,

$$CL = \sum_{n=n_0+1}^{\infty} P_N(n) = 1 - \sum_{n=0}^{n_0} P_N(n) \tag{8}$$



[The small figure in Eq. (8) is drawn with $n_0 = 2$ and CL = 90%.] A useful relation between Poisson and chi-squared confidence levels allows one to look up this quantity on the above figure. Specifically, the quantity 1-CL is given by the ordinate of the $n_D = 2(n_0+1)$ curve at $\chi^2 = 2N$. Thus, 90% confidence level upper limits for n_0 = 0, 1, and 2 are given by half the χ^2 value corresponding to an ordinate of 0.1 on the n_D = 2,4, and 6 curves, respectively; the values are N = 2.3, 3.9, and 5.3.

- -

Tables of confidence levels for all three of these distributions, the relation between Poisson and chi-squared confidence levels, and numerous other useful tables and relations may be found in Ref. 2.

B. STATISTICS

We consider here the situation in which one is presented with N independent data, $y_n \pm \sigma_n$, and it is desired to make some inference about the "true" value of the quantity represented by these data. For this purpose we interpret each datum y_n as a single sample point drawn randomly (and independently of the other data) from a distribution having mean $\bar{y}_n$ (which we wish to estimate) and variance σ_n^2. (Identification of the true σ_n with the σ_n datum is an approximation which may become seriously inaccurate when σ_n is an appreciable fraction of y_n.) Some methods of estimation commonly used in high energy physics are given below; see Ref. 3 for numerous applications. Section B.1. deals with the case in which all $\bar{y}_n$ are the same, e.g., several different measurements of the same quantity; Sec. B.2. deals with the case in which $\bar{y}_n = \bar{y}(x_n)$, where x_n represents some set of independent variables, e.g., cross-section measurements at various values of energy and angle, $x_n = \{E_n, \theta_n\}$.

B.1. Single Mean and Variance Estimates

(1) If the y_n represent a set of values all supposedly drawn from a single distribution with mean $\bar{y}$ and variance σ^2 (i.e., the σ_n are all the same, but their common value is unknown) then

$$\bar{y}_e = \frac{1}{N}\sum_n y_n \quad \text{and} \tag{9}$$

$$\sigma_e^2 = \frac{1}{N-1}\sum_n (y_n - \bar{y}_e)^2 \tag{10}$$

are unbiased estimates of $\bar{y}$ and σ^2. The variance of $\bar{y}_e$ is σ^2/N. If the parent distribution is normal and N is large, the variance of σ_e^2 is $2\sigma^4/N$.

(2) If the $\bar{y}_n$ all have the common value $\bar{y}$ and the σ_n are known, then the weighted average

$$\bar{y}_e = \frac{1}{w}\sum_n w_n y_n , \tag{11}$$

where $w_n = 1/\sigma_n^2$ and $w = \Sigma w_n$, is an appropriate unbiased estimate of $\bar{y}$. This choice of weighting factors in Eq. (11) minimizes the variance of the estimate; the variance is $1/w$.

B.2. Linear Least Squares Fit

A least squares fit of the function $y(x) = \Sigma_i a_i f_i(x)$ to independent data $y_n \pm \sigma_n$ at points x_n (e.g., a Legendre fit in which the f_i are Legendre polynomials and the a_i are Legendre coefficients) gives the following estimates of the parameters a_i:

$$a_{e,i} = \sum_{j,n} V_{ij} f_j(x_n) y_n/\sigma_n^2 . \tag{12}$$

Here V is the covariance matrix of the fitted parameters

$$V_{ij} = \overline{(a_{e,i} - \bar{a}_{e,i})(a_{e,j} - \bar{a}_{e,j})} , \tag{13}$$

which is given by

$$(V^{-1})_{ij} = \sum_n f_i(x_n) f_j(x_n)/\sigma_n^2 . \tag{14}$$

The variance of an interpolated or extrapolated value of y at point x, $y_e = \Sigma a_{e,i} f_i(x)$, is:

$$\overline{(y_e - \bar{y}_e)^2} = \sum_{ij} V_{ij} f_i(x) f_j(x) . \tag{15}$$

For the case of a straight line fit, $y(x) = a + bx$, one obtains the following estimates of a and b,

$$a_e = (S_y S_{xx} - S_x S_{xy})/D, \quad b_e = (S_1 S_{xy} - S_x S_y)/D, \tag{16}$$

where

$$S_1, S_x, S_y, S_{xx}, S_{xy} = \Sigma(1, x_n, y_n, x_n^2, x_n y_n)/\sigma_n^2 , \quad D = S_1 S_{xx} - S_x^2 . \tag{17}$$

The covariance matrix of the fitted parameters is:

$$\begin{pmatrix} V_{aa} & V_{ab} \\ V_{ab} & V_{bb} \end{pmatrix} = \frac{1}{D}\begin{pmatrix} S_{xx} & -S_x \\ -S_x & S_1 \end{pmatrix} \tag{18}$$

The variance of an interpolated or extrapolated value of y at point x is:

$$\overline{(y_e - \bar{y}_e)^2} = \frac{1}{S_1} + \frac{S_1}{D}\left(x - \frac{S_x}{S_1}\right)^2 \tag{19}$$

C. ERROR PROPAGATION

We consider here the situation in which one wishes to calculate the value and error of a function of some other quantities with errors, e.g., in a Monte Carlo program. Let $\{y\}$ be a set of random variables with means $\{\bar{y}\}$ and covariance matrix V. Then the mean and variance of a function of these variables are approximately (to second order in $\{y-\bar{y}\}$):

$$\bar{f} \approx f(\{y\}) + \frac{1}{2}\sum_{mn} V_{mn}\left(\frac{\partial^2 f}{\partial y_m \partial y_n}\right)_{\{y\}=\{\bar{y}\}} , \tag{20}$$

$$\overline{(f - \bar{f})^2} = \sum_{mn} V_{mn}\left(\frac{\partial f}{\partial y_m}\right)_{\{y\}=\{\bar{y}\}}\left(\frac{\partial f}{\partial y_n}\right)_{\{y\}=\{\bar{y}\}} . \tag{21}$$

E.g., the mean and variance of a function of a single variable with mean $\bar{y}$ and variance σ^2 are:

$$\bar{f} \approx f(\bar{y}) + \frac{1}{2}\sigma^2 f''(\bar{y}), \tag{22}$$

$$\overline{(f - \bar{f})^2} = \sigma^2 f'(\bar{y})^2 . \tag{23}$$

Note that these equations will usually be applied by substituting some measured quantities, $\{\tilde{y}\}$ say, for the true means, $\{\bar{y}\}$. If, as is often the case, $\tilde{y}_n - \bar{y}_n$ is of order $\sqrt{V_{nn}}$, then there is no point in keeping the second order terms in Eq. (20) or (22) since the substitution itself introduces first order errors.

1. R. A. Fisher, Statistical Methods for Research Workers (Oliver and Boyd, Edinburgh and London, 1958).
2. M. Abramovitz and I. Stegun, eds., Handbook of Mathematical Functions (National Bureau of Standards, Applied Mathematics Series, Vol. 55, Washington, 1964).
3. W. T. Eadie, D. Drijard, F. E. James, M. Roos, and B. Sadoulet, Statistical Methods in Experimental Physics (North-Holland, Amsterdam and London, 1971).

Revised and expanded April 1974.

RELATIVISTIC KINEMATICS*

DEFINITIONS AND GENERAL FORMULAE

I. NOTATION

We define any 4-vector p by its components:

$$p \equiv (p_0, \vec{P}) \quad \text{with} \quad \begin{cases} p_0 \equiv E \equiv \text{the energy} \\ \vec{P} \equiv (P_\parallel, \vec{P}_\perp) = \text{3-vector of magnitude } P, \end{cases} \tag{I-1}$$

where $\begin{cases} P_\parallel \equiv \text{the longitudinal momentum along a beam direction} \\ \vec{P}_\perp \equiv \text{the transverse momentum (2 components, along 2 axes perpendicular to the beam);} \end{cases}$

then

$$p^{lab} = (E^{lab}, P_\parallel^{lab}, \vec{P}_\perp^{lab}) , \tag{I-2}$$

$$p^{cm} = (E^{cm}, P_\parallel^{cm}, \vec{P}_\perp^{cm}) . \tag{I-3}$$

The 4-vector scalar products are defined by

$$A \cdot B = A_0 B_0 - \vec{A} \cdot \vec{B} , \tag{I-4}$$

so that

$$p^{lab} \cdot p^{lab} = p^{cm} \cdot p^{cm} = m^2 . \tag{I-5}$$

II. GENERAL INVARIANT DEFINITIONS AND RELATED FORMULAE

For any 2 particles i and j, the most commonly used invariants are defined as follows:

A. *The invariant mass squared of the combination of particles i and j is*

$$s_{ij} \equiv m_{ij}^2 \equiv (p_i + p_j)^2 = m_i^2 + m_j^2 + 2(E_i E_j - \vec{P}_i \cdot \vec{P}_j) . \tag{II-1}$$

Using the function $\Delta(x,y,z)$ [also called $\lambda(x,y,z)$], defined by

$$\Delta(x,y,z) \equiv x^2 + y^2 + z^2 - 2xy - 2yz - 2zx$$
$$= [x - (\sqrt{y} + \sqrt{z})^2][x - (\sqrt{y} - \sqrt{z})^2] , \tag{II-2}$$

we have the relations:

A.1. *In the particle j rest frame* ($\vec{P}_j = 0$), the longitudinal axis being along $\vec{P}_i$,

$$p_i^{(j)} = \left(\frac{s_{ij} - m_i^2 - m_j^2}{2m_j} , \frac{\sqrt{\Delta(s_{ij}, m_i^2, m_j^2)}}{2m_j} , 0 \right) ; \tag{II-6}$$

A.2. *In the c.m. frame for particles (i and j)* ($\vec{P}_j = -\vec{P}_i$), the longitudinal axis being along $\vec{P}_i$,

$$p_i^{(ij)} = \left(\frac{s_{ij} + m_i^2 - m_j^2}{2\sqrt{s_{ij}}} , \frac{\sqrt{\Delta(s_{ij}, m_i^2, m_j^2)}}{2\sqrt{s_{ij}}} , 0 \right) ; \tag{II-11}$$

thus,

$$p_i^{(ij)} = \frac{m_j}{\sqrt{s_{ij}}} p_i^{(j)} . \tag{II-13}$$

A.3. *Applications: Useful relations involving* s_{ij}:

i) *In a Dalitz plot for the 3-body decay,* $X \to 1 + 2 + 3$,

$$\sum_{i<j} s_{ij} = \sum_i m_i^2 + m_{123}^2 = \text{const. } (i,j = 1,2,3) \tag{II-14}$$

with $m_{123}^2 = (p_1 + p_2 + p_3)^2 = m_X^2$.

ii) *In a triangle plot for the 4-body decay,* $X \to 1 + 2 + 3 + 4$,

$$\sum_{i<j} s_{ij} = 2\sum_i m_i^2 + m_{1234}^2 = \text{const. } (i,j = 1,2,3,4) \tag{II-15}$$

with $m_{1234}^2 = (p_1 + p_2 + p_3 + p_4)^2 = m_X^2$.

B. *The invariant momentum transfer squared* between particles i and k is

$$t_{ik} \equiv (p_i - p_k)^2 = m_i^2 + m_k^2 - 2(E_i E_k - \vec{P}_i \cdot \vec{P}_k) . \tag{II-16}$$

$$t_{ik} = t_{ik}^{min} + 2(\vec{P}_i \cdot \vec{P}_k - P_i P_k) = t_{ik}^{min} - 4P_i P_k \sin^2 \frac{\theta_{ik}}{2} \tag{II-19}$$

(θ_{ik} being the angle between $\vec{P}_i$ and $\vec{P}_k$).

PARTICULAR CASES AND ASYMPTOTIC VALUES ($\simeq$)

III. VERY HIGH ENERGY PHYSICS: ASYMPTOTIC FORMULAE

A. *Colliding beams*

$$s \simeq 2(E_a E_b - \vec{P}_a \cdot \vec{P}_b) \tag{III-1}$$

If θ is the *supplement* of the angle between the two beams, (and if we assume $E_i \simeq P_i$), then:

$$s \simeq 4P_a P_b \cos^2 \frac{\theta}{2} \simeq 4P_a P_b \left(1 - \frac{\theta^2}{8} + \ldots\right) \tag{III-2}$$

B. *Interaction of particle a with target b at rest*

B.1. *In the lab frame*

$$s = s_{ab} = m_a^2 + m_b^2 + 2m_b E_a^{lab} \simeq 2m_b E_a^{lab} \tag{III-3}$$

and

$$P_{inc} \simeq \frac{s}{2m_b} . \tag{III-4}$$

B.2. *In the center-of-mass frame*

$$s = s_{ab} = (E_a^{cm} + E_b^{cm})^2 \simeq 4(P_a^{cm})^2 \tag{III-5}$$

and

$$P_a^{cm} = P_b^{cm} \simeq \frac{\sqrt{s}}{2} \tag{III-6}$$

and

$$\begin{cases} p_a = \left(\dfrac{s + m_a^2 - m_b^2}{2\sqrt{s}} , \dfrac{m_b}{\sqrt{s}} P_{inc} , 0 \right) \\ p_b = \left(\dfrac{s + m_b^2 - m_a^2}{2\sqrt{s}} , \dfrac{-m_b}{\sqrt{s}} P_{inc} , 0 \right) . \end{cases}$$

RELATIVISTIC KINEMATICS (Cont'd)

Application to the reaction $a + b \to c + d$:

1. *General formulae*

$$t \equiv t_{ac} = t_{bd} = t_{ac}^{min} - 4P_a P_c \sin^2\left(\frac{\theta_{ac}}{2}\right) ,$$

with
$$t_{ac}^{\substack{min\\max}} = (E_a - E_c)^2 - (P_a \mp P_c)^2 \quad \text{(II-20)}$$

which, after expansion in powers of (1/s), gives

$$t_{ac}^{min} = -\frac{(m_a^2 - m_c^2)(m_b^2 - m_d^2)}{s} - \frac{(m_a^2 + m_b^2 - m_c^2 - m_d^2)(m_a^2 m_b^2 - m_c^2 m_d^2)}{s^2} + O\left(\frac{1}{s^3}\right) \quad \text{(II-22)}$$

In a similar way, defining $u_{ad} = (p_a - p_d)^2$, one finds

$$u \equiv t_{ad} = t_{bc} = u_{ad}^{min} - 4P_a P_d \sin^2\left(\frac{\theta_{ad}}{2}\right) .$$

$$u_{ad}^{min} = -\frac{(m_a^2 - m_d^2)(m_b^2 - m_c^2)}{s} - \frac{(m_a^2 + m_b^2 - m_c^2 - m_d^2)(m_a^2 m_b^2 - m_c^2 m_d^2)}{s^2} + O\left(\frac{1}{s^3}\right) \quad \text{(II-23)}$$

A general relation between the invariants is

$$s + t + u = m_a^2 + m_b^2 + m_c^2 + m_d^2 .$$

2. *Particular case*

In the c.m.: $dt = 2P_a P_c\, d(\cos\theta_{ac})$.

i) $m_a = m_c$, $m_b \neq m_d$:

$$t_{ac}^{min} \simeq -\frac{m_a^2 (m_b^2 - m_d^2)^2}{s^2} \quad \text{(II-24)}$$

$$u_{ad}^{min} \simeq -\frac{(m_a^2 - m_d^2)(m_b^2 - m_c^2)}{s} \quad \text{(II-25)}$$

ii) For elastic scattering $(a + b \to a' + b')$,

$$t_{aa'}^{min} = 0,$$

and
$$t_{aa'} = -4P_a^2 \sin^2\left(\frac{\theta_{aa'}}{2}\right) ,$$

$$dt_{aa'} = 2P_a^2\, d(\cos\theta_{aa'}); \quad \text{(II-26)}$$

also
$$u_{ab'}^{min} = \frac{(m_a^2 - m_b^2)^2}{s} \quad \text{(II-27)}$$

IV. RELATIONS BETWEEN THE (j) PARTICLE AND (ij) PARTICLE REST FRAMES: LORENTZ TRANSFORMATION

The general Lorentz transformation has the matrix form

$$\begin{pmatrix} E \\ P_\parallel \\ \vec{P}_\perp \end{pmatrix}^{(ij)} = \begin{pmatrix} \gamma & -\eta & 0 \\ -\eta & \gamma & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} E \\ P_\parallel \\ \vec{P}_\perp \end{pmatrix}^{(j)} \quad \text{(IV-1)}$$

If we define, in any frame, the quantity: $P_\pm = E \pm P_\parallel$,

$$\begin{pmatrix} P_+ \\ P_- \\ \vec{P}_\perp \end{pmatrix}^{(ij)} = \begin{pmatrix} (\gamma-\eta) & 0 & 0 \\ 0 & (\gamma+\eta) & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} P_+ \\ P_- \\ \vec{P}_\perp \end{pmatrix}^{(j)} , \quad \text{(IV-3)}$$

$$\gamma \mp \eta = \frac{s_{ij} + m_j^2 - m_i^2 \mp \sqrt{\Delta(s_{ij}, m_i^2, m_j^2)}}{2m_j \sqrt{s_{ij}}} = e^{\mp\xi_{ij}} . \quad \text{(IV-4)}$$

$$\left\{ \begin{array}{ll} |\vec{\beta}| = \dfrac{|\vec{\eta}|}{\gamma} = \tanh \xi_{ij} = \dfrac{\sqrt{\Delta(s_{ij}, m_i^2, m_j^2)}}{s_{ij} + m_j^2 - m_i^2} = \dfrac{P_i^{(j)}}{E_i^{(j)} + m_j} & \text{(IV-5)} \\ \gamma = \dfrac{1}{\sqrt{1-\beta^2}} = \cosh \xi_{ij} = \dfrac{s_{ij} + m_j^2 - m_i^2}{2m_j\sqrt{s_{ij}}} = \dfrac{E_i^{(j)} + m_j}{\sqrt{s_{ij}}} & \text{(IV-6)} \\ |\vec{\eta}| = |\vec{\beta}|\gamma = \sinh \xi_{ij} = \dfrac{\sqrt{\Delta(s_{ij}, m_i^2, m_j^2)}}{2m_j\sqrt{s_{ij}}} = \dfrac{P_i^{(j)}}{\sqrt{s_{ij}}} & \text{(IV-7)} \end{array} \right.$$

The spatial part of the matrix in Eq. (IV-1) above can be written with the classical vector form

$$\vec{P}^{(ij)} = \vec{P}^{(j)} + \vec{\eta}\left(\frac{\vec{\eta}\cdot\vec{P}}{\gamma+1} - E^{(j)}\right) \quad \text{(IV-9)}$$

A convenient way to write the latter expression is

$$\vec{P}^{(ij)} = \vec{P}^{(j)} - \vec{\eta}\left[\frac{E^{(ij)} + E^{(j)}}{\gamma+1}\right] \quad \text{(IV-10)}$$

At high energy:

$$e^{\xi_{ij}} \simeq \frac{\sqrt{s_{ij}}}{m_j} \quad \text{and} \quad \xi_{ij} \simeq \ln\frac{\sqrt{s_{ij}}}{m_j} .$$

ξ_{ij} is called the *boost parameter* of the Lorentz transformation that connects the particle ij rest frame to the particle j rest frame.

Application

1. *To reaction* a(beam) + b(target)

The transformation from the lab frame into the c.m. frame is given by:

$$\gamma = \frac{E_a^{lab} + m_b}{\sqrt{s}} \quad \text{and} \quad \eta = \frac{P_{inc}}{\sqrt{s}} ;$$

$$P_\pm^{cm} = e^{\mp\xi} P_\pm^{lab}$$

with
$$e^{\pm\xi} = \frac{s + m_b^2 - m_a^2 \mp \sqrt{\Delta(s, m_a^2, m_b^2)}}{2m_b\sqrt{s}} \quad \text{(IV-11)}$$

2. *The Lorentz transform of any vector* $p_1 = (E_1, \vec{P}_1)$, *given in a frame containing another vector* $p_2 = (E_2, \vec{P}_2)$, *into the* p_2 *rest frame* — where $p_2 = (m_2, 0)$, and $p_1 = (E_1', \vec{P}_1')$ — may be calculated using:

$$\gamma = \frac{E_2}{m_2} \quad \text{and} \quad \vec{\eta} = \frac{\vec{P}_2}{m_2} :$$

$$\left. \begin{array}{l} E_1' = \gamma E_1 - \vec{\eta}\cdot\vec{P}_1 = \dfrac{E_1 E_2 - \vec{P}_1\cdot\vec{P}_2}{m_2} , \\ \vec{P}_1' = \vec{P}_1 - \dfrac{\vec{P}_2}{m_2}\left(\dfrac{E_1 + E_1'}{\gamma+1}\right) = \vec{P}_1 - \vec{P}_2\left(\dfrac{E_1 + E_1'}{E_2 + m_2}\right) \end{array} \right\} \quad \text{(IV-12)}$$

RELATIVISTIC KINEMATICS (Cont'd)

V. RAPIDITY VARIABLE: DEFINITION AND KINEMATIC RELATIONS

Definition: in any system, for a particle of energy E and longitudinal momentum $P_{\parallel}$, the rapidity is defined by

$$y \equiv \tfrac{1}{2}\ln\left(\frac{E+P_{\parallel}}{E-P_{\parallel}}\right) = \tanh^{-1}\left(\frac{P_{\parallel}}{E}\right)$$
$$= \tfrac{1}{2}\ln\left(\frac{P_+}{P_-}\right) = \ln\left(\frac{P_+}{m_\perp}\right) = -\ln\left(\frac{P_-}{m_\perp}\right) , \qquad \text{(V-1)}$$

with the transverse mass $m_\perp \equiv (m^2 + P_\perp^2)^{\frac{1}{2}}$.

From the last of the two equations above, one gets

$$P_+ = m_\perp e^{y} , \qquad \text{(V-2)}$$
$$P_- = m_\perp e^{-y} , \qquad \text{(V-3)}$$

so that

$$E = m_\perp \cosh y , \qquad \text{(V-4)}$$
$$P_{\parallel} = m_\perp \sinh y . \qquad \text{(V-5)}$$

A. *Relations between the rapidities of different frames:*

$$y^{(ij)} = y^{(j)} - \xi_{ij} \qquad \text{(V-7)}$$

B. *Application to a reaction* a + b → c + d (or a + b → c + X):

In the lab frame,

$$p_a^{lab} = (m_a \cosh y_a^{lab},\ m_a \sinh y_a^{lab},\ 0)$$
$$p_b^{lab} = (m_b,\ 0,\ 0) \qquad \text{(V-8)}$$
$$p_c^{lab} = (m_{\perp c} \cosh y_c^{lab},\ m_{\perp c} \sinh y_c^{lab},\ \vec{P}_{\perp c})$$

(and a similar formula for particle d or X).

In the c.m. frame,

$$p_a^{cm} = (m_a \cosh y_a^{cm},\ m_a \sinh y_a^{cm},\ 0)$$
$$p_b^{cm} = (m_b \cosh y_b^{cm},\ m_b \sinh y_b^{cm},\ 0) \qquad \text{(V-9)}$$
$$p_c^{cm} = (m_{\perp c} \cosh y_c^{cm},\ m_{\perp c} \sinh y_c^{cm},\ \vec{P}_{\perp c})$$

(and a similar formula for particle d or X).

$$y_a^{lab} = \cosh^{-1}\left(\frac{s - m_a^2 - m_b^2}{2m_a m_b}\right) \xrightarrow[\text{at large } s]{} y_a^{lab} \simeq \ln\frac{s}{m_a m_b} \qquad \text{(V-10)}$$

$$y_a^{cm} = \cosh^{-1}\left(\frac{s + m_a^2 - m_b^2}{2m_a\sqrt{s}}\right) \xrightarrow[\text{at large } s]{} y_a^{cm} \simeq \ln\frac{\sqrt{s}}{m_a} \qquad \text{(V-11)}$$

$$y_b^{cm} = \cosh^{-1}\left(\frac{s + m_b^2 - m_a^2}{2m_b\sqrt{s}}\right) \xrightarrow[\text{at large } s]{} y_b^{cm} \simeq -\ln\frac{\sqrt{s}}{m_b} \qquad \text{(V-12)}$$

$$y_c^{cm} = \cosh^{-1}\left(\frac{s + m_c^2 - m_d^2}{2m_{\perp c}\sqrt{s}}\right) \xrightarrow[\text{at large } s]{} y_c^{cm} \simeq \ln\frac{\sqrt{s}}{m_{\perp c}} \qquad \text{(V-13)}$$

and m_d^2 (or m_X^2) $<<$s

With $\xi \simeq \ln\frac{\sqrt{s}}{m_b}$, one gets, at large s:

$$y_c^{lab} \simeq \ln\frac{s}{m_b m_{\perp c}} \qquad \text{(V-14)}$$

$$y^{lab} \simeq \tfrac{1}{2}\ln\left(\frac{p^{lab} + p_{\parallel}^{lab}}{p^{lab} - p_{\parallel}^{lab}}\right) \simeq -\ln(\tan\frac{\theta}{2}) .$$

The *maximum rapidity gap* for the reaction a + b → c + d at large s is:

i) for the incoming particles (a,b):

$$y_{ab} = y_a^{lab} = y_a^{cm} - y_b^{cm} \simeq \ln\frac{s}{m_a m_b} \qquad \text{(V-15)}$$

ii) for the outgoing particles (c,d):

$$y_{cd} = y_c^{lab} - y_d^{lab} = y_c^{cm} - y_d^{cm} \simeq \ln\frac{s}{m_{\perp c} m_{\perp d}} \qquad \text{(V-16)}$$

Application to reaction a + b → 1 + 2 ... + N, with the N outgoing particles being ordered by increasing rapidity.

1. *The maximum rapidity gap* between the outgoing particles has an approximate value

$$y_{1N} \simeq \ln\frac{s}{m_{\perp 1}\, m_{\perp N}} \qquad \text{(V-17)}$$

2. *The rapidity gap* $(y_i - y_j)$ between the rapidities y_i and y_j of particles i and j, respectively, is related to the invariant mass squared of particles i and j

$$s_{ij} = m_i^2 + m_j^2 + 2m_{\perp i}\cdot m_{\perp j}\cosh(y_i - y_j) - 2\vec{P}_{\perp i}\cdot\vec{P}_{\perp j} , \qquad \text{(V-18)}$$

$$y_i - y_j = \cosh^{-1}\frac{s_{ij} - m_i^2 - m_j^2 + 2\vec{P}_{\perp i}\cdot\vec{P}_{\perp j}}{2m_{\perp i}m_{\perp j}} \qquad \text{(V-19)}$$

3. *The rapidity gap between either of the extreme particles (1 or N) and its adjacent neighbor* [2 or (N - 1) respectively] is, on a statistical basis, and in first approximation

$$|y_1 - y_2| \simeq \ln\frac{s}{M_1^2} , \qquad \text{(V-20)}$$

and

$$|y_{N-1} - y_N| \simeq \ln\frac{s}{M_N^2} , \qquad \text{(V-21)}$$

M_1 (M_N) being the missing mass with respect to particle 1 (N) in the reaction a + b → 1 + M_1 (a + b → N + M_N).

4. The rapidity gap y_{a1} between the incoming particle a and the outgoing particle closest to a, 1, is related to the transverse momentum $t_{a1} = (p_a - p_1)^2$:

$$y_a - y_1 = \cosh^{-1}\left(\frac{t_{a1} - m_a^2 - m_1^2}{2m_a m_{\perp 1}}\right) \qquad \text{(V-23)}$$

RELATIVISTIC KINEMATICS (Cont'd)

VI. INCLUSIVE REACTIONS AND SCALING VARIABLES: DEFINITIONS AND KINEMATIC RELATIONS

A. Scaling Variable: Definitions

• For the *inclusive reaction* $a + b \to c + X$

1) Feynman's definition:

$$x = P_{\parallel}^{cm}/P_{max}^{cm} \quad \text{(VI-3)}$$

where

$$P_{max}^{cm} = \frac{\sqrt{\Delta(s, m_c^2, m_{X,min}^2)}}{2\sqrt{s}} \quad \text{(VI-4)}$$

is the center-of-mass momentum of particle c and the lightest possible particle(s) $m_{X,min}$ which, consistent with conservation laws, could recoil against particle c.

A *relationship between x and* m_X^2 which becomes useful at high energy [see (VI-6)] derives from

$$m_X^2 = (p_a + p_b - p_c)^2 = s + m_c^2 - 2p_c \cdot (p_a + p_b)$$

• *At high energy*,

$$P_{max}^{cm} \simeq \frac{\sqrt{s}}{2} \quad \text{and} \quad x \simeq \frac{2P_{\parallel}^{cm}}{\sqrt{s}} . \quad \text{(VI-5)}$$

The relation between x and y is trivial:

$$x \simeq 2\frac{P_{\parallel}^{cm}}{\sqrt{s}} \simeq \frac{2m_{\perp}}{\sqrt{s}} \sinh y^{cm} \quad \text{(VI-8)}$$

and, for y also large:

$$y^{cm} \simeq \ln \frac{x\sqrt{s}}{m_{\perp}} \quad \text{(VI-9)}$$

$$x = 1 - \frac{m_X^2 - m_c^2}{s} \simeq 1 - \frac{m_X^2}{s} \quad \text{(VI-6)}$$

(for $m_X^2 >> m_c^2$) .

2) An alternative definition:

$$x' = P_{\parallel}^{cm}/P_{\parallel max}^{cm} \quad \text{(VI-7)}$$

with

$$P_{\parallel max}^{cm} = \sqrt{\left(P_{max}^{cm}\right)^2 - P_{\perp}^2} .$$

For $P_{\perp}$ fixed as $s \to \infty$,

$$x' \simeq \frac{2P_{\parallel}^{cm}}{\sqrt{s}} \simeq x .$$

• For *electro- and photoproduction*:

1) Bjorken's definition:

$$\omega = \frac{2m_p\nu}{q^2} ,$$

where

- $\nu = e - e'$ = the difference between the incident and the outgoing energies
- m_p = proton mass
- q^2 = momentum transfer squared .

(NOTE: ω^{-1} is sometimes also called x.)

2) Bloom-Gilman's definition:

$$\omega' = \omega + \frac{m_p^2 - q^2}{q^2}$$

For q^2 and ν large (Bjorken limit),

$$\omega' \simeq \omega - 1 .$$

B. For the inclusive reaction $a + b \to c + X$, *the invariant differential cross section* $E(d^3\sigma/dp_c^3)$ may be written in the following forms using various expressions of the phase space volume d^3p_c/E_c (and omitting the subscript c):

Longitudinal variable of particle c	Transverse variable of particle c	Corresponding invariant (differential) cross section $E(d^3\sigma/dp^3)$
P^{lab}	θ^{lab}	$\frac{E^{lab}}{(P^{lab})^2} \frac{d^3\sigma}{dP^{lab} d\Omega^{lab}}$ (VI-10)
$P_{\parallel}$	$P_{\perp}$	$\frac{E}{\pi} \frac{d^2\sigma}{dP_{\parallel}\, dP_{\perp}^2}$ (averaged over azimuth) (VI-11)
x	$P_{\perp}$	$\frac{E^{cm}}{P_{max}^{cm}} \cdot \frac{1}{\pi} \frac{d^2\sigma}{dx dP_{\perp}^2} \simeq \frac{2E^{cm}}{\pi\sqrt{s}} \frac{d^2\sigma}{dx dP_{\perp}^2}$ (averaged over azimuth) (VI-12)
y	$P_{\perp}$ (or $m_{\perp}$)	$\frac{1}{\pi} \frac{d^2\sigma}{dy dP_{\perp}^2} = \frac{1}{\pi} \frac{d^2\sigma}{dy dm_{\perp}^2}$ (averaged over azimuth) (VI-13)
$m_X^2 = (p_a + p_b - p_c)^2$	$t = (p_a - p_c)^2$	$\frac{\sqrt{\Delta(s, m_a^2, m_b^2)}}{\pi} \frac{d^2\sigma}{dm_X^2 dt}$ (averaged over azimuth) (VI-14)

*See Denyse M. Chew, "Relativistic Kinematics", Particle Data Group Memo PDG-101, for details and references.

Revised and expanded April 1976.

PARTICLE DETECTORS, ABSORBERS, AND RANGES*

A. DETECTOR PARAMETERS

In this section we give various parameters for common detectors. The quoted numbers represent at best an order of magnitude useful only for preliminary design.

A.1 Scintillators: Photon yield $\approx 1\gamma/100$ eV in plastic scintillator[1] and $\approx 1\gamma/25$ eV in Na I.[1,2]

A.2 Čerenkov[3]: Half angle θ_c of cone aperture in terms of velocity β and index of refraction n:

$$\theta_c = \arc\cos\left(\frac{1}{\beta n}\right) \sim \sqrt{2\left(1 - \frac{1}{\beta n}\right)}\ .$$

Threshold velocity: $\beta_t = 1/n;\ \gamma_t = 1/\sqrt{1-\beta_t^2}$.

Therefore, $\beta_t\gamma_t = 1/\sqrt{2\delta + \delta^2}$, where $\delta = n-1$. Values of δ for various commonly used gases are given as a function of pressure and wavelength in Ref. 4; for values at atmospheric pressure, see the Table of Atomic and Nuclear Properties following.

Number of photons N per cm:

$$N = \frac{\alpha}{c}\int\left(1 - \frac{1}{\beta^2 n^2}\right) 2\pi\, d\nu = \frac{\alpha}{c}\beta_t^2\int\left(\frac{1}{\beta_t^2\gamma_t^2} - \frac{1}{\beta^2\gamma^2}\right) 2\pi d\nu$$

$$\approx 500 \sin^2\theta_c/\text{cm (visible spectrum)}$$

A.3 Photon Collection: In addition to the photon yield, one should take into account the light collection efficiency ($\lesssim 10\%$ for typical 1 cm thick scintillator), attenuation length (≈ 1 to 4 m for typical scintillators[5]), and quantum efficiency of the photomultiplier cathode ($\lesssim 25\%$).

A.4 Bubble, Streamer, Wire Chambers:

Chamber Type	Accuracy(rms)	Resolution Time	Dead Time
Bubble	$\pm$ 75μ	$\approx$ 1 ms	$\approx$ 1/20 s[a)]
Streamer	$\pm$ 300μ	$\approx$ 2 μs	$\approx$ 100 ms
Optical Spark	$\pm$ 200μ[b)]	$\approx$ 2 μs	$\approx$ 10 ms
Magnetostrictive Spark	$\pm$ 500μ	$\approx$ 2 μs	$\approx$ 10 ms
Proportional	$\geq \pm$ 300μ[c, d)]	$\approx$ 50 ns	$\approx$ 200 ns
Drift	$\pm$ 50 to 300μ	$\approx$ 2 ns[e)]	$\approx$ 100 ns

a) Multiple pulsing time.
b) 60μ for high pressure.
c) 300μ is for 1 mm pitch.
d) Delay line cathode readout can give $\pm$ 150μ parallel to anode wire.
e) For two chambers.

A.5 Shower Detectors: Typical energy resolution for incident electron in the 1 GeV range, E in GeV.

Na I (20 rad. lengths)[6]: $\frac{2\%}{E^{1/4}}$ (FWHM)

Lead Glass (14 rad. lengths)[7]: $\frac{8\text{-}12\%}{\sqrt{E}}$ (FWHM)

Lead Scintillator Sandwich (10 rad. lengths)[8]: $\frac{22\%}{\sqrt{E}}$ (FWHM)

(10 lead plates, each 1 radiation length, and scintillators, each 1 cm in thickness).

A.6 Proportional Chamber Wire Instability: The limit on the voltage V for a wire tension T is given by[9]

$$V \leq \frac{sT^{\frac{1}{2}}}{\ell C}$$

where s, ℓ, and C are the wire spacing, length, and capacitance per unit length. An approximation to C for chamber half gap t and wire diameter d (good for $s \leq t$) gives[10]

$$V \lesssim 59T^{\frac{1}{2}}\left[\frac{t}{\ell} + \frac{s}{\pi\ell}\ln\left(\frac{s}{\pi d}\right)\right]\ ,$$

where V is in kV, and T is in grams.

B. COSMIC RAY FLUXES

The fluxes of particles of different types depend on the latitude, their energy, and on the conditions of measurement. Some typical sea-level values[11] are given below:

I_V vertical flux
J_1 total flux crossing a unit horizontal area
J_2 total flux crossing a sphere of unit radius

	Total Intensity	Hard component	Soft component
I_V	1.14×10^{-2}	0.83×10^{-2}	0.31×10^{-2} cm^{-2}sec^{-1}sterad^{-1}
J_1	1.79×10^{-2}	1.27×10^{-2}	0.52×10^{-2} cm^{-2}sec^{-1}
J_2	2.41×10^{-2}	1.68×10^{-2}	0.73×10^{-2} cm^{-2}sec^{-1}

Very approximately, about 75% of all particles at sea-level are penetrating, and are μ mesons. The absolute flux of protons at sea-level, in a momentum range 700-1100 MeV/c, is 1.5×10^{-5} cm^{-2}sec^{-1}sterad^{-1}, or $\sim$0.1% of all particles.

C. PASSAGE OF PARTICLES THROUGH MATTER

C.1 dE/dx[12]: Ionization energy loss for particles heavier than an electron and having charge z|e| (Bethe-Bloch equation):

$$-\frac{1}{\rho}\frac{dE}{dx} = z^2 D \frac{Z}{A}\frac{1}{\beta^2}\left[\ln\left(\frac{2m_e c^2\beta^2\ T'_{max}}{(1-\beta^2)\ I^2}\right) - 2\beta^2 - K\right],$$

where $D = 2\pi N r_e^2 m_e c^2 = 0.1535$ MeV cm^2/g (see Physical and Numerical Constants Table), Z and A are charge and mass number of the material, $\beta = v/c$ for the incident particle, T'_{max} is the maximum-energy δ ray considered to be ionization loss, I is the mean ionization potential ($I \approx 20Z$ eV for Z = 1, tending toward $I \approx 10Z$ for $Z \gtrsim 20$), and K includes the shell correction (maximum $\approx 10\%$ around $\beta = 0.1$ in the heaviest elements), density effect (important at high velocities and high densities), and the z^3 correction[13] (important at low velocity, a few percent at $\beta \approx 0.1$).

A point of minimum ionization occurs in the range $\beta \approx 0.95$ to 0.97, with the dependence on absorber confined to that range. Energy loss increases approximately as $\ln\gamma$ thereafter (relativistic rise), until modified by the density effect (which reduces the rate of increase). Values of dE/dx at minimum are listed in the Table of Atomic and Nuclear Properties of Materials (following).

Figures are given below for ionization energy loss and range in lead (with scaling indicated for copper, aluminum, and carbon), and in liquid hydrogen, with T'_{max} taken to be T_{max} as defined in Sec. C.2 below. Energy losses due to bremsstrahlung, nuclear collisions, etc., are not included. For thin samples of absorber, fluctuations are very important.[14] A review of the problem of the penetration of charged particles into matter may be found in Fano[15].

PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

Mixtures or compounds may be treated in first (but fairly accurate) approximation using Bragg's additivity rule:

$$\left(\frac{1}{\rho}\frac{dE}{dx}\right)_{mix} = \sum_i \left(\frac{1}{\rho}\frac{dE}{dx}\right)_i f_i,$$

where f_i is the fractional weight ($= \rho_i/\rho_{mix}$) of element i.

C.2 δ rays[16]: Number N per g/cm^2 per MeV of δ rays of kinetic energy T produced by an incident particle of momentum p and velocity β (Rutherford formula):

$$\frac{dN}{dTdx} = D\frac{Z}{A}\frac{1}{\beta^2 T^2} ,$$

where D is defined in the dE/dx section. This expression is valid for any unit charge incident particle if $T \ll T_{max}$. T_{max} is the maximum δ-ray energy, given by

$$T_{max} = \frac{2 m_e c^2 (pc)^2}{s} = \frac{2\beta^2\gamma^2 m_e c^2}{1+2\gamma\frac{m_e}{M}+\frac{m_e^2}{M^2}}$$

where m_e and M are the electron and incident particle masses and s is their center-of-mass energy squared.

C.3 Multiple Coulomb Scattering[17, 18, 19]: Sketched below are the multiple scattering angle θ, displacement y, and sagitta s, of a particle passing through a scatterer of thickness L. If the incident particle has mass M, charge z|e| , velocity β, and energy E, and the scatterer has atomic mass m_s and radiation length L_R, the projection of the 1/e multiple scattering angle (i.e., the value of the scattering angle at which the distribution falls to 1/e of its peak value) is given by

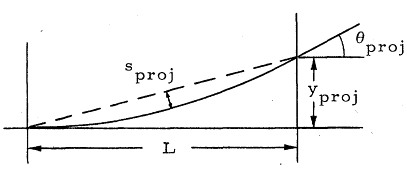
$$\theta^{1/e}_{proj} = z\,\frac{14\,\text{MeV}/c}{p\beta}\sqrt{\frac{L}{L_R}}\left[1+\frac{1}{9}\log_{10}\left(\frac{L}{L_R}\right)\right]\left[1+\frac{M^2}{Em_s}\right],$$

in the small angle approximation. The distribution is approximately Gaussian for $\theta < \theta^{1/e}$, but has long tails.[20] The accuracy of this expression is ≈ 5% except for low z or β, where it is ≈ 10-20%.

For a given θ_{proj},

$$y_{proj} = \frac{L\theta_{proj}}{\sqrt{3}} ,$$

$$s_{proj} = \frac{L\theta_{proj}}{4\sqrt{3}} .$$



C.4 Electron Range in Lead, Copper, Carbon and Hydrogen: See figure following.

C.5 Fractional Energy Loss for Electrons and Positrons in Lead: See figure following.

C.6 Contributions to Photon Cross Section in Lead: See figure following.

C.7 Photon Cross Section: See figure following.

D. ATOMIC AND NUCLEAR PROPERTIES OF MATTER

See table following.

*Prepared April 1974 by Sherwood Parker and Bernard Sadoulet. Revised April 1976.

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13. H. H. Heckman et al., Phys. Rev. Lett. 22, 871 (1969) and J. D. Jackson et al., Phys. Rev. B 6, 4131 (1972).

14. John H. Cobb, "A Study of Some Electromagnetic Interactions of High Velocity Particles with Matter," (thesis), University of Oxford Report HEP/T/55 (1975).

15. U. Fano, Ann. Rev. Nucl. Sci. 13, 1 (1963).

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17. Virgil L. Highland, Nucl. Instr. and Meth. 129, 497 (1975).

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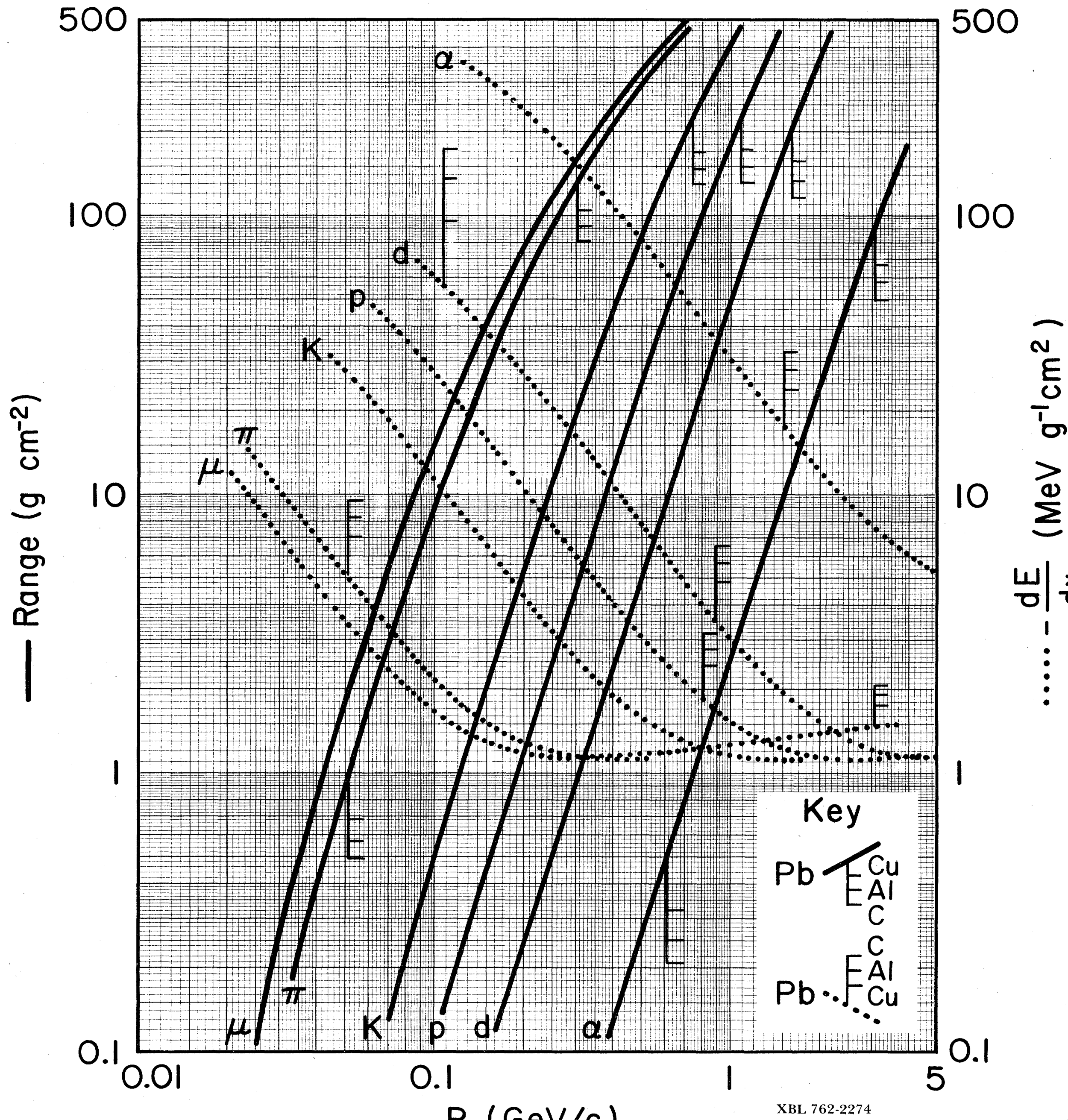
19. G.Z. Moliere, Naturforsch. 3(a), 78 (1948).

20. See, for example, the experimental work of A. D. Hansen, L. H. Lanzl, E. M. Lyman, and M. B. Scott, Phys. Rev. 84, 634 (1951).

PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

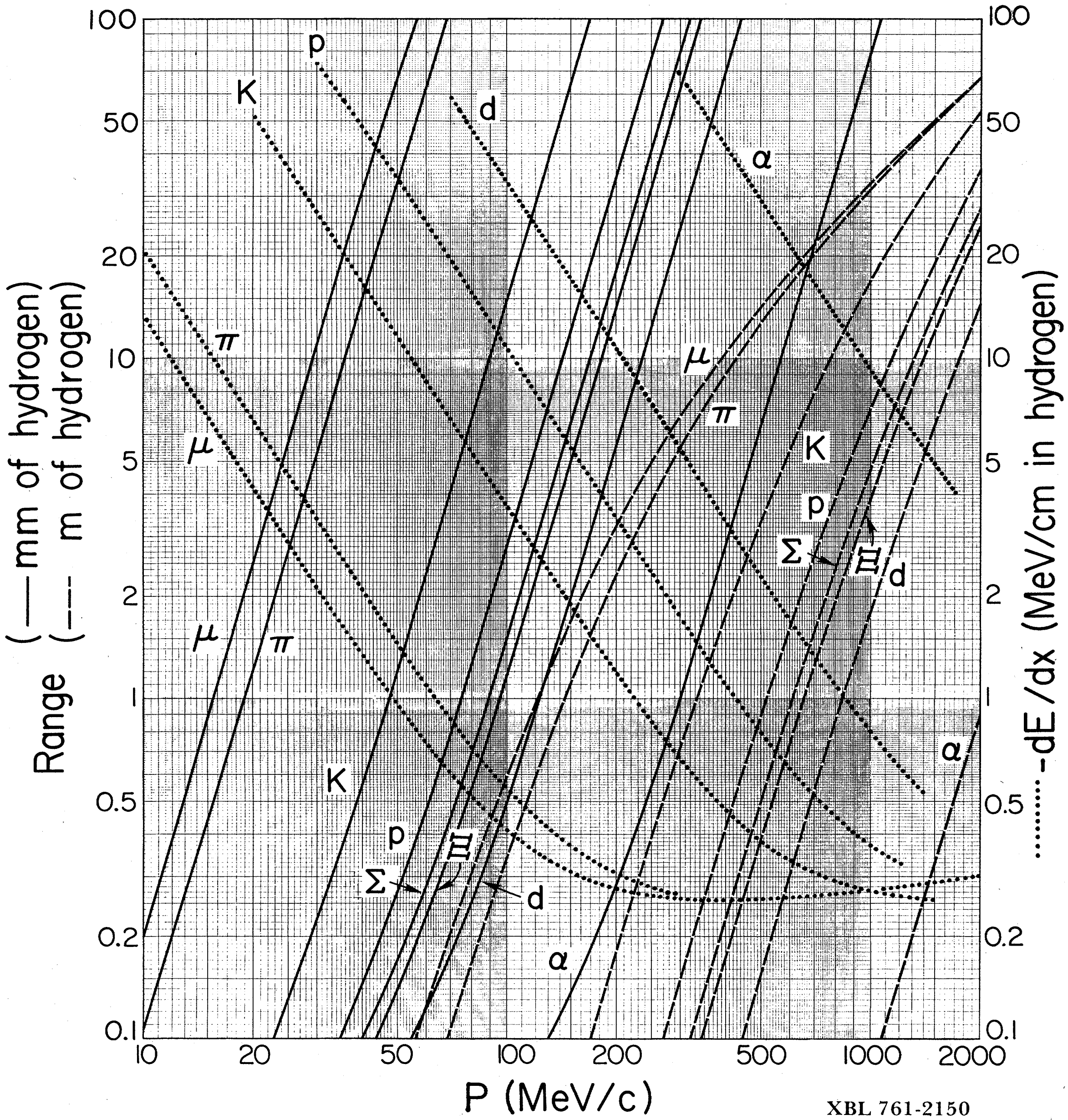
Mean Range and Energy Loss in Lead, Copper, Aluminum, and Carbon



Mean range and energy loss due to ionization for the indicated particles in Pb, with scaling to Cu, Al, and C indicated, using Bethe-Bloch equation (Section C.1 above) with corrections. Calculated using program of Hans Bichsel (UCRL-17538), with density correction added (Hans Bichsel, private communication). See also Joseph F. Janni [Air Force Weapons Laboratory Technical Report No. AFWL-TR-65-150 (1966)]. The average ionization potentials (I) assumed were: Pb (820 eV), Cu (320 eV), Al (166 eV), and C(77.5 eV). Figure indicates total path length; observed range may be smaller (by ~ 1% - 2% in heavy elements) due to multiple scattering, primarily from small energy-loss collisions with nuclei. The functional forms have not been experimentally verified to better than roughly ± 1%. For higher energies refer to discussion by Cobb ["A Study of Some Electromagnetic Interactions of High Velocity Particles with Matter," University of Oxford Report HEP/T/55 (1973)] and by Turner ["Penetration of Charged Particles in Matter: A Symposium", National Academy of Sciences, Washington D.C. (1970), p. 48]. Scaling to other beam particles is, to a good approximation, described by the expression on the next page.

PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

Mean Range and Energy Loss in Liquid Hydrogen



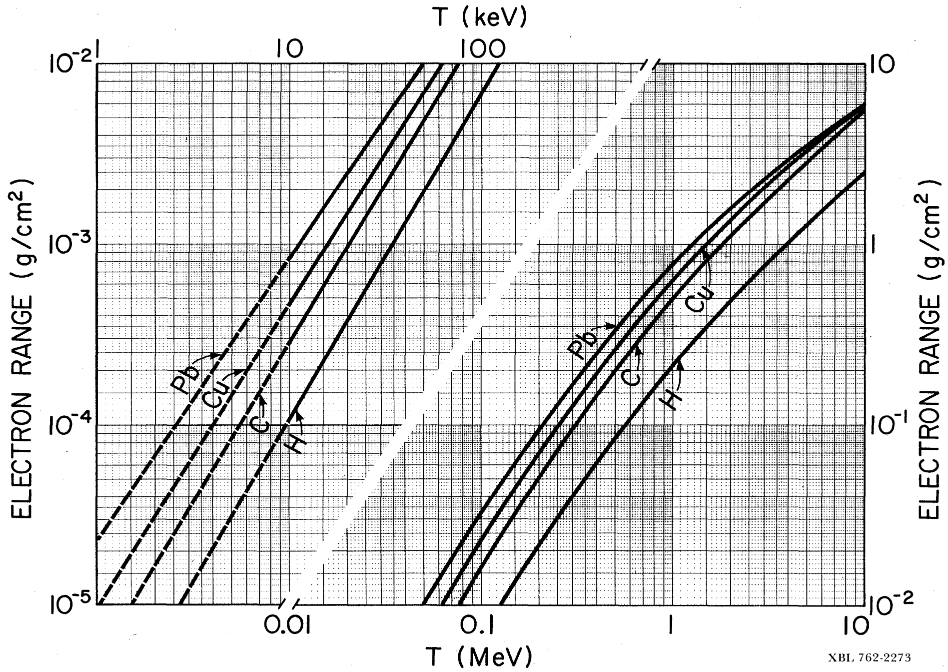
Range and energy loss in liquid hydrogen bubble chamber, based on Bethe-Bloch equation (Section C.1 above), using an average ionization potential for H_2 of I = 20.0 eV, which is an approximate average of the recent experimental result of Garbincius and Hyman [Phys. Rev. A2, 1834 (1970)] and the recent theoretical result of Ford and Browne [Phys. Rev. A7, 418 (1973)]. This is somewhat higher than used in the last edition. Bubble chamber conditions are chosen to be those of Garbincius and Hyman: parahydrogen of density = 0.0625 g/cm^3 (note: range $\propto$ 1/density), with vapor-pressure 60.8 lb/in^2 (absolute) and temperature 26.2°K. The functional dependence of the Bethe-Bloch equation is not experimentally verified to better than about ±1% over large momentum ranges. It should be noted that the number of bubbles per cm of a track in a bubble chamber is nearly proportional to $1/\beta^2$, not dE/dx. For the linear portions of the range curves, $R \propto p^{3.6}$.

Scaling law for particles of other mass or charge (except electrons): for a given medium, the range R_b of any beam particle with mass M_b, charge z_b, and momentum p_b is given in terms of the range R_a of any other particle with mass M_a, charge z_a, and momentum $p_a = p_b M_a/M_b$ (i.e., having the same velocity) by the expression

$$R_b(M_b, z_b, p_b) = \left[\frac{M_b/M_a}{z_b^2/z_a^2}\right] R_a(M_a, z_a, p_a = p_b M_a/M_b).$$

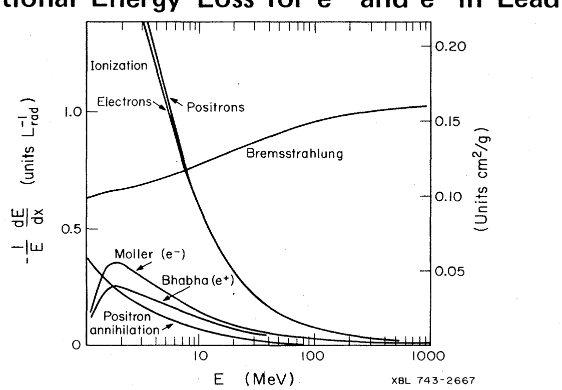
PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

Mean Electron Range in Lead, Copper, Carbon, and Liquid Hydrogen



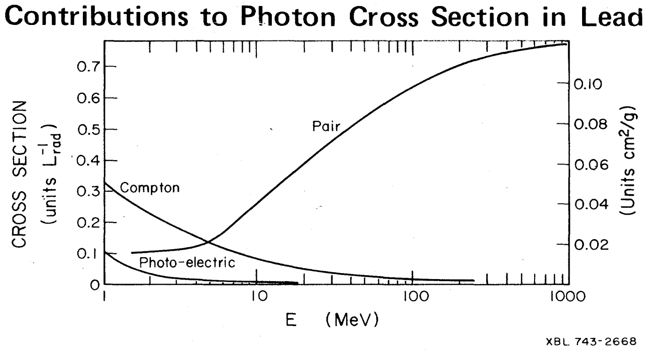
Mean range of electrons in the continuous-slowing-down approximation, taking into account energy loss by collisions with atomic electrons and by bremsstrahlung; strong fluctuations are to be expected for individual tracks. This range is the total path length; the practical range is shorter because of multiple Coulomb scattering, which becomes increasingly important as the electron slows down. E.g., for a fast electron the rms projected angle due to multiple Coulomb scattering reaches 1 radian by the time the electron has slowed to 0.4 MeV in hydrogen, 1.5 MeV in carbon, 9 MeV in copper, and 24 MeV (off scale) in lead. The "critical energy" (above which the energy loss due to bremsstrahlung exceeds that due to ionization and showering becomes important) is 400 MeV for hydrogen, 100 MeV for carbon, 25 MeV for copper, and 10 MeV for lead. The mean positron range may differ from the mean electron range by several percent. See Berger and Seltzer, NASA SP-3012 (1964) and SP-3036, and P. Trower, UCRL-2426, Vol. III Rev. (1966). 1-10 keV range was obtained by linear extrapolation.

Fractional Energy Loss for e^+ and e^- in Lead



Fractional energy loss per radiation length in lead as a function of electron or positron energy. Electron (positron) scattering is considered as ionization when the energy loss per collision is below 0.255 MeV, and as Moller (Bhabha) scattering when it is above.

Contributions to Photon Cross Section in Lead

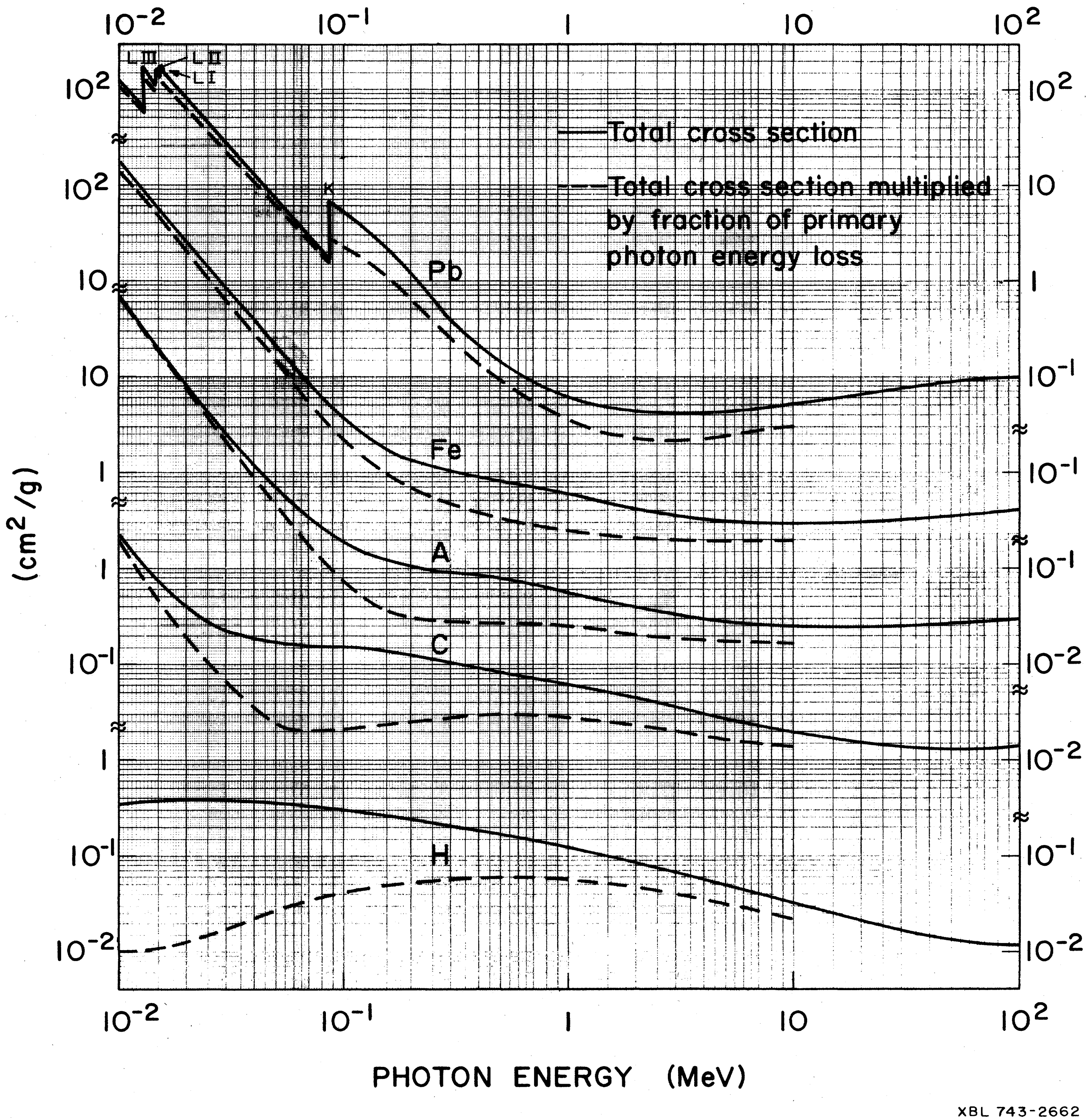


Photon cross section in lead in inverse radiation lengths as a function of photon energy. The intensity of photons can be expressed as $I = I_0 \exp(-\sigma x)$, where σ is read above and x is the path length in radiation lengths. See also figure following.

These figures are adapted from Fig. 3.2 and Fig. 3.3 from Messel and Crawford, Electron-Photon Shower Distribution Function Tables for Lead, Copper and Air Absorbers, Pergamon Press, 1970. Messel and Crawford use L_r (Pb) = 5.82 g/cm^2, but we have modified the figures to reflect the value given in the Table of Atomic and Nuclear Properties of Materials (following), namely L_r(Pb) = 6.4 g/cm^2. Note that the development of electron-photon cascades is approximately independent of absorber when the results are expressed in terms of inverse radiation lengths (i.e., scales on left of plots).

PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

Photon Cross Sections



XBL 743-2662

The photon cross section as a function of photon energy for various substances. The solid curve for each substance gives the total cross section in (cm^2/g). The dashed curve is the total cross section multiplied by the fraction of energy deposited by the photon (different from solid curve because of Compton scattering and bremsstrahlung of secondary electrons). See J. H. Hubbell, NSRDS-NBS 29 (1969).

PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

Atomic and Nuclear Properties of Materials*

Material	Z	A	Nuclear cross section σ[a] [barns]	Nuclear collision length L_{coll}[b] [g/cm²]	Nuclear collision length L_{coll}[b] [cm]	Absorption length λ[b] [cm]	dE/dx min[c] [MeV/(g/cm²)]	dE/dx min[c] [MeV/cm]	Radiation length L_{rad}[d] [g/cm²]	Radiation length L_{rad}[d] [cm]	Density[e] [g/cm³] () is for gas [g/ℓ]	Refractive index n;[e] () is $(n-1)\times10^6$ for gas
H_2	1	1.01	0.039	43.0	607	790	4.12	0.292	63.05	890	0.0708 (0.090)	1.112 (140)
D_2	1	2.01	0.074	45.1	273	342	2.07	0.342	126.1	764	0.163	1.128
He	2	4.00	0.134	49.6	397	478	1.94	0.243	94.32	755	0.125 (0.178)	1.024 (35)
Li	3	6.94	0.215	53.6	100.4	120.6	1.65	0.881	82.76	155	0.534	–
Be	4	9.01	0.270	55.4	30.0	36.7	1.61	2.97	65.19	35.3	1.848	–
C	6	12.01	0.340	58.7	≈37.8	49.9	1.78	≈2.76	42.70	≈27.5	≈1.55[f]	–
N_2	7	14.01	0.390	59.7	73.8	99.4	1.82	1.47	37.99	47.0	0.808 (1.25)	1.205 (300)
Ne	10	20.18	0.520	64.4	53.7	74.9	1.73	2.08	28.94	24.0	1.207 (0.90)	1.092 (67)
Al	13	26.98	0.650	68.9	25.5	37.2	1.62	4.37	24.01	8.9	2.70	–
A	18	39.95	0.890	74.5	53.2	80.9	1.51	2.11	19.55	14.0	1.40 (1.78)	1.233 (283)
Fe	26	55.85	1.160	79.9	10.2	17.1	1.48	11.6	13.84	1.76	7.87	–
Cu	29	63.54	1.270	83.1	9.3	14.8	1.44	12.9	12.86	1.43	8.96	–
Sn	50	118.69	2.040	96.6	13.2	22.8	1.28	9.4	8.82	1.21	7.31	–
W	74	183.85	2.810	108.6	5.6	10.3	1.17	22.6	6.76	0.35	19.3	–
Pb	82	207.19	3.080	111.7	9.8	18.5	1.13	12.8	6.37	0.56	11.35	–
U	92	238.03	3.380	116.9	≈6.2	12.0	1.09	≈20.7	6.00	≈0.32	≈18.95	–
Air				60.2	50000[g]	67500[g]	1.82	0.0022[g]	36.20	30050[g]	0.001205[g] (1.29)	1.000273[g] (293)
H_2O				58.3	58.3	78.8	2.03	2.03	36.08	36.1	1.00	1.33
H_2 (bubble chamber 26°K)[h]				43.0	≈683	887	4.12	≈0.26	63.05	≈1000	≈0.063[h]	1.112
D_2 (bubble chamber 31°K)[h]				45.1	≈322	403	2.07	≈0.29	126.1	≈900	≈0.140[h]	1.110
H-Ne mixture (50 mole percent)[i]				62.9	154.5	215	1.84	0.75	29.70	73.0	0.407	1.092
Propane (C_3H_8)[j]				55.0	134	176	2.28	0.98	45.38	111	0.41[j] (2.0)	1.25[j] (1005)
Freon 13B1 (CF_3Br)[j]				74.3	≈49.5	73.5	1.52	≈2.3	16.53	≈11	≈1.50[j] (8.71)	1.238[j] (750)
Ilford emulsion				79.5	23.6	39.1	1.44	5.49	11.02	2.94	3.815	–
NaI				91.9	25.0	41.3	1.32	4.84	9.49	2.59	3.67	1.775
LiF				61.1	23.1	30.7	1.69	4.46	39.25	14.9	2.64	1.394
Polyethylene (CH_2)				55.7	≈59.6	78.4	2.09	≈1.95	44.78	≈48	0.92–0.95	–
Mylar ($C_5H_4O_2$)				58.5	42.1	56.1	1.91	2.65	39.95	28.7	1.39	–
Polystyrene, scintillator (CH)[k]				57.0	55.2	68.5	1.97	2.03	43.8	42.9	1.032	1.581
Lucite, Plexiglas ($C_5H_8O_2$)				57.7	≈48.9	65.0	1.97	≈2.32	40.55	≈34.5	1.16–1.20	≈1.49
Spark or proportional chamber[ℓ]				0.05%		0.03%	–	0.073	2.7%		0.046	–
Shielding concrete[m]				64.9	26.0	32.2	1.70	4.25	26.7	10.7	2.5	–
CO_2[n]				60.4	33800	46000	1.82	0.0033	36.2	20210	(1.79)[n]	(410)[n]
Freon 12 (CCl_2F_2)[n]				68.1	13800	20200	1.64	0.0081	23.7	4810	(4.93)[n]	(1080)[n]
Freon 13 ($CClF_3$)[n]				66.0	15000	21400	1.70	0.0072	27.15	6380	(4.26)[n]	(720)[n]
Silica Aerogel[o]				62.3	≈311	430	1.82	≈0.36	30	≈150	0.1–0.3	$1.0+0.25\rho$

*) Table revised January 1976 by J. Engler and F. Mönnig. For details and references, see CERN NP Internal Report 74-1.

a) σ of neutrons ($\approx \sigma$ of protons) at 20 GeV from Landolt-Bornstein, New Series I, Vol. 5. Energy dependence for all nuclei ≈ 1/2 percent/GeV (from 5–25 GeV).

b) $L_{coll} = A/(N.\sigma)$. In the absorption length the elastic scattering is subtracted.

c) For a minimum-ionizing, singly-charged particle in the material. From W.H. Barkas and M.J. Berger, Tables of Energy Losses and Ranges of Heavy Charged Particles, NASA-SP-3013 (1964).

d) From Y.S. Tsai, Pair Production and Bremsstrahlung of Charged Leptons, SLAC-PUB-1365 (1974), Table III.6.

e) Values for solids, or the liquid phase at boiling point, except where noted. Values in parentheses for gaseous phase STP (0°C, 1 atm.), except where noted.

f) Density variable.

g) Gas at 20°C.

h) Density may vary about ±3%, depending on operating conditions.

i) Values for typical working condition with H_2 target: 50 mole percent, 29°K, 7 atm.

j) Values for typical chamber working conditions: Propane ~ 57°C, 8–10 atm. Freon 13B1 ~ 28°C, 8–10 atm.

k) Typical scintillator; e.g. PILOT B and NE 102A have an atomic ratio H/C = 1.10.

ℓ) Values for typical construction: 2 layers 50 μm Cu/Be wires, 8 mm gap, 60% argon, 40% isobutane or CO_2; 2 layers 50 μm Mylar/Aclar foils.

m) Standard shielding blocks, typical composition O_2 52%, Si 32.5%, Ca 6%, Na 1.5%, Fe 2%, Al 4% plus reinforcing iron bars. Attenuation length ℓ = 115 ± 5 g/cm², also valid for earth (typical ρ = 2.15) from CERN-LRL-RHEL Shielding exp. UCRL 17841 (1968).

n) Used in Čerenkov counters, value at 26°C and 1 atm. Indices of refraction from E.R. Hayes, R.A. Schluter, and A. Tamosaitis, ANL-6916 (1964).

o) $n(SiO_2) + 2n(H_2O)$ used in Čerenkov counters, ρ = density in g/cm³. From M. Cantin et al., Nucl. Instr. Meth. 118, 177 (1974).

ELECTROMAGNETIC RELATIONS

Maxwell's Equations

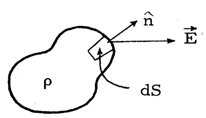
Quantity	CGS (statcoul., statamp., sec cm^{-1})	MKSA (coul., amp., ohm)
Potentials:	$V = \sum_{\text{charges}} \frac{q}{r}$,	$V = \frac{1}{4\pi\epsilon_0} \sum_{\text{charges}} \frac{q}{r}$,
	$\vec{A} = \frac{1}{c} \sum_{\text{currents}} \frac{\vec{I}}{r}$;	$\vec{A} = \frac{\mu_0}{4\pi} \sum_{\text{currents}} \frac{\vec{I}}{r}$;
	c = speed of light in vacuum	$\epsilon_0 = \frac{1}{36\pi} 10^{-9}$ MKSA, $\mu_0 = 4\pi\ 10^{-7}$ MKSA
Fields:	$\vec{E} = -\vec{\nabla}V$, $\vec{B} = \vec{\nabla}\times\vec{A}$	$\vec{E} = -\vec{\nabla}V$, $\vec{B} = \vec{\nabla}\times\vec{A}$
Materials:	$\vec{D} = \epsilon\vec{E}$, $\vec{B} = \mu\vec{H}$	$\vec{D} = \epsilon\vec{E}$, $\vec{B} = \mu\vec{H}$
Force:	$\vec{F} = q(\vec{E} + \frac{\vec{v}}{c}\times\vec{B})$	$\vec{F} = q(\vec{E} + \vec{v}\times\vec{B})$
Maxwell:	$\vec{\nabla}\cdot\vec{E} = 4\pi\rho$,	$\vec{\nabla}\cdot\vec{D} = \rho$,
	$\vec{\nabla}\times\vec{E} = -\frac{1}{c}\frac{\partial\vec{B}}{\partial t}$,	$\vec{\nabla}\times\vec{E} = -\frac{\partial\vec{B}}{\partial t}$,
	$\vec{\nabla}\cdot\vec{B} = 0$,	$\vec{\nabla}\cdot\vec{B} = 0$,
	$\vec{\nabla}\times\vec{B} = \frac{4\pi\vec{j}}{c} + \frac{1}{c}\frac{\partial\vec{E}}{\partial t}$	$\vec{\nabla}\times\vec{H} = \vec{j} + \frac{\partial\vec{D}}{\partial t}$

Integral Forms (MKSA)

1. Gauss' theorem:

$$\int_{\text{surface}} \vec{E}\cdot\hat{n}\ dS = \int_{\text{volume}} \rho/\epsilon_0\ dV$$

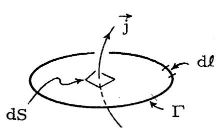
(ρ = charge/volume)



2. Ampere's law:

$$\int_{\Gamma} \vec{H}\cdot d\vec{\ell} = \int_{\text{surface}} \vec{j}\cdot\hat{n}\ dS$$

($\vec{j}$ = surface current density)



Impedances: Alternating Currents (MKSA)

Ohm's law: $V = ZI$, $V = V_0 e^{i\omega t}$

1. Impedance of self-inductance of inductance L : $Z = i\omega L$
2. Impedance of a capacitor of capacitance C : $Z = \frac{1}{i\omega C}$
3. Impedance of a flat conductor of width w at high frequency:

$$Z = \frac{(1+i)\rho}{w\delta};$$

ρ = resistivity $\begin{cases} \sim 1.7\times10^{-8}\ \Omega\,\text{m for Cu} \\ \sim 2.8\times10^{-8}\ \Omega\,\text{m for Al} \end{cases}$

δ = effective skin depth

$$= \sqrt{\frac{\rho}{\pi\nu\mu}} \approx \frac{6.6\text{ cm}}{\sqrt{\nu(\sec^{-1})}} \quad \text{for Cu}$$

Capacitance C and Inductance L per Unit Length (MKSA)

1. For flat plates of width w, separated by $d \ll w$:

$$C = \frac{\epsilon w}{d}\ ;\quad L = \mu\frac{d}{w}$$

2. For coax cable of interior and exterior radii r_1 and r_2:

$$C = \frac{2\pi\epsilon}{\ln(r_2/r_1)}\ ;\quad L = \frac{\mu}{2\pi}\ln(r_2/r_1);$$

ϵ = dielectric constant $\begin{cases} \text{2 to 6 for plastics} \\ \text{4 to 8 for porcelain, glasses} \end{cases}$

μ = magnetic susceptibility

Transmission Lines (No Loss) (MKSA)

Velocity $= 1/\sqrt{LC} = 1/\sqrt{\mu\epsilon}$

Impedance $= \sqrt{L/C}$

L, C are inductance and capacitance per unit length

Synchrotron Radiation (CGS)

Energy loss/revolution $= \frac{4\pi}{3}\frac{e^2}{\rho}\beta^3\gamma^4$, ρ = orbit radius.

For electrons ($\beta \approx 1$), $\frac{\Delta E(\text{MeV})}{\text{rev.}} = 0.0885\,[E(\text{GeV})]^4/\rho(\text{meter})$.

Critical frequency: $\omega_c = 3\gamma^3\ c/\rho$

See J.D. Jackson, Classical Electrodynamics, 2nd Ed., John Wiley & Sons, New York, 1975, for more formulae and details. (Prepared April 1974; revised April 1976.)

RADIOACTIVITY AND RADIATION PROTECTION

Unit of activity = Curie:
1 Ci = 3.7×10^{10} disintegrations/sec
Unit of exposure dose for x and γ radiation = Roentgen:
1 R = 1 esu/cm^3 = 87.8 erg/g (5.49×10^7 MeV/g) of air
Unit of absorbed dose = rad:
1 rad = 100 erg/g (6.25×10^7 MeV/g) in any material
Unit of dose equivalent (for protection) = rem:
rems (Roentgen equivalents for man) = rads $\times$ QF,
where QF (quality factor) depends upon the type of radiation and other factors. For γ rays and HE protons, QF $\approx$ 1; for thermal neutrons, QF $\approx$ 3; for fast neutrons, QF ranges up to 10; and for α particles and heavy ions, QF ranges up to 20.
Maximum permissible occupational dose for the whole body:
5 rem/year (or $\approx$ 100 millirem/week)
Fluxes (per cm^2) to liberate 1 rad in carbon:
3.5×10^7 minimum ionizing singly charged particles
1.0×10^9 photons of 1 MeV energy
(These fluxes are correct to within a factor of 2 for all materials.)
Natural background: 120 to 130 millirem/year
cosmic radiation (charged particles + neutrons) ~25 } mrem/yr
cosmic radiation (γ rays) ~25
radiation from rocks and air (γ rays) ~73
Cosmic ray background in counters: ~ 1/min/cm^2/ster

C.M. ENERGY AND MOMENTUM VS. BEAM MOMENTUM

$$E_{cm} dE_{cm} = m_p dT_{beam} = m_p v_{beam} dP_{beam} \approx m_p dP_{beam}$$

PBEAM (MEV/C)	C.M. ENERGY (MEV) γp ep	πp	Kp	pp	MOMENTUM IN C.M. (MEV/C) γp ep	πp	Kp	pp
0	939	1078	1432	1877	0	0	0	0
20	958	1079	1432	1877	20	17	13	10
40	977	1083	1433	1877	38	35	26	20
60	996	1089	1434	1877	56	52	39	30
80	1015	1096	1436	1878	74	68	52	40
	T(PI) = PBEAM - 59 MEV							
100	1033	1105	1439	1879	91	85	65	50
120	1051	1116	1441	1880	107	101	78	60
140	1069	1127	1445	1882	123	117	91	70
160	1087	1139	1449	1883	138	132	104	80
180	1104	1152	1453	1885	153	147	116	90
	T(PI) = PBEAM - 92 MEV							
200	1121	1165	1457	1887	167	161	129	99
220	1137	1178	1462	1889	182	175	141	109
240	1154	1192	1468	1892	195	189	153	119
260	1170	1206	1474	1894	209	202	166	129
280	1186	1219	1480	1897	222	215	178	138
	T(PI) = PBEAM - 107 MEV							
300	1201	1233	1486	1900	234	228	189	148
320	1217	1247	1493	1903	247	241	201	158
340	1232	1261	1500	1906	259	253	213	167
360	1247	1274	1507	1910	271	265	224	177
380	1262	1288	1514	1913	282	277	235	186
	T(PI) = PBEAM - 115 MEV							
400	1277	1302	1522	1917	294	288	247	196
420	1292	1315	1530	1921	305	300	258	205
440	1306	1329	1538	1925	316	311	268	214
460	1320	1342	1546	1929	327	322	279	224
480	1335	1356	1554	1933	337	332	290	233
	T(PI) = PBEAM - 120 MEV							
500	1349	1369	1563	1938	348	343	300	242
520	1362	1382	1572	1943	358	353	310	251
540	1376	1395	1580	1947	368	363	321	260
560	1390	1408	1589	1952	378	373	331	269
580	1403	1421	1598	1957	388	383	341	278
	T(PI) = PBEAM - 123 MEV							
600	1416	1434	1607	1962	397	393	350	287
620	1430	1446	1616	1967	407	402	360	296
640	1443	1459	1625	1973	416	412	370	304
660	1456	1472	1634	1978	425	421	379	313
680	1468	1484	1644	1984	434	430	388	322
	T(PI) = PBEAM - 125 MEV							
700	1481	1496	1653	1989	443	439	397	330
720	1494	1509	1662	1995	452	448	406	339
740	1506	1521	1671	2001	461	457	415	347
760	1519	1533	1681	2007	470	465	424	355
780	1531	1545	1690	2013	478	474	433	364
	T(PI) = PBEAM - 127 MEV							
800	1543	1557	1699	2019	486	482	442	372
820	1555	1569	1709	2025	495	490	450	380
840	1567	1580	1718	2031	503	499	459	388
860	1579	1592	1728	2037	511	507	467	396
880	1591	1604	1737	2043	519	515	475	404
	T(PI) = PBEAM - 129 MEV							
900	1603	1615	1747	2049	527	523	483	412
920	1615	1627	1756	2056	535	531	492	420
940	1626	1638	1765	2062	542	538	500	428
960	1638	1649	1775	2069	550	546	508	435
980	1649	1661	1784	2075	558	554	515	443
	T(PI) = PBEAM - 130 MEV							
1000	1660	1672	1794	2082	565	561	523	451
1020	1672	1683	1803	2088	573	569	531	458
1040	1683	1694	1812	2095	580	576	538	466
1060	1694	1705	1822	2102	587	583	546	473
1080	1705	1716	1831	2108	594	591	553	481
	T(PI) = PBEAM - 131 MEV							
1100	1716	1726	1840	2115	601	598	561	488
1120	1727	1737	1850	2122	609	605	568	495
1140	1738	1748	1859	2129	616	612	575	502
1160	1748	1758	1868	2135	622	619	583	510
1180	1759	1769	1877	2142	629	626	590	517
	T(PI) = PBEAM - 131 MEV							
1200	1770	1780	1887	2149	636	633	597	524
1220	1780	1790	1896	2156	643	639	604	531
1240	1791	1800	1905	2163	650	646	611	538
1260	1801	1811	1914	2170	656	653	618	545
1280	1812	1821	1923	2177	663	660	624	552
	T(PI) = PBEAM - 132 MEV							
1300	1822	1831	1932	2184	669	666	631	559
1320	1832	1841	1941	2191	676	673	638	565
1340	1843	1851	1950	2198	682	679	645	572
1360	1853	1862	1959	2205	689	685	651	579
1380	1863	1872	1968	2212	695	692	658	585
	T(PI) = PBEAM - 133 MEV							
1400	1873	1881	1977	2219	701	698	664	592
1420	1883	1891	1986	2226	708	704	671	599
1440	1893	1901	1995	2233	714	711	677	605
1460	1903	1911	2004	2240	720	717	684	612
1480	1912	1921	2013	2247	726	723	690	618
	T(PI) = PBEAM - 133 MEV							

PBEAM (MEV/C)	C.M. ENERGY (MEV) γp ep	πp	Kp	pp	MOMENTUM IN C.M. (MEV/C) γp ep	πp	Kp	pp
1500	1922	1930	2022	2254	732	729	696	624
1520	1932	1940	2031	2261	738	735	702	631
1540	1942	1950	2039	2268	744	741	709	637
1560	1951	1959	2048	2275	750	747	715	643
1580	1961	1969	2057	2282	756	753	721	650
	T(PI) = PBEAM - 133 MEV							
1600	1970	1978	2065	2289	762	759	727	656
1620	1980	1988	2074	2296	768	765	733	662
1640	1989	1997	2083	2304	773	770	739	668
1660	1999	2006	2091	2311	779	776	745	674
1680	2008	2016	2100	2318	785	782	751	680
	T(PI) = PBEAM - 134 MEV							
1700	2018	2025	2109	2325	791	788	756	686
1720	2027	2034	2117	2332	796	793	762	692
1740	2036	2043	2126	2339	802	799	768	698
1760	2045	2053	2134	2346	807	805	774	704
1780	2054	2062	2143	2353	813	810	779	710
	T(PI) = PBEAM - 134 MEV							
1800	2064	2071	2151	2360	818	816	785	716
1820	2073	2080	2159	2367	824	821	791	721
1840	2082	2089	2168	2374	829	827	796	727
1860	2091	2098	2176	2381	835	832	802	733
1880	2100	2107	2184	2388	840	837	808	739
	T(PI) = PBEAM - 134 MEV							
1900	2108	2115	2193	2395	845	843	813	744
1920	2117	2124	2201	2402	851	848	818	750
1940	2126	2133	2209	2409	856	853	824	756
1960	2135	2142	2217	2416	861	859	829	761
1980	2144	2150	2226	2423	867	864	835	767
	T(PI) = PBEAM - 135 MEV							
2000	2153	2159	2234	2430	872	869	840	772
2020	2161	2168	2242	2437	877	874	845	778
2040	2170	2176	2250	2444	882	879	851	783
2060	2179	2185	2258	2451	887	885	856	789
2080	2187	2194	2266	2458	892	890	861	794
	T(PI) = PBEAM - 135 MEV							
2100	2196	2202	2274	2465	897	895	866	799
2120	2204	2211	2282	2472	902	900	872	805
2140	2213	2219	2290	2479	907	905	877	810
2160	2221	2227	2298	2486	912	910	882	815
2180	2230	2236	2306	2493	917	915	887	821
	T(PI) = PBEAM - 135 MEV							
2200	2238	2244	2314	2500	922	920	892	826
2220	2246	2253	2322	2507	927	925	897	831
2240	2255	2261	2330	2514	932	930	902	836
2260	2263	2269	2338	2520	937	934	907	841
2280	2271	2277	2346	2527	942	939	912	846
	T(PI) = PBEAM - 135 MEV							
2300	2280	2286	2353	2534	947	944	917	852
2320	2288	2294	2361	2541	951	949	922	857
2340	2296	2302	2369	2548	956	954	927	862
2360	2304	2310	2377	2555	961	959	932	867
2380	2312	2318	2384	2561	966	963	937	872
	T(PI) = PBEAM - 135 MEV							
2400	2320	2326	2392	2568	970	968	941	877
2420	2328	2334	2400	2575	975	973	946	882
2440	2336	2342	2407	2582	980	977	951	887
2460	2344	2350	2415	2589	984	982	956	892
2480	2352	2358	2423	2595	989	987	960	897
	T(PI) = PBEAM - 136 MEV							
2500	2360	2366	2430	2602	994	991	965	901
2520	2368	2374	2438	2609	998	996	970	906
2540	2376	2382	2445	2616	1003	1001	975	911
2560	2384	2390	2453	2622	1007	1005	979	916
2580	2392	2398	2460	2629	1012	1010	984	921
	T(PI) = PBEAM - 136 MEV							
2600	2400	2405	2468	2636	1017	1014	988	926
2620	2408	2413	2475	2643	1021	1019	993	930
2640	2415	2421	2483	2649	1025	1023	998	935
2660	2423	2429	2490	2656	1030	1028	1002	940
2680	2431	2436	2498	2663	1034	1032	1007	944
	T(PI) = PBEAM - 136 MEV							
2700	2439	2444	2505	2669	1039	1037	1011	949
2720	2446	2452	2512	2676	1043	1041	1016	954
2740	2454	2459	2520	2682	1048	1045	1020	958
2760	2462	2467	2527	2689	1052	1050	1025	963
2780	2469	2474	2534	2696	1056	1054	1029	968
	T(PI) = PBEAM - 136 MEV							
2800	2477	2482	2542	2702	1061	1058	1034	972
2820	2484	2490	2549	2709	1065	1063	1038	977
2840	2492	2497	2556	2715	1069	1067	1042	981
2860	2499	2505	2563	2722	1074	1071	1047	986
2880	2507	2512	2570	2728	1078	1076	1051	990
	T(PI) = PBEAM - 136 MEV							
2900	2514	2520	2578	2735	1082	1080	1056	995
2920	2522	2527	2585	2742	1086	1084	1060	999
2940	2529	2534	2592	2748	1091	1088	1064	1004
2960	2537	2542	2599	2755	1095	1093	1069	1008
2980	2544	2549	2606	2761	1099	1097	1073	1013
	T(PI) = PBEAM - 136 MEV							

PBEAM (GEV/C)	C.M. ENERGY (GEV) γp ep πp	Kp	pp	MOMENTUM IN C.M. (GEV/C) γp ep πp	Kp	pp
3.0	2.56	2.61	2.77	1.10	1.08	1.02
3.2	2.63	2.68	2.83	1.14	1.12	1.06
3.4	2.70	2.75	2.89	1.18	1.16	1.10
3.6	2.77	2.82	2.96	1.22	1.20	1.14
3.8	2.83	2.88	3.02	1.26	1.24	1.18
	T(PI) = PBEAM - .137 GEV					
4.0	2.90	2.95	3.08	1.29	1.27	1.22
4.2	2.96	3.01	3.14	1.33	1.31	1.26
4.4	3.03	3.07	3.19	1.36	1.34	1.29
4.6	3.09	3.13	3.25	1.40	1.38	1.33
4.8	3.15	3.19	3.31	1.43	1.41	1.36
	T(PI) = PBEAM - .138 GEV					
5.0	3.21	3.25	3.36	1.46	1.44	1.40
5.5	3.35	3.39	3.50	1.54	1.52	1.48
6.0	3.49	3.52	3.63	1.61	1.60	1.55
6.5	3.62	3.65	3.75	1.69	1.67	1.63
7.0	3.75	3.78	3.87	1.75	1.74	1.70
	T(PI) = PBEAM - .138 GEV					
7.5	3.87	3.90	3.99	1.82	1.80	1.76
8.0	3.99	4.02	4.11	1.88	1.87	1.83
8.5	4.11	4.14	4.22	1.94	1.93	1.89
9.0	4.22	4.25	4.33	2.00	1.99	1.95
9.5	4.33	4.36	4.44	2.06	2.05	2.01
	T(PI) = PBEAM - .139 GEV					
10.0	4.43	4.46	4.54	2.12	2.10	2.07
11.0	4.64	4.67	4.74	2.22	2.21	2.18
12.0	4.84	4.86	4.93	2.33	2.31	2.28
13.0	5.03	5.05	5.12	2.43	2.41	2.38
14.0	5.21	5.24	5.30	2.52	2.51	2.48
	T(PI) = PBEAM - .139 GEV					
15.0	5.39	5.41	5.47	2.61	2.60	2.57
16.0	5.56	5.58	5.64	2.70	2.69	2.66
17.0	5.73	5.75	5.81	2.79	2.78	2.75
18.0	5.89	5.91	5.97	2.87	2.86	2.83
19.0	6.05	6.07	6.12	2.95	2.94	2.91
	T(PI) = PBEAM - .139 GEV					
20.0	6.20	6.22	6.27	3.03	3.02	2.99
22.0	6.49	6.51	6.56	3.18	3.17	3.14
24.0	6.78	6.79	6.84	3.32	3.31	3.29
26.0	7.05	7.07	7.11	3.46	3.45	3.43
28.0	7.31	7.33	7.37	3.59	3.59	3.56
	T(PI) = PBEAM - .139 GEV					
30.0	7.56	7.58	7.62	3.72	3.71	3.69
32.0	7.81	7.82	7.86	3.85	3.84	3.82
34.0	8.04	8.06	8.10	3.97	3.96	3.94
36.0	8.27	8.29	8.33	4.08	4.08	4.06
38.0	8.50	8.51	8.55	4.20	4.19	4.17
	T(PI) = PBEAM - .139 GEV					
40.0	8.72	8.73	8.77	4.31	4.30	4.28
42.0	8.93	8.94	8.98	4.41	4.41	4.39
44.0	9.14	9.15	9.18	4.52	4.51	4.50
46.0	9.34	9.35	9.39	4.62	4.62	4.60
48.0	9.54	9.55	9.58	4.72	4.72	4.70
	T(PI) = PBEAM - .139 GEV					
50.0	9.73	9.74	9.78	4.82	4.81	4.80
55.0	10.20	10.21	10.25	5.06	5.05	5.04
60.0	10.65	10.66	10.69	5.28	5.28	5.26
65.0	11.08	11.10	11.12	5.50	5.50	5.48
70.0	11.50	11.51	11.54	5.71	5.71	5.69
	T(PI) = PBEAM - .139 GEV					
75.0	11.90	11.91	11.94	5.91	5.91	5.89
80.0	12.29	12.30	12.32	6.11	6.10	6.09
85.0	12.67	12.67	12.70	6.30	6.29	6.28
90.0	13.03	13.04	13.06	6.48	6.48	6.46
95.0	13.39	13.39	13.42	6.66	6.65	6.64
	T(PI) = PBEAM - .139 GEV					
100.0	13.73	13.74	13.76	6.83	6.83	6.82
200.0	19.40	19.40	19.42	9.67	9.67	9.66
300.0	23.75	23.75	23.76	11.85	11.85	11.84
400.0	27.41	27.42	27.43	13.69	13.69	13.68
500.0	30.65	30.65	30.66	15.31	15.31	15.30
	T(PI) = PBEAM - .140 GEV					
600.0	33.57	33.57	33.58	16.77	16.77	16.76
700.0	36.26	36.26	36.27	18.12	18.11	18.11
800.0	38.76	38.76	38.77	19.37	19.37	19.36
900.0	41.11	41.11	41.12	20.54	20.54	20.54
1000.0	43.33	43.33	43.34	21.65	21.65	21.65
	T(PI) = PBEAM - .140 GEV					
1100.0	45.44	45.45	45.45	22.71	22.71	22.71
1200.0	47.46	47.47	47.47	23.72	23.72	23.72
1300.0	49.40	49.40	49.41	24.69	24.69	24.69
1400.0	51.26	51.27	51.27	25.62	25.62	25.62
1500.0	53.06	53.07	53.07	26.52	26.52	26.52
	T(PI) = PBEAM - .140 GEV					
1600.0	54.80	54.81	54.81	27.39	27.39	27.39
1700.0	56.49	56.49	56.50	28.24	28.24	28.23
1800.0	58.13	58.13	58.13	29.06	29.05	29.05
1900.0	59.72	59.72	59.73	29.85	29.85	29.85
2000.0	61.27	61.27	61.28	30.63	30.63	30.62
	T(PI) = PBEAM - .140 GEV					

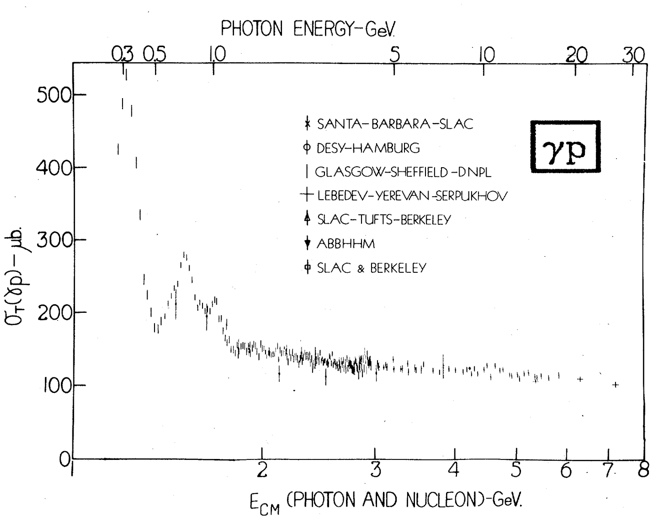
PERIODIC TABLE OF THE ELEMENTS

IA	IIA							1 H 1.008				IIIA	IVA	VA	VIA	VIIA	2 He 4.0026
3 Li 6.94	4 Be 9.0122											5 B 10.81	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.17
11 Na 22.9898	12 Mg 24.305	IIIB	IVB	VB	VIB	VIIB	VIII			IB	IIB	13 Al 26.9815	14 Si 28.086	15 P 30.9738	16 S 32.06	17 Cl 35.453	18 A 39.948
19 K 39.09	20 Ca 40.08	21 Sc 44.956	22 Ti 47.90	23 V 50.941	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.71	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.906	40 Zr 91.22	41 Nb 92.906	42 Mo 95.94	43 Tc 98.9062	44 Ru 101.07	45 Rh 102.906	46 Pd 106.4	47 Ag 107.868	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.9045	54 Xe 131.30
55 Cs 132.905	56 Ba 137.34	57–71 Rare Earths	72 Hf 178.49	73 Ta 180.947	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.22	78 Pt 195.09	79 Au 196.967	80 Hg 200.59	81 Tl 204.37	82 Pb 207.2	83 Bi 208.981	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.025	89– Acti- nides	104 (261)	105 (262)	106 (263)												

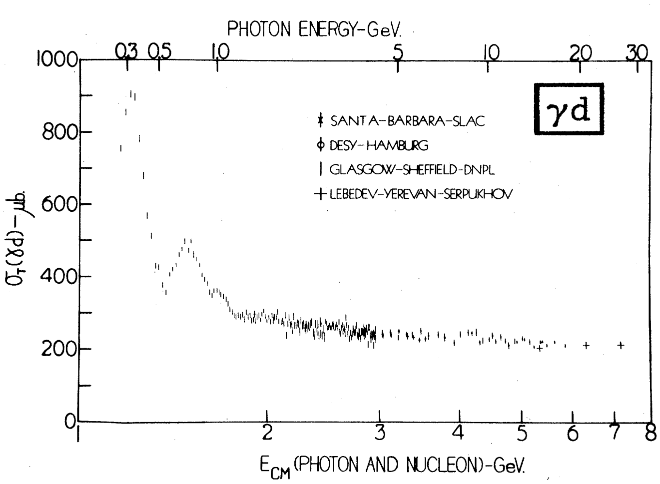
57 La 138.91	58 Ce 140.12	59 Pr 140.908	60 Nd 144.24	61 Pm (145)	62 Sm 150.4	63 Eu 151.96	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.97	Rare earths (Lanthanide series)
89 Ac (227)	90 Th 232.038	91 Pa 231.036	92 U 238.03	93 Np 237.048	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (254)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)	Actinide series

Numbers in parentheses are mass numbers of most stable isotope of that element. Adapted from the *Handbook of Chemistry and Physics, 1975-76.* (Particle Data Group update, April 1976.)

CROSS SECTION PLOTS

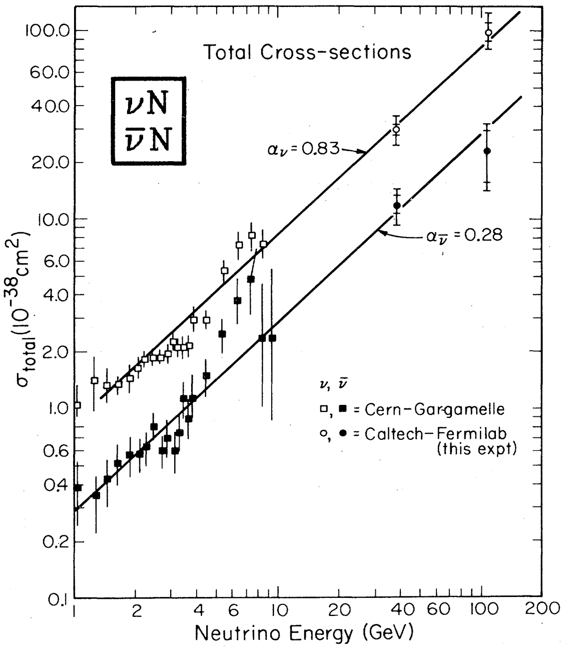


γp total cross section versus photon energy (top scale) and photon-plus-nucleon total center-of-mass energy (lower scale). Courtesy Gething M. Lewis, Glasgow.

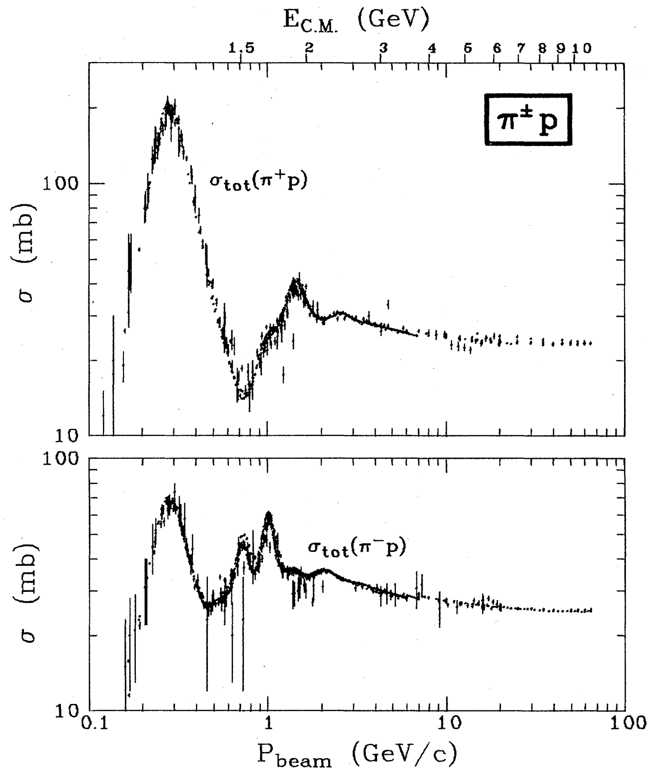


γd total cross section versus photon energy (top scale) and photon-plus-single-nucleon total center-of-mass energy (lower scale). Courtesy Gething M. Lewis, Glasgow.

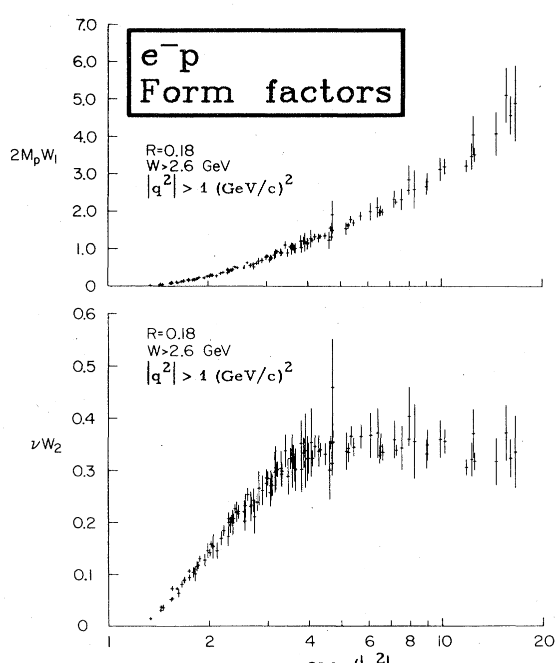
CROSS SECTION PLOTS (Cont'd)



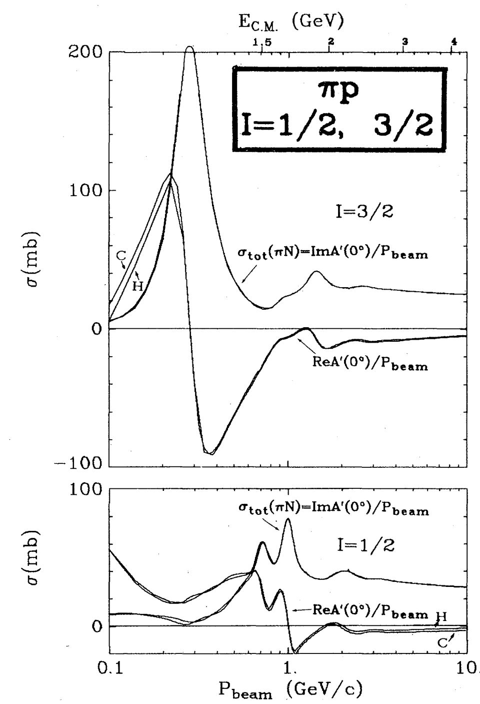
Neutrino and anti-neutrino total cross sections per nucleon [reproduced, with permission, from B.C. Barish et al., Phys. Rev. Lett. 35, 1316 (1975)]. The data are consistent with the form $\sigma_{tot} = \alpha E_{\nu,\bar\nu}$.



$\pi^{\pm}p$ total cross-section data from the Particle Data Group compilation "πN Two-Body Scattering Data," LBL-63 (1973).

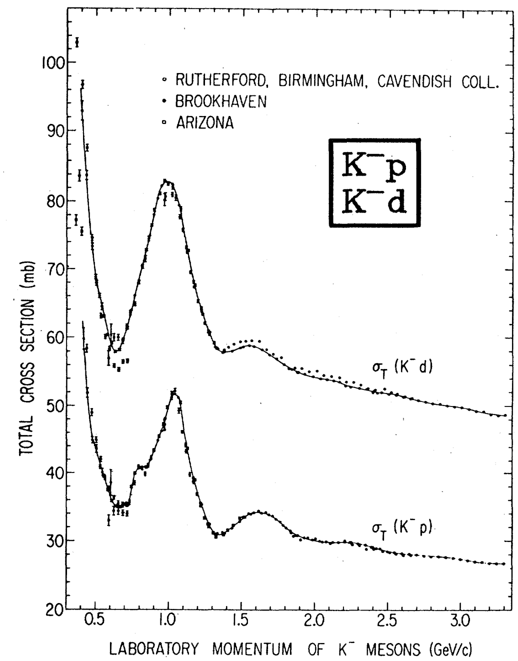


Inelastic electroproduction form factors for a virtual space-like photon scattering on a proton, from SLAC-MIT, Phys. Rev. D5, 528 (1972). $R = \sigma_S/\sigma_T$, the ratio of the longitudinal to transverse cross sections. See L. Hand, Phys. Rev. 129, 1834 (1963).

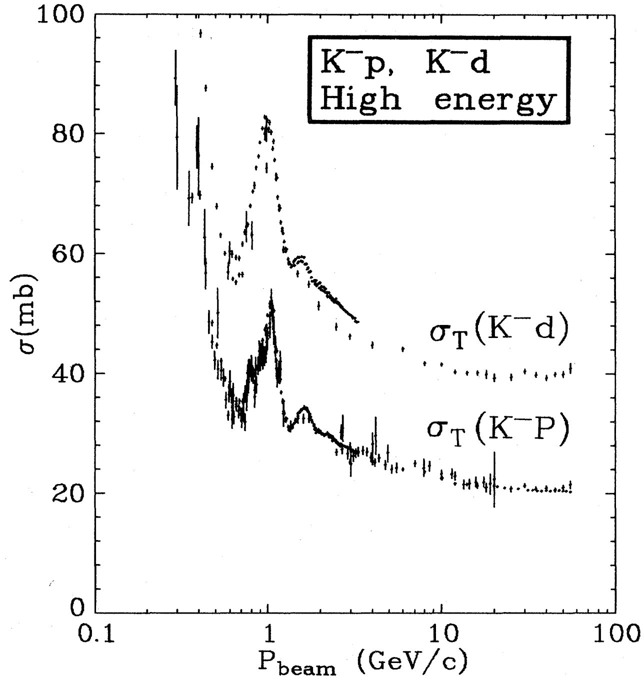


Interpolations of πN total cross sections for I=3/2 and 1/2, and the corresponding real parts of the forward amplitudes as calculated from dispersion relations by A. A. Carter and J. R. Carter (RHEL ppt. RL-73-024, 1973; labeled C above) and by G. Hohler and H. P. Jakob (priv. comm., 1972; labeled H above). The normalization of the curves for each value of I is such that the sum of their squares divided by 19.6 gives $d\sigma/dt$ at 0° in mb/(GeV/c)^2.

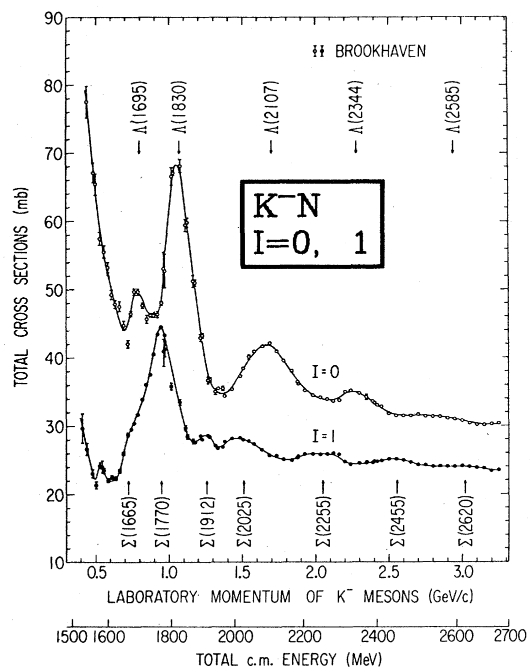
CROSS SECTION PLOTS (Cont'd)



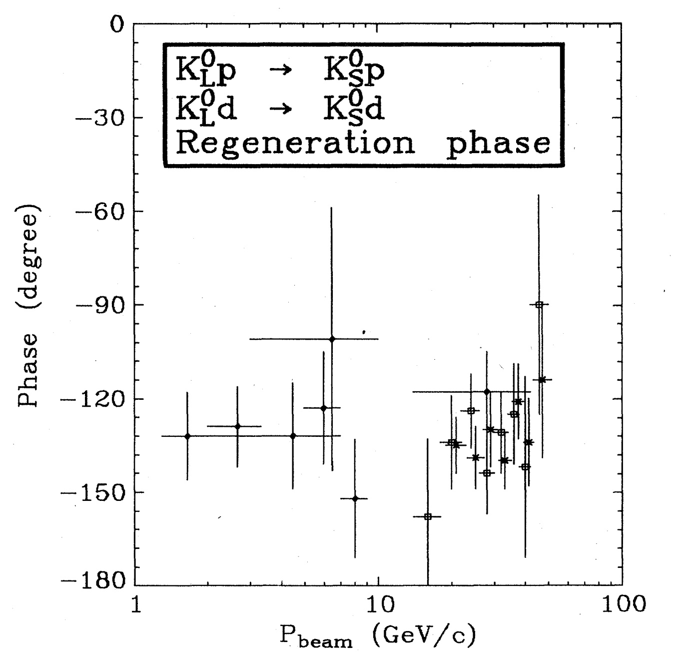
K⁻p and K⁻d total cross-section data compiled by Li et al., Proc. 1973 Purdue Conf. on Baryon Resonances. The solid curve passes through the Brookhaven data.



K⁻p and K⁻d total cross-section data. Compilation sources: E. Bracci et al., CERN/HERA 72-2, K⁻p; G.R. Lynch, K⁻d (< 3 GeV/c); Particle Data Group, K⁻d (>3 GeV/c). The new BNL data below 1 GeV/c are not included.

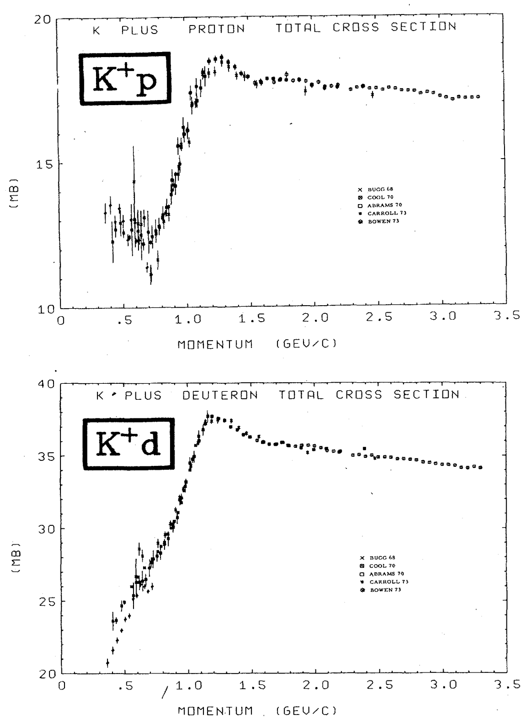


K⁻N total cross sections for I = 0 and I = 1 below 3.3 GeV/c. Compiled and unfolded by Li et al., Proc. 1973 Purdue Conf. on Baryon Resonances.

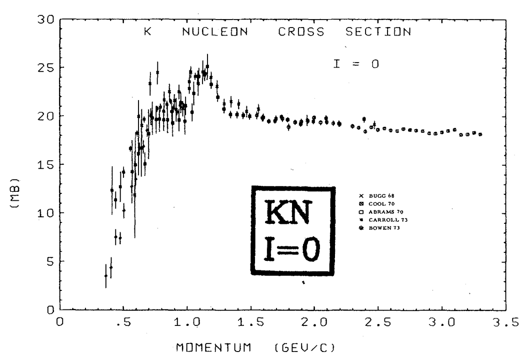


Phases of forward amplitudes for $K_L^0p \rightarrow K_S^0p$ (◇,□) and $K_L^0d \rightarrow K_S^0d$ (*). The deuterium data are shifted 1 GeV/c higher to avoid overlap with the proton data. ◇-p, compiled by Particle Data Group, LBL-55; □-p, V. Birnlev et al; JINR-E1-6851 (1972); *-d, K.-F. Albrecht et al., Phys. Lett. 48B, 257 (1974).

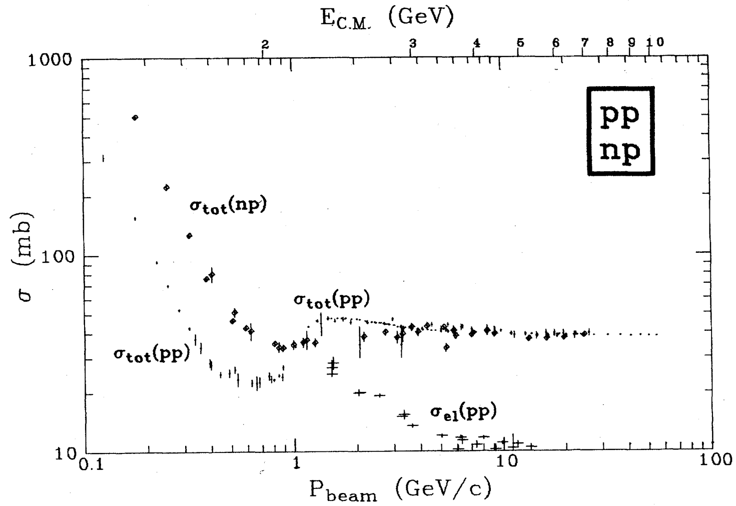
CROSS SECTION PLOTS (Cont'd)



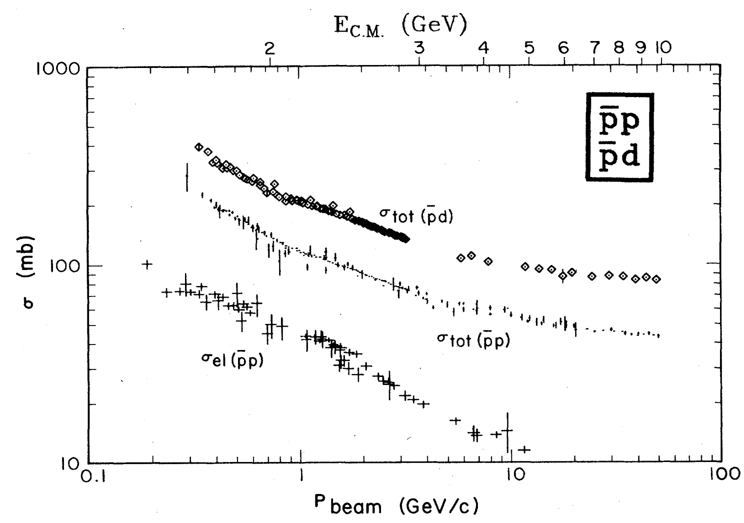
Compilation of recent K^+p and K^+d total cross-section measurements. References can be found in the Baryon Data Card Listings.



Total cross-section for isospin zero KN system. Unfolding of the BUGG 68 and BOWEN 70 and 73 data was done by G. R. Lynch (as in Proc. of 1970 Duke Conference). Tables of σ_0 were provided by the BNL authors. Lynch and BNL use the same method of unfolding; the BOWEN 73 unfolded distribution is obtained by a different method (see plot in Z^* mini-review in the Baryon Data Card Listings).

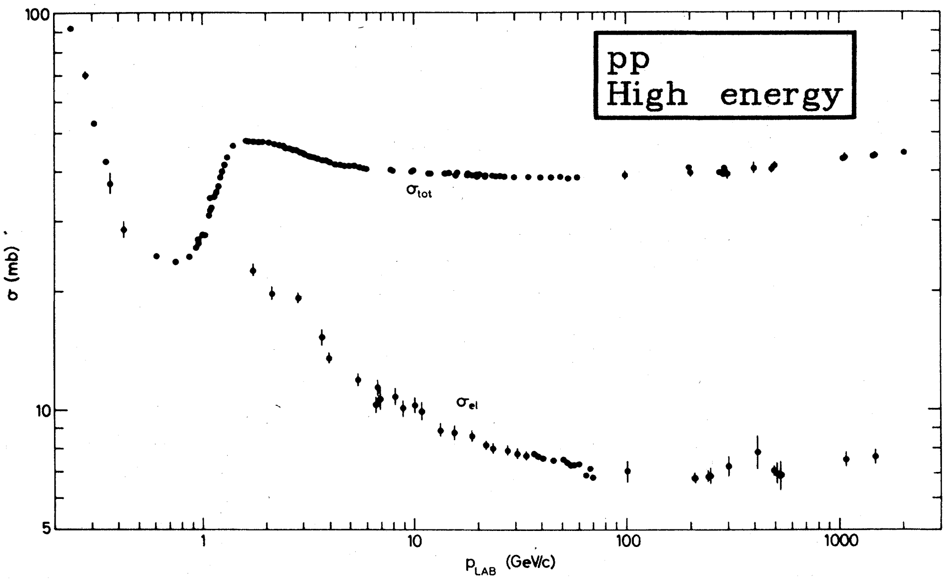


pp and np cross sections from Particle Data Group, "NN and ND Interactions -- A Compilation", UCRL-20 000 NN (August 1970); some points at higher energies added since original compilation.

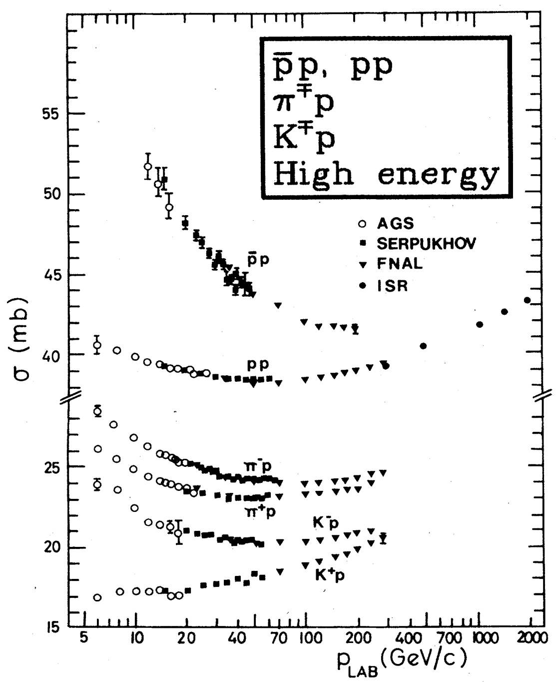


$\bar{p}p$ and $\bar{p}d$ cross sections from Particle Data Group, " A Compilation of NN and $\bar{N}$D Reactions," LBL-58 (1972); some points added since original compilation.

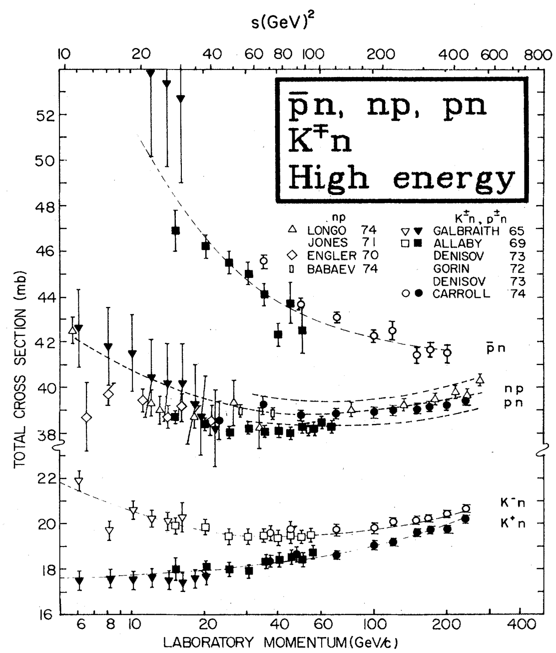
CROSS SECTION PLOTS (Cont'd)



Total and elastic pp cross-section data compiled by U. Amaldi, CERN.



$\bar{p}p$, pp, π^-p, π^+p, K^-p, and K^+p total cross sections versus s($\approx 2m_p p_{lab}$), as compiled by U. Amaldi, CERN.



$\bar{p}n$, np, pn, K^-n, and K^+n total cross sections versus s($\approx 2m_p p_{lab}$), as compiled by G. Giacomelli, CERN.

DATA CARD LISTINGS

Illustrative Key

- Name of particle as it appears in table.
- Arrow indicates this particle omitted from table.
- Quantity tabulated below.
- Code for quantity tabulated (M=mass, W=width, etc.)
- Symbols used to key together data card and related comments.
- Number of events above background.
- Measured values (parentheses indicate value not used in average).
- ± Error in measured value (– field blank if error symmetric; parentheses on error only indicate data not used in average due to problems with error estimation).
- Average value (and error) of quantity measured.
- Vertical bar indicates average; width of horizontal bar on top is error (scaled) in average.
- Value and error for each experiment.
- Partial decay mode (labeled by P_i).
- Branching ratio (labeled by R_j).
- Value (and error) of quantity measured, as determined from constrained fit (using all measured branching ratios for this particle).
- References listed by year, then author.
- Abbreviated reference form used on data cards above.
- Journal, report, preprint, etc. (see abbreviations on next page).

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XX(1200)   74  XX MESON (1200,JPG=  -)  I=1
               ORIGINALLY CALLED XXX
   ---->       OMITTED FROM TABLE
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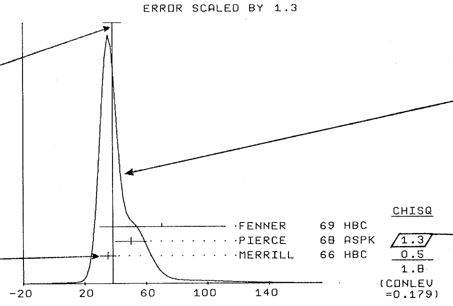
                   74  XX(1200) MASS (MEV)

 M              1216.       11.           MERRILL   66 HBC     0 3.2 K-P          7/66
 M   L   150   1192.       (16.)          LYNCH     67 HBC    +-  2.7 PI-P        6/67
 M   L     LYNCH DATA HAS QUESTIONABLE BACKGROUND SUBTRACTION
 M              1198.       10.     7.    PIERCE    68 ASPK +      2.1 K-P        9/68
 M             (1208.)                    FENNER    69 HBC     0 4.2 PI+P         9/69
 M   S     80  1210.         8.           SMITH     70 MMS   -    3.5 PI-P        2/76*
 M   S     SUPERSEDES EARLIER RESULT
 M              . . . . . . . . . .
 M   AVG        1206.9       5.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
------ --------- --------- --------- --------- --------- --------- --------

                   74  XX(1200) WIDTH (MEV)

 W              35.          5.           MERRILL   66 HBC     0/3.2 K-P          7/66
 W              50.         10.           PIERCE    68 ASPK +    2.1 K-P          9/68
 W              70.         40.           FENNER    69 HBC     0 4.2 PI+P         9/69
 W             (60.)     OR LESS          SMITH     70 MMS   -    3.5 PI-P        2/76*
 W              . . . . . . . . . .
 W   AVG        38.4         6.0      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                          (SEE IDEOGRAM BELOW )

                   WEIGHTED AVERAGE = 38.4 ± 6.0
                       ERROR SCALED BY 1.3
```

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                   74  XX(1200) PARTIAL DECAY MODES

                                                          DECAY MASSES
 P1        XX(1200) INTO 3PI                             139+ 139+ 139
 P2        XX(1200) INTO K KBAR                          493+ 493
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                   74  XX(1200) BRANCHING RATIOS

 R1        XX(1200) INTO 3PI/TOTAL                        (P1)
 R1                  .66        .02        MERRILL    66 HBC     0 3.2 K-P        7/66
 R1  L              (.68)      (.03)       LYNCH      67 HBC    +-  2.7 PI-P      6/67
 R1  L     LYNCH DATA HAS QUESTIONABLE BACKGROUND SUBTRACTION
 R1                 . . . . . . . . . .
 R1  FIT         0.675      0.012   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

 R2        XX(1200) INTO KKBAR/TOTAL                      (P2)
 R2                  .35        .05        PIERCE     68 ASPK +     2.1 K-P       9/68
 R2                 . . . . . . . . . .
 R2  FIT         0.325      0.012   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

 R3        XX(1200) INTO KKBAR/3PI                        (P2)/(P1)
 R3                  .50        .03        FENNER     69 HBC     0 4.2 PI+P       9/69
 R3                  .41        .04        SMITH      70 MMS   -   3.5 PI-P       2/76*
 R3                 . . . . . . . . . .
 R3  AVG         0.468      0.043   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.8)
 R3  FIT         0.480      0.026   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

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                   REFERENCES FOR XX(1200)

 MERRILL   66 PRL 16 143        A. MERRILL                   (TORINO+CERN)IJP
 LYNCH     67 PR 155 610        B. LYNCH                              (BNL)
 PIERCE    68 PL 27B 230        N. PIERCE                             (LRL)
 FENNER    69 NC 61B 372        D. FENNER,B. BEANE              (NYSE+AMEX)
 SMITH     70 PRL 24 14         J. SMITH                             (SLAC)

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- Particle name, and quantum numbers (if known).
- Particle code (for internal use only).
- General comments on particle.
- Abbreviated reference for this result; full reference given below.
- Measurement technique (see abbreviations on next page.)
- Charge(s) of particle detected.
- Reaction producing particle, or comments.
- Date this result punched (asterisk indicates result added or changed since previous edition).
- Scale factor > 1 indicates inconsistent data.
- Ideogram to display inconsistent data; curve is sum of Gaussians, one for each experiment (area of Gaussian = 1/error; width of Gaussian = ± error).
- Contribution of experiment to χ^2 (if no entry present, experiment not used in calculating χ^2 or scale factor because of large error).
- Representative masses of decay products (used for calculating last column of Particle Property Tables)
- Branching ratio R_j in terms of partial decay mode fractions P_i above.
- Author(s)
- Quantum number determinations in this reference
- Institution(s) of author(s) (see abbreviations on next page).

Illustrative Key *(cont'd)*

Abbreviations

Journals

APAH	Acta Phys. Acad. Hungarica
ADVP	Advances in Physics
ANP	Annals of Physics
ARNS	Annual Reviews of Nuclear Science
BAPS	Bulletin of the Amer. Phys. Soc.
JETP	English Transl. of Soviet Physics JETP
JETPL	Letters of Soviet Physics JETP
LNC	Letters to Nuovo Cimento
NC	Nuovo Cimento
NP	Nuclear Physics
PL	Physics Letters
PN	Particles and Nuclei
PPSL	Proc. of the Phys. Soc. of London
PR	Physical Review
PRL	Physical Review Letters
PRSL	Proc. of the Royal Soc. of London
RMP	Reviews of Modern Physics
SJNP	Soviet Journal of Nuclear Physics
ZPHY	Zeitschrift für Physik

Measurement techniques

ASPK	Automatic spark chambers	HYBR	Hybrid: BC + electronics
CC	Cloud chamber	IPWA	Energy-independent PWA
CNTR	Counters	MMS	Missing mass spectrometer
DASP	DESY double-arm spectrometer	MPWA	Model-dependent PWA
DBC	Deuterium bubble chamber	OSPK	Optical spark chamber
DPWA	Energy-dependent PWA	PBC	Propane bubble chamber
ELEC	Electronic combination	PLUT	DESY PLUTO detector
EMUL	Emulsions	PWA	Partial-wave analysis
FBC	Freon bubble chamber	RVUE	Review of previous data
FRAB	ADONE $B\bar{B}$ Group detector	SMAG	SPEAR magnetic detector
FRAG	ADONE $\gamma\gamma$ Group detector	SPEC	Spectrometer
FRAM	ADONE MEA Group detector	SPRK	Spark chamber
HBC	Hydrogen bubble chamber	STRC	Streamer chamber
HEBC	Helium bubble chamber	WIRE	Wire chamber
HLBC	Heavy liquid bubble chamber	XEBC	Xenon bubble chamber

Conferences

Conferences are referred to by the location in which they were held (e.g., DUBNA, BOULDER, LUND, etc.).

Institutions

AACH	TECHNISCHE UNIV. AACHEN	AACHEN, GERMANY
AARH	AARHUS UNIV.	AARHUS, DENMARK
AERE	ATOMIC ENERGY RES. ESTAB.	HARWELL, BERKS., ENGLAND
ALBA	STATE UNIV. OF NEW YORK AT ALBANY	ALBANY, N. Y., USA
AMST	UNIV. OF AMSTERDAM	AMSTERDAM, NETHERLANDS
ANKA	MIDDLE EAST TECHNICAL UNIV.	ANKARA, TURKEY
ANL	ARGONNE NAT. LAB.	ARGONNE, ILL., USA
ARIZ	UNIV. OF ARIZONA	TUCSON, ARIZ., USA
ATEN	NUCLEAR RES. CENTRE DEMOKRITOS	ATHENS, GREECE
ATHU	UNIV. OF ATHENS	ATHENS, GREECE
BARC	UNIV. DE BARCELONA	BARCELONA, SPAIN
BARI	UNIV. DI BARI	BARI, ITALY
BELG	INST. INTERUNIV. DES SCI. NUC.	BRUXELLES, BELGIUM
BERG	FYSISK INSTITUTT	BERGEN, NORWAY
BERL	INST. HOCHENERGIEPHYS. DAW	ZEUTHEN/BERLIN, DDR
BERN	UNIV. BERN	BERN, SWITZERLAND
BGNA	UNIV. DI BOLOGNA	BOLOGNA, ITALY
BING	STATE UNIV. OF NEW YORK AT BINGHAMTON	BINGHAMTON, N. Y., USA
BIRM	BIRMINGHAM UNIV.	BIRMINGHAM, ENGLAND
BNL	BROOKHAVEN NATIONAL LAB.	UPTON, L.I., N. Y., USA
BOHR	NIELS BOHR INSTITUTE	COPENHAGEN, DENMARK
BONN	UNIV. BONN	BONN, GERMANY
BORD	UNIV. DE BORDEAUX	BORDEAUX, FRANCE
BOST	BOSTON UNIV.	BOSTON, MASS., USA
BRAN	BRANDEIS UNIV.	WALTHAM, MASS., USA
BRIS	H. H. WILLS PHYS. LAB., U. OF BRISTOL	BRISTOL, ENGLAND
BROW	BROWN UNIV.	PROVIDENCE, R. I., USA
BRUX	UNIV. LIBRE DE BRUXELLES	BRUXELLES, BELGIUM
BUCH	BUCHAREST STATE UNIV.	BUCHAREST, ROMANIA
BUDA	CENTRAL RESEARCH INSTITUTE OF PHYSICS	BUDAPEST, HUNGARY
BUFF	STATE UNIV. OF NEW YORK AT BUFFALO	BUFFALO, N. Y., USA
CAEN	LAB. DE PHYS. CORPUSCULAIRE	CAEN, FRANCE
CANB	AUSTRALIAN NATIONAL UNIV.	CANBERRA, AUSTRALIA
CARL	CARLTON UNIV.	OTTAWA, CANADA
CARN	CARNEGIE-MELLON UNIV.	PITTSBURGH, PA., USA
CASE	CASE WESTERN RESERVE UNIV.	CLEVELAND, OHIO, USA
CAVE	CAVENDISH LAB., CAMBRIDGE UNIV.	CAMBRIDGE, ENGLAND
CCAC	COMMUNITY COLLEGE OF ALLEGHENY COUNTY	PITTSBURGH, PENN., USA
CDEF	COLLEGE DE FRANCE	PARIS, FRANCE
CEA	CAMBRIDGE ELECTRON ACCEL.	CAMBRIDGE, MASS., USA
CERN	EUROPEAN ORG. FOR NUC. RES.	GENEVA, SWITZERLAND
CHIC	UNIV. OF CHICAGO	CHICAGO, ILL., USA
CINC	UNIV. OF CINCINNATI	CINCINNATI, OHIO, USA
CIT	CALIF. INSTITUTE OF TECHNOLOGY	PASADENA, CALIF., USA
CNRC	CANADIAN NATIONAL RESEARCH COUNCIL	OTTAWA, CANADA
COLO	UNIV. OF COLORADO	BOULDER, COLO., USA
COLU	COLUMBIA UNIV.	NEW YORK, N. Y., USA
CORN	CORNELL UNIV.	ITHACA, N. Y., USA
CRAC	INST. FOR NUCLEAR RESEARCH	CRACOW, POLAND
CUNY	CITY UNIV. OF NEW YORK	NEW YORK, N. Y., USA
CURI	LABORATOIRE JOLIOT-CURIE	PARIS, FRANCE
DARE	DARESBURY NUC. PHYS. LAB.	DARESBURY, ENGLAND
DART	DARTMOUTH COLLEGE	HANOVER, N. H., USA
DESY	DEUTSCHES ELEKTRONEN-SYNCH.	HAMBURG, GERMANY
DUKE	DUKE UNIV.	DURHAM, N. C., USA
DURH	UNIV. OF DURHAM	DURHAM, ENGLAND
DUUC	UNIVERSITY COLLEGE	DUBLIN, IRELAND
EDIN	UNIV. OF EDINBURGH	EDINBURGH, SCOTLAND
EFI	ENRICO FERMI INST. FOR NUCL. STUDIES	CHICAGO, ILL., USA
EPOL	ECOLE POLYTECHNIQUE	PARIS, FRANCE
ETHZ	SWISS FEDERAL INST. OF TECHNOLOGY	ZURICH, SWITZERLAND
FIRZ	UNIV. DI FIRENZE	FIRENZE, ITALY
FISK	FISK UNIV.	NASHVILLE, TENN., USA
FLOR	UNIV. OF FLORIDA	GAINSVILLE, FLA., USA
FNAL	FERMI NATIONAL ACCELERATOR LAB.	BATAVIA, ILL., USA
FRAS	LAB. NAZIONALI DEL SINCROTRONE	FRASCATI, ITALY
FSU	FLORIDA STATE UNIV.	TALLAHASSEE, FLA., USA
GENO	UNIV. DI GENOVA	GENOVA, ITALY
GESC	GENERAL ELECTRIC RES. AND DEV. CENTER	SCHENECTADY, N. Y., USA
GEVA	UNIV. DE GENEVE	GENEVA, SWITZERLAND
GLAS	UNIV. OF GLASGOW	GLASGOW, SCOTLAND
GRAZ	UNIV. GRAZ	GRAZ, AUSTRIA
GSCO	GEOLOGICAL SURVEY OF CANADA	OTTAWA, CANADA
HAIF	TECHNION - ISRAEL INST. OF TECHNOLOGY	HAIFA, ISRAEL
HAMB	UNIV. HAMBURG	HAMBURG, GERMANY
HARV	HARVARD UNIV.	CAMBRIDGE, MASS., USA
HAWA	UNIV. OF HAWAII	HONOLULU, HAWAII, USA
HEID	UNIV. HEIDELBERG	HEIDELBERG, GERMANY
HELS	HELSINGIN YLIOPISTO	HELSINKI, FINLAND
IBM	INTERNATIONAL BUSINESS MACHINES	PALO ALTO, CALIF., USA
IIT	ILLINOIS INST. OF TECH.	CHICAGO, ILL., USA
ILL	UNIV. OF ILLINOIS	URBANA, ILL., USA
ILLC	UNIV. OF ILLINOIS AT CHICAGO	CHICAGO, ILL., USA
IND	UNIV. OF INDIANA	BLOOMINGTON, IND., USA
INNS	PHYS. INST., UNIV. INNSBRUCK	INNSBRUCK, AUSTRIA
IOWA	UNIV. OF IOWA	IOWA CITY, IOWA, USA
IPN	INST. DE PHYS. NUCLEAIRE	ORSAY, FRANCE
IPNP	INSTITUT DE PHYSIQUE NUCLEAIRE	PARIS, FRANCE
IPPC	INST. FOR PARTICLE PHYSICS OF CANADA	CANADA
IRAD	INSTITUTE DU RADIUM	PARIS, FRANCE
ISU	IOWA STATE UNIV.	AMES, IOWA, USA
ITEP	INST. FOR TEOR. AND EXP. PHYS.	MOSCOW, USSR
IUPU	INDIANA U. - PURDUE U. AT INDIANAPOLIS	INDIANAPOLIS, IND., USA
JAGL	JAGELLONIAN UNIV.	CRACOW, POLAND
JHU	JOHNS HOPKINS UNIV.	BALTIMORE, MD., USA
JINR	JOINT INST. FOR NUCL. RESEARCH	DUBNA, USSR
KANS	UNIV. OF KANSAS	LAWRENCE, KANSAS, USA
KARL	TECHNISCHE UNIV. KARLSRUHE	KARLSRUHE, GERMANY
KEK	NAT. LAB FOR HIGH ENERGY PHYS., JAPAN	TSUKUBA-GUN, JAPAN
KIAE	KURCHATOV INST. OF ATOMIC ENERGY	MOSCOW, USSR
KNTY	UNIV. OF KENTUCKY	LEXINGTON, KY., USA
LALC	LINEAR ACCELERATOR LAB, ORSAY	ORSAY, FRANCE
LANC	LANCASTER UNIV.	LANCASTER, ENGLAND
LASL	U. C. LOS ALAMOS SCIENTIFIC LAB.	LOS ALAMOS, N. M., USA
LAUS	UNIV. OF LAUSANNE	LAUSANNE, SWITZERLAND
LBL	U. C. LAWRENCE BERKELEY LAB.	BERKELEY, CALIF., USA
LEBD	LEBEDEV PHYSICS INST.	MOSCOW, USSR
LEHI	LEHIGH UNIV.	BETHLEHEM, PA., USA
LEID	INST. LORENTZ	LEIDEN, NETHERLANDS
LINZ	LINZ INSTITUT FUR PHYSIK, KEPLER HOCH.	LINZ, AUSTRIA
LIVP	LIVERPOOL UNIV.	LIVERPOOL, ENGLAND
LOIC	IMPERIAL COL. OF SCI. AND TECH.	LONDON, ENGLAND
LOQM	QUEEN MARY COLLEGE	LONDON, ENGLAND
LOUC	UNIVERSITY COLLEGE	LONDON, ENGLAND
LOWC	WESTFIELD COLLEGE	LONDON, ENGLAND
LPNP	LAB. DE PHYS. NUCL. ET HAUTES ENERGIES	PARIS, FRANCE
LPTP	LAB. DE PHYS. THEOR. ET HAUTES ENERGIES	PARIS, FRANCE
LRL	U. C. LAWRENCE BERKELEY LAB.	BERKELEY, CALIF., USA
LSU	LOUISIANA STATE UNIV.	BATON ROUGE, LA., USA
LUND	UNIV. I LUND	LUND, SWEDEN
MADR	JUNTA DE ENERGIA NUCLEAR	MADRID, SPAIN
MADU	UNIV. AUTONOME DE MADRID	MADRID, SPAIN
MANH	MANHATTAN COLLEGE	NEW YORK, N. Y., USA
MANI	UNIV. OF MANITOBA	WINNIPEG, CANADA
MANZ	UNIV. MAINZ	MAINZ, GERMANY
MASA	UNIV. OF MASSACHUSETTS	AMHERST, MASS., USA
MASB	UNIV. OF MASSACHUSETTS	BOSTON, MASS., USA
MCGI	MCGILL UNIV.	MONTREAL, CANADA
MCHS	UNIV. MANCHESTER	MANCHESTER, ENGLAND
MHCO	MOUNT HOLYOKE COLL.	SOUTH HADLEY, MASS., USA
MICH	UNIV. OF MICHIGAN	ANN ARBOR, MICH., USA
MILA	UNIV. DI MILANO	MILANO, ITALY
MINN	UNIV. OF MINNESOTA	MINNEAPOLIS, MINN., USA
MIOH	MIAMI UNIV.	OXFORD, OHIO, USA
MIT	MASSACHUSETTS INST. OF TECHNOLOGY	CAMBRIDGE, MASS., USA
MODE	ISTITUTO DI FISICA DELLA UNIVERSITA	MODENA, ITALY
MONL	UNIV. DE MONTREAL	MONTREAL, CANADA
MONS	UNIV. DE L'ETAT, MONS	MONS, BELGIUM
MONT	UNIV. DE MONTPELLIER	MONTPELLIER, FRANCE
MPIH	MAX-PLANCK-INST. FUR PHYS.-ASTROPHYS.	HEIDELBERG, GERMANY
MPIM	MAX-PLANCK-INST. FUR PHYS.-ASTROPHYS.	MUNICH, GERMANY
MSNA	INS. DI FISICA DELL UNIV.	MESSINA, ITALY
MSU	MICHIGAN STATE UNIV.	EAST LANSING, MICH., USA
MUNC	UNIV. OF MUNICH	MUNICH, GERMANY
NAGO	NAGOYA UNIV.	NAGOYA, JAPAN
NAPL	UNIV. DI NAPOLI	NAPOLI, ITALY
NDAM	UNIV. OF NOTRE DAME	NOTRE DAME, IND., USA
NEAS	NORTHEASTERN UNIV.	BOSTON, MASS., USA
NEUC	UNIV. DE NEUCHATEL	NEUCHATEL, SWITZERLAND
NEVI	NEVIS LAB.	IRVINGTON-ON-HUDSON, N.Y., USA
NIJM	R. K. UNIV. NIJMEGEN	NIJMEGEN, NETHERLANDS
NORD	NORDISK INS. FOR TEOR. ATOMFYS.	COPENHAGEN, DENMARK
NOVO	INST. OF NUCL. PHYS.	NOVOSIBIRSK, USSR
NRL	NAVAL RESEARCH LABORATORY	WASHINGTON, D.C., USA
NWES	NORTHWESTERN UNIV.	EVANSTON, ILL., USA
NYU	NEW YORK UNIV.	NEW YORK, N. Y., USA
OHIO	OHIO UNIV.	ATHENS, OHIO, USA
OREG	UNIV. OF OREGON	EUGENE, ORE., USA
ORNL	OAK RIDGE NATIONAL LAB.	OAK RIDGE, TENN., USA
ORSA	UNIV. DE PARIS, FAC. DES SCI.	ORSAY, FRANCE
OSLO	OSLO UNIV.	OSLO, NORWAY
OSU	OHIO STATE UNIV.	COLUMBUS, OHIO, USA
OXF	OXFORD UNIV.	OXFORD, ENGLAND
PADO	UNIV. DI PADOVA	PADOVA, ITALY
PATR	UNIV. OF PATRAS	PATRAS, GREECE
PENN	UNIV. OF PENNSYLVANIA	PHILADELPHIA, PA., USA
PISA	UNIV. DI PISA	PISA, ITALY
PITT	UNIV. OF PITTSBURGH	PITTSBURGH, PA., USA
PPA	PRINCETON-PENN. PROTON ACCEL.	PRINCETON, N. J., USA
PRAG	INSTITUTE OF PHYSICS, CSAV	PRAGUE, CZECHOSLOVAKIA
PRIN	PRINCETON UNIV.	PRINCETON, N. J., USA
PURD	PURDUE UNIV.	LAFAYETTE, IND., USA
REHO	WEIZMANN INST. OF SCI.	REHOVOTH, ISRAEL
RHEL	RUTHERFORD HIGH ENERGY LAB.	CHILTON, DID., BERKS., ENGLAND
RISO	RESEARCH ESTAB. RISO	ROSKILDE, DENMARK
RMCS	ROYAL MILITARY COLLEGE OF SCIENCE	SHRIVENHAM, ENGLAND
ROCH	UNIV. OF ROCHESTER	ROCHESTER, N. Y., USA
ROMA	UNIV. DI ROMA	ROMA, ITALY
RUTG	RUTGERS UNIV.	NEW BRUNSWICK, N. J., USA
SACL	CNTR. D'ETUDES NUC. SACLAY	GIF-SUR-YVETTE, FRANCE
SAGA	SAGA UNIV.	SAGA, JAPAN
SEAT	SEATTLE PACIFIC COLLEGE	SEATTLE, WASH., USA
SEIB	RESEARCH CENTER SEIBERSDORF	VIENNA, AUSTRIA
SERP	INST. OF HIGH EN. PHYS.	SERPUKOV, USSR
SETO	SETON HALL UNIV.	SOUTH ORANGE, N. J., USA
SFLA	UNIV. OF SOUTH FLORIDA	TAMPA, FLA., USA
SHEF	UNIV. OF SHEFFIELD	SHEFFIELD, ENGLAND
SHMP	UNIV. OF SOUTHAMPTON	SOUTHAMPTON, ENGLAND
SIN	SWISS INST. FOR NUCLEAR RESEARCH	VILLIGEN, SWITZERLAND
SLAC	STANFORD LINEAR ACCEL. CENTER	STANFORD, CALIF., USA
SOFI	BULGARIAN ACAD. OF SCI.	SOFIA, BULGARIA
STAN	STANFORD UNIV.	STANFORD, CALIF., USA
STEV	STEVENS INST. OF TECH.	HOBOKEN, N. J., USA
STLO	ST. LOUIS UNIV.	ST. LOUIS, MO., USA
STOH	STOCKHOLM UNIV.	STOCKHOLM, SWEDEN
STON	STATE UNIV. OF NEW YORK AT STONYBROOK	STONYBROOK, L.I., N. Y., USA
STRB	CENTRE DES RES. NUCLEAIRES	STRASBOURG, FRANCE
SUSS	SUSSEX UNIV.	SUSSEX, ENGLAND
SYRA	SYRACUSE UNIV.	SYRACUSE, N. Y., USA
TATA	TATA INST. OF FUNDAMENTAL RESEARCH	BOMBAY, INDIA
TELA	UNIV. OF TEL-AVIV	TEL-AVIV, ISRAEL
TEMP	TEMPLE UNIV.	PHILADELPHIA, PA., USA
TENN	UNIV. OF TENNESSEE	KNOXVILLE, TENN., USA
TNTO	UNIV. OF TORONTO	TORONTO, CANADA
TOHO	TOHOKU UNIV.	SENDAI, JAPAN
TOKY	UNIV. OF TOKYO	TOKYO, JAPAN
TORI	UNIV. DI TORINO	TORINO, ITALY
TRST	UNIV. DI TRIESTE	TRIESTE, ITALY
TUFT	TUFTS UNIV.	MEDFORD, MASS., USA
UBC	UNIV. OF BRITISH COLUMBIA	VANCOUVER, CANADA
UCB	UNIV. OF CALIF. AT BERKELEY	BERKELEY, CALIF., USA
UCD	UNIV. OF CALIF. AT DAVIS	DAVIS, CALIF., USA
UCI	UNIV. OF CALIF. AT IRVINE	IRVINE, CALIF., USA
UCLA	UNIV. OF CALIF. AT LOS ANGELES	LOS ANGELES, CALIF., USA
UCND	UNION CARBIDE NUCLEAR DIVISION	OAK RIDGE, TENN., USA
UCR	UNIV. OF CALIF. AT RIVERSIDE	RIVERSIDE, CALIF., USA
UCSB	UNIV. OF CALIF. AT SANTA BARBARA	SANTA BARBARA, CALIF., USA
UCSC	UNIV. OF CALIF. AT SANTA CRUZ	SANTA CRUZ, CALIF., USA
UCSD	UNIV. OF CALIF. AT SAN DIEGO	LA JOLLA, CALIF., USA
UMD	UNIV. OF MARYLAND	COLLEGE PARK, MD., USA
UNCS	UNION COLL.	SCHENECTADY, N. Y., USA
UPNJ	UPSALA COLLEGE	EAST ORANGE, N. J., USA
UTAH	UNIV. OF UTAH	SALT LAKE CITY, UTAH, USA
VAND	VANDERBILT UNIV.	NASHVILLE, TENN., USA
VIEN	INST. FOR HIGH EN. PHYS., A. A. S.	VIENNA, AUSTRIA
VIRG	UNIV. OF VIRGINIA	CHARLOTTESVILLE, VA., USA
VPI	VIRGINIA POLYTECHNIC INST.	BLACKSBURG, VA., USA
WARS	UNIV. OF WARSAW	WARSAW, POLAND
WASH	UNIV. OF WASHINGTON	SEATTLE, WASH., USA
WIEN	UNIV. WIEN	WIEN, AUSTRIA
WILL	COLLEGE OF WILLIAM AND MARY	WILLIAMSBURG, VA., USA
WISC	UNIV. OF WISCONSIN	MADISON, WISC., USA
WOOD	WOODSTOCK COLLEGE	WOODSTOCK, MD., USA
WUSL	WASHINGTON UNIV.	ST. LOUIS, MO., USA
WYOM	UNIV. OF WYOMING	LARAMIE, WYOMING, USA
YALE	YALE UNIV.	NEW HAVEN, CONN., USA
ZEEM	ZEEMAN LAB., UNIV. OF AMSTERDAM	AMSTERDAM, NETHERLANDS

Stable Particles

γ, ν_e, ν_μ, e, μ

Data Card Listings

For notation, see key at front of Listings.

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γ

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                      0  GAMMA(0,J=1)
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                      0  GAMMA MASS (IN UNITS OF 10**-21 MEV)

M   P       (6.)   OR LESS          PATEL     65          SATELLITE DATA   10/69
M            6.    OR LESS          GINTSBURG 64          SATELLITE DATA  .10/69
M            2.3   OR LESS          GOLDHABER 68          SATELLITE DATA   10/69
M   F       (0.06) OR LESS          FRANKEN   71          LOW FREQ RES CIR  3/72
M           10.    OR LESS          WILLIAMS  71 CNTR     TESTS GAUSS LAW   3/71
M            0.73  OR LESS          HOLLWEG   74          ALFVEN WAVES      7/74*
M   F   VALIDITY QUESTIONABLE ACCORDING TO AUTHORS AND KROLL 71.            3/72
M   P   SEE CRITICISM IN GOLDHABER 71                                       3/72

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                              REFERENCES FOR GAMMA

GINTSBUR 64 SOV. ASTR.AJ7 536 M. A. GINTSBURG              (ACAD SCI,USSR)
PATEL    65 PL     14  105    V. L. PATEL                          (DURHAM)
GOLDHABE 68 PRL    21  567    A. GOLDHABER,M. NIETO          (STONY BROOK)
FRANKEN  71 PRL 26 115        P A FRANKEN, G W AMPULSKI              (MICH)
WILLIAMS 71 PRL 26 721        +FALLER,HILL                       (WESLEYAN)
HOLLWEG  74 PRL 32 961        J V HOLLWEG  (NATL CENTER FOR ATMOS RESRCH)

                              PAPERS NOT REFERRED TO IN DATA CARDS

GOLDHABE 71 RMP 43 277        A S GOLDHABER, M M NIETO   (STON+BOHR+UCSB)
KROLL    71 PRL 26 1395       N M KROLL                              (SLAC)
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ν_e

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                      1  E-NEUTRINO(0,J=1/2)
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                      1  E-NEUTRINO MASS (KEV)

M          (0.25) OR LESS            LANGER    52 CNTR ANTI-NEUT.(TRITIUM)
M          (0.50) OR LESS            HAMILTON  53 CNTR ANTI-NEUT.(TRITIUM).11/73
M          (0.55)   (0.28)           FRIEDMAN  58 CNTR ANTI-NEUT.(TRITIUM)
M            4.1   OR LESS  CL=.67   BECK      68 CNTR NEUTRINO(SODIUM 22) 11/73
M   D        0.5   OR LESS  CL=.90   DARIS     69 CNTR ANTI-NEUT.(TRITIUM) 11/73
M            0.32  OR LESS  CL=.90   SALGO     69 CNTR ANTI-NEUT.(TRITIUM) 11/73
M            0.06  OR LESS  CL=.90   BERGKVIS  72 CNT  ANTI-NEUT.(TRITIUM) 11/73
M          (0.008)OR LESS            COWSIK    72 THEOR.LIM.FROM COSMOLOGY  3/74
M            0.086 OR LESS  CL=.90   RODE      72 CNTR ANTI-NEUT.(TRITIUM) 11/73
M   D    DARIS 69 VALUE .075KEV(CL=.67) DISAGREES WITH FIG.6.  WE USE FIG.6. 11/73

M   C       450.   OR LESS  CL=.90   CLARK     74 ASPK KE3 DECAY           11/75*
M   C    LOWEST LIMIT FROM STRANGENESS CHANGING DECAY.                    11/75*

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                      1  (E-NEUTRINO) - (E-ANTINEUTRINO) MASS DIFF. (KEV)

DM          450.   OR LESS  CL=.90   CLARK     74 ASPK KE3 DECAY           11/75*

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                              REFERENCES FOR E-NEUTRINO

LANGER   52 PR   88   689     L M LANGER,R J D MOFFAT              (INDIANA)
HAMILTON 53 PR   92   1521    D HAMILTON,W P ALFORD,L GROSS     (PRINCETON)
FRIEDMAN 58 PR 109   2214     LEWIS FRIEDMAN,LINCOLN G SMITH           (BNL)
BECK     68 ZPHY 216 229      F BECK,H DANIEL                         (MPIH)
DARIS    69 NP A138 545       K DARIS,C ST-PIERRE             (LAVAL-QUEBEC)
SALGO    69 NP A138 417       R C SALGO,H H STAUB                   (ZURICH)
BERGKVIS 72 NP B39 317        KARL-ERIK BERGKVIST          (UNIV STOCKHOLM)
COWSIK   72 PRL 29 669        R COWSIK,J MC CLELLAND                   (UCB)
RODE     72 LNC 5 139         B RODE,H DANIEL                   (MUNICH+MPIH)
CLARK    74 PR D9 533         +ELIOFF,FRISCH,JOHNSON,KERTH,SHEN+       (LBL)
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                      2  MU-NEUTRINO(0,J=1/2)
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                      2  MU-NEUTRINO MASS (MEV)

M              3.5    OR LESS            BARKAS    56 EMUL
M              4.0    OR LESS            DUDZIAK   59 CNTR
M              3.6    OR LESS            FEINBERG  63 RVUE                     7/66
M              3.0    OR LESS            ALLCOCK   65 RVUE                     7/66
M              2.5    OR LESS            BARDON    65 ASPK
M              2.8    OR LESS   CL=.90   SHAFER    65 CNTR                     5/71
M              1.6    OR LESS   CL=.90   BOOTH     67 CNTR                     3/68
M              2.2    OR LESS   CL=.90   HYMAN     67 HEBC    0. K- HE        11/67
M   B M       (1.2)   OR LESS   CL=.90   BACKENSTO 71 CNTR    M**2=-1.28+-1.24 10/71
M   S          1.15   OR LESS   CL=.90   SHRUM     71 CNTR    M**2=-1.55+-1.14 12/71
M             (8 EV)  OR LESS            COWSIK    72 THEOR.LIM.FROM COSMOLOGY  3/74
M   B M        1.15   OR LESS   CL=.90   BACKENSTO 73 CNTR    M**2=-0.29+-0.90  1/73
M              0.65   OR LESS   CL=.90   CLARK     74 ASPK    KMU3 DECAY        7/74*
M   D M        1.0    OR LESS   CL=.90   DAUM      76 SPEC    M**2= 0.23+-0.54  1/76*
M     M  WE CALCULATE UPPER LIMIT AT CL=.90 FROM M**2.                          1/76*
M   B    BACKENSTOSS 73 REPLACES BACKENSTOSS 71 AND USES THEIR NEW PI- MASS.  1/73
M   S    SHRUM 71 USES SHAFER 67 PI- MASS VALUE AND CRANE 71 MU MASS VALUE.   1/73
M   D    DAUM 76 USES OUR 1974 PI- AND MU MASSES.                               1/76*

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                      2  (MU-NEUTRINO) - (MU-ANTINEUTRINO) MASS DIFF. (MEV)

DM            (0.45) OR LESS   CL=.90   CLARK     74 ASPK KMU3 DECAY          11/75*

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                              REFERENCES FOR MU-NEUTRINO

BARKAS   56 PR 101   778      W H BARKAS,W BIRNBAUM,F M SMITH          (LRL)
DUDZIAK  59 PR 114   336      W F DUDZIAK,R SAGANE,J VEDDER            (LRL)
FEINBERG 63 ARNS 13 431       G FEINBERG, L M LEDERMAN            (COLUMBIA)
ALLCOCK  65 PPSL   85   875   G R ALLCOCK                        (LIVERPOOL)
BARDON   65 PRL   14 449      BARDON,NORTON,PEOPLES +   (COLU+STONY BROOK)
SHAFER   65 PRL   14 923      R E SHAFER,CROWE,JENKINS                 (LRL)
BOOTH    67 PL 26B  39        BOOTH,JOHNSON,WILLIAMS,WORMALD  (LIVERPOOL)
HYMAN    67 PL  25B 376       +LOKEN,PEWITT,MCKENZIE+        (ANL+CARN+NWES)
BACKENST 71 PL 36B 403        BACKENSTOSS,DANIEL,KOCH+    (CERN,KARL,HEID)
SHRUM    71 PL 37B 114        E V SHRUM,K O H ZIOCK     (UNIV OF VIRGINIA)
COWSIK   72 PRL 29 669        R COWSIK,J MC CLELLAND                   (UCB)
BACKENST 73 PL 43B 539        BACKENSTOSS,DANIEL,KOCH+ (CERN+KARL+MUNICH)
CLARK    74 PR D9 533         +ELIOFF,FRISCH,JOHNSON,KERTH,SHEN +      (LBL)
DAUM     76 PUBL. IN PL B FEB +DUBAL,EATON,FROSCH,MCCULLOCH+    (SIN,ETHZ)
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                      3  ELECTRON(0.5,J=1/2)
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                      3  ELECTRON MASS (MEV)

M         (.511006)(.00002)          COHEN     65 RVUE
M         (.5110041(.0000016)        TAYLOR    69 RVUE    USING NEW E/H       7/70
M          .5110034 .0000014         COHEN     73 RVUE                        3/74

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                      3  ELECTRON MEAN LIFE (UNITS 10**21 YR)

T              2.0  OR MORE          MOE       65 CNTR                        6/66
T   S          5.3  OR MORE          STEINBERG 75 CNTR                        2/76*
T   S    STEINBERG 75 SENSITIVE TO ALL DECAY MODES IN WHICH DECAY PARTICLES    2/76*
T   S    ESCAPE FROM DETECTOR WITHOUT DEPOSITING ENERGY. TEST OF CHARGE       2/76*
T   S    CONSERVATION.                                                        2/76*

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                      3  ELECTRON MAGNETIC MOMENT(E/2ME)

MM       SEE RICH 72 FOR A REVIEW OF THEORY AND EXPERIMENTS.                  3/74
MM         (1.0011609)    +-(24)*10**-7 SCHUPP    61 CNTR  -
MM         (1.001159622)  +-(27)*10**-9 WILKINSON 63 CNTR -                   8/66
MM         (1.001168)     +-(22)*10**-6 RICH      66 CNTR +  POSITRON         8/66
MM R       (1.001159557)  +-(30)*10**-9 RICH      68 CNTR -                   6/68
MM         (1.0011596389)+-(31)*10**-10TAYLOR     69 RVUE                   . 2/71
MM         (1.001159644)  +-(7)* 10**-9 WESLEY    70 CNTR                     6/70
MM         (1.0011596577)+-(35)*10**-10WESLEY     71 CNTR -                   2/72
MM         (1.0011603)    +-(12)*10**-7 GILLELAND 72 CNTR +                   2/72
MM          1.0011596567 +-(35)*10**-10COHEN      73 RVUE                     3/74
MM R     RICH 68 IS REEVALUATION OF WILKINSON 63.

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                              REFERENCES FOR ELECTRON

SCHUPP   61 PR  121    1      A A SCHUPP,R W PIDD,H R CRANE           (MICH)
WILKINSO 63 PR 130 852        D T WILKINSON,H R CRANE                 (MICH)
COHEN    65 RMP 37 537        COHEN,DUMOND  (N.A.AVIATION SCI.CENTER+CIT)
MOE      65 PR 140 B 992      M K MOE,F REINES      (CASE INST TECHNOLOGY)
RICH     66 PRL   17  271     A RICH, H R CRANE                       (MICH)
RICH     68 PRL 20 967        A RICH                                  (MICH)
TAYLOR   69 RMP 41 375        +PARKER,LANGENBERG              (PRIN+UCI+PENN)
WESLEY   70 PRL 24 1320       J C WESLEY,A.RICH                       (MICH)
WESLEY   71 PR A4 1341        J C WESLEY,A RICH                       (MICH)
GILLELAN 72 PR A5 38          J GILLELAND,A RICH                      (MICH)
RICH     72 RMP 44 250        A RICH,J C WESLEY                       (MICH)
COHEN    73 J.PHYS.CHEM.REF.DATA 2, P.663, E.R.COHEN,B.N.TAYLOR
STEINBER 75 PR D12 2582       STEINBERG,KWIATKOWSKI,MAENHAUT,WALL     (UMD)
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                      4  MUON(106,J=1/2)
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                      4  MUON MASS (MEV)

M          (105.659)  (0.002)          FEINBERG  63 RVUE
M          (105.6599) (0.0014)         TAYLOR    69 RVUE    USING NEW E/H      7/70
M   C      (105.6597) (0.0005)         CRANE     71 CNTR INCLUDED IN COHEN73  1/73
M   D      (105.6594) (0.0004)         CROWE     72 CNTR INCLUDED IN COHEN73  2/72
M           105.65948  0.00035         COHEN     73 RVUE                       3/74
M   C  CRANE 71 GIVES MU/ME=206.76878(85).  WE USE ME=.5110041(16)MEV.         1/73
M   D  CROWE 72 GIVES MU/ME=206.7682(5) AND USES ME=.5110041(16)MEV.           1/73
M           . . . . . . . . . .
M  FIT      105.65948  0.00035 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*

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                      4  MUON MEAN LIFE (UNITS 10**-6)

T              2.198     0.001      0.001 FARLEY    62 CNTR
T              2.203     0.004            LUNDY     62 CNTR    CONLEV=.98     11/67
T              2.202     0.003      0.003 ECKHAUSE  63 CNTR
T              2.197     0.005      0.002 MEYER     63 CNTR +
T              2.198     0.002      0.002 MEYER     63 CNTR -                 7/66
T   W        (2.20026)(0.00081)          WILLIAMS  72 CNTR +                 2/76*
T              2.1973    0.0003           DUCLOS    73 CNTR +                 1/76*
T              2.19711   0.00008          BALANDIN  74 CNTR +                 1/76*
T   W   WILLIAMS 72 MEAN LIFE MEASUREMENT WAS NOT THE PRIMARY PURPOSE OF      1/76*
T   W   THEIR EXPERIMENT AND DISAGREES STRONGLY WITH LATER EXPTS. NOT AVGD.   1/76*
T              . . . . . . . . . .
T   AVG      2.197134 0.000077 0.000077 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T   STUDENT 2.197133 0.000084 0.000084 AVG. USING STUDENT10(H/1.11) -- SEE TEXT

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                      4  MU+/MU- MEAN LIFE RATIO

DT               1.000     0.001            MEYER     63 CNTR  MEAN LIFE MU+/MU-   7/66

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                      4  MUON ANOMALOUS MAGN. MOMENT (10**-6*E/(2*MU MASS))

MM       SEE RICH 72 FOR A REVIEW OF THEORY AND EXPERIMENTS.                  3/74
MM         (1162.0)      (5.0)             CHARPAK   62 CNTR +
MM  B      (1165.75)     (0.71)            BAILEY    68 CNTR +  STOR. RINGS     5/69
MM  B      (1166.25)     (0.24)            BAILEY    68 CNTR  - STOR. RINGS     5/69
MM  B       ERRORS STATISTICAL. VALUES COMBINED TO GIVE MU+- VALUE BELOW      5/69
MM          1166.16       0.31             BAILEY    68 CNTR +- STOR. RINGS     5/69
MM          1165.895      0.027            BAILEY    75 CNTR +  STORAGE RING   11/75*
MM          . . . . . . . . . .
MM  AVG     1165.897      0.027    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
MM  STUDENT1165.897       0.029    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

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                  4  MUON TO PROTON MAGNETIC MOMENT RATIO

MMR       THIS RATIO IS USED TO OBTAIN PRECISE VALUES OF THE MUON MASS.        3/72
MMR       SEE CROWE 72.                                                         3/72
MMR         (3.1865)  (.0022)          COFFIN    58 CNTR +  SPIN RESONANCE     2/72
MMR         (3.1830)  (.0011)          LUNDY     58 CNTR +  PRECESSION STROB   2/72
MMR         (3.176)   (.013)           LUNDY     58 CNTR -  PRECESSION STROB   2/72
MMR         (3.1834)  (.0002)          GARWIN    60 CNTR +  PRECESSION PHASE   2/72
MMR         (3.18336) (.00007)         BINGHAM   63 CNTR +  PRECESSION STROB   2/72
MMR         (3.1808)  (.0004)          BINGHAM   63 CNTR -  PRECESSION STROB   2/72
MMR         (3.18338) (.00004)         HUTCHINS  63 CNTR +  PRECESSION PHASE   2/72
MMR D       (3.183351)(.000016)        EHRLICH   69 CNTR    HFS SPLITTING      2/72
MMR C       (3.183314)(.000034)        THOMPSON  69 CNTR    HFS SPLITTING      2/72
MMR         (3.183330)(.000044)        HUTCHINS  70 CNTR +  PRECESSION PHASE   2/72
MMR H       (3.183347)(.000009)        HAGUE     70 CNTR +  PRECESSION PHASE   2/72
MMR  C      (3.183336)(.000013)        CRANE     71 CNTR    HFS SPLITTING      2/72
MMR  D      (3.183349)(.000015)        DEVOE     71 CNTR    HFS SPLITTING      1/73
MMR F       (3.183326)(.000013)        FAVART    71 CNTR    HFS SPLITTING      2/72
MMR  H     (3.1833467(.0000082)        CROWE     72 CNTR +  PRECESSION PHASE   2/72
MMR  R    THE RESULTS THROUGH 1972 ARE INCLUDED IN COHEN 73.                    3/74
MMR  R       3.1833402 .0000072        COHEN     73 RVUE                        3/74
MMR          3.1833299 .0000025        CASPERSON 75 CNTR                        2/76*
MMR C     CRANE 71 SUPERSEDES THOMPSON 69. THIS IS NOT A DIRECT MEASUREMENT.   1/73
MMR H     CROWE 72 SUPERSEDES HAGUE 70.
MMR F     FAVART 71 ASSUMES A ZERO VALUE FOR THE PROTON POLARIZABILITY.        1/73
MMR  D    DEVOE 71 SUPERCEDES EHRLICH 69.  THIS IS NOT A DIRECT MEASUREMENT.   1/73
MMR  D    WE GIVE A NEW VALUE WHICH CONTAINS A THEORETICAL CORRECTION OF       1/73
MMR  D    -7.8+-2.3 PPM, AS DISCUSSED IN FOOTNOTE 35A OF CROWE 72.             1/73
MMR            . . . . . . . . . . .
MMR AVG      3.18333100.0000032  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
MMR STUDENT3.18333090.0000026  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                  4  MUON PARTIAL DECAY MODES

                                                               DECAY MASSES
P1       MUON INTO E ANTI(E-NEU) (MU-NEU)                      .5+   0+    0
P2       MUON INTO E 2GAMMA                                    .5+   0+    0
P3       MUON INTO 3ELECTRONS                                  .5+  .5+   .5
P4       MUON INTO E GAMMA                                     .5+   0
P5       MUON INTO E (E-NEU) ANTI(MU-NEU)                      .5+   0+    0

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                  4  MUON BRANCHING RATIOS

R1       MUON INTO E+2GAMMA (IN UNITS OF 10**-5)            (P2)/(P1)
R1              1.6   OR LESS  CL=.90   FRANKEL1  63 OSPK +
R1 P            0.4   OR LESS  CL=.90   POUTISSOU 74 CNTR +                    12/75*
R1 P      POUTISSOU 74 LIMIT APPLIES TO SUM OF ALL NEUTRINOLESS MU+ DECAYS.    1/76*

R2       MUON INTO 3E (IN UNITS OF 10**-7)                  (P3)/(P1)
R2 F            5.0   OR LESS  CL=.90   PARKER    62 CNTR
R2 F            1.3   OR LESS  CL=.90   ALIKHANOV 62 OSPK
R2 F            1.5   OR LESS  CL=.90   FRANKEL2  63 CNTR
R2 F            1.2   OR LESS  CL=.90   BABAEV    63 OSPK
R2 K            0.062 OR LESS  CL=.90   KORENCH2  71 OSPK                       2/72
R2 K      KORENCHENKO2 71 ASSUMES A CONSTANT MATRIX ELEMENT.                    2/72
R2 F      FOUR ABOVE EXPERIMENTS EVALUATED UPPER LIMITS ASSUMING A SECOND
R2        ORDER V-A NEUTRINO LOOP DIAGRAM. LIMITS NOT SIGNIFICANTLY CHANGED BY
R2        ASSUMING A CONSTANT MATRIX ELEMENT.

R3       MUON INTO E+GAMMA (IN UNITS OF 10**-8)             (P4)/(P1)
R3              4.3   OR LESS  CL=.90   FRANKEL1  63 OSPK
R3              2.2   OR LESS  CL=.90   PARKER    64 OSPK
R3              2.9   OR LESS  CL=.90   KORENCH1  71 OSPK +                    10/71

R4       MUON+ INTO (E+ (E-ANTINEU) (MU-NEU))               (P5)/(P1)
R4        FORBIDDEN BY ADDITIVE CONSERVATIVATION LAW FOR MUON NUMBER.
R4        MULTIPLICATIVE LAW PREDICTS R4=0.5
R4              0.25  OR LESS  CL=.90   EICHTEN   73 HLBC +                    11/75*

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                  4  MUON DECAY PARAMETERS

        RELATED TEXT SECTION VI A


RHO      RHO PARAMETER                 (V-A THEORY PREDICTS RHO=0.75)
RHO C          (0.741)  (0.027)          DUDZIAK   59 CNTR +  20-53 MEV E+       10/69
RHO  P9213      0.745    0.025           PLANO     60 HBC  +  WHOLE SPECTRUM     10/69
RHO  P  TWO PARAMETER FIT TO RHO AND ETA.
RHO C 2276     (0.751)  (0.034)          BLOCK     62 HEBC  - WHOLE SPECTRUM     10/69
RHO D          (0.64)   (0.04)           BARLOW    64 CNTR  - WHOLE SPECTRUM     10/69
RHO D          (0.661)  (0.016)          BARLOW    64 CNTR +  WHOLE SPECTRUM     10/69
RHO D          (0.867)  (0.035)          PONTECORV 64 CC    -                    10/69
RHO D    RESULTS IN DOUBT.                                                      10/69
RHO C 800K     (0.7503) (0.0026)         PEOPLES   66 ASPK +  20-53 MEV E+       10/69
RHO C 280K     (0.760)  (0.009)          SHERWOOD  67 ASPK +  25-53 MEV E+       10/69
RHO C 170K     (0.762)  (0.008)          FRYBERGER 68 ASPK +  25-53 MEV E+       10/69
RHO C    ETA CONSTRAINED =0. THESE VALUES INCORPORATED INTO A TWO PARAMETER
RHO C    FIT TO RHO AND ETA BY DERENZO 69.
RHO             0.7518   0.0026          DERENZO   69 RVUE                      10/69
RHO          . . . . . . . . . . .
RHO AVG         0.7517   0.0026   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
RHO STUDENT     0.7517   0.0028   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

ETA      ETA PARAMETER                 (V-A THEORY PREDICTS ETA=0)
ETA P 9213  (-2.0)      (0.9)            PLANO     60 HBC  +  WHOLE SPECTRUM     10/69
ETA P    TWO PARAMETER FIT TO RHO AND ETA- PLANO 60 DISCOUNTS VALUE FOR ETA     10/69
ETA C 800K   (0.05)     (0.5)            PEOPLES   66 ASPK +  20-53 MEV E+       10/69
ETA C 280K  (-0.7)      (0.6)            SHERWOOD  67 ASPK +  25-53 MEV E+       10/69
ETA C 170K  (-0.7)      (0.5)            FRYBERGER 68 ASPK +  25-53 MEV E+       10/69
ETA C    RHO CONSTRAINED =0.75.
ETA   6346   -0.12       0.21            DERENZO   69 HBC  +  1.6-6.8 MEV E+     10/69

XSI      XSI PARAMETER                 (V-A THEORY PREDICTS XSI=1)
XSI     9K      0.97     0.05            BARDON    59 CNTR    BROMOFORM TARGET  10/69
XSI   8354      0.93     0.06            PLANO     60 HBC  +  8.8 KGAUSS         10/69
XSI A          (0.903)  (0.027)          ALI-ZADE  61 EMUL +  27 KGAUSS          10/69
XSI A    DEPOLARIZATION BY MEDIUM NOT KNOWN SUFFICIENTLY WELL.
XSI G  66K     (0.975)  (0.030)          GUREVICH  64 EMUL    140 KGAUSS         10/69
XSI             0.975    0.014           GUREVICH  67 EMUL                       10/69
XSI G    GUREVICH 67 SUPERSEDES GUREVICH 64                                     10/69
XSI          . . . . . . . . . . .
XSI AVG         0.972    0.013    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
XSI STUDENT     0.973    0.014    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

DEL      DELTA PARAMETER               (V-A THEORY PREDICTS DELTA=0.75)
DEL  8354       0.78     0.05            PLANO     60 HBC  +  WHOLE SPECTRUM     10/69
DEL             0.782    0.031           KRUGER    61                            10/69
DEL   490K      0.752    0.009           FRYBERGER 68 ASPK +  25-53 MEV E+       10/69
DEL      VOSSLER 69 HAS MEASURED THE ASYMMETRY BELOW 10 MEV                     11/69
DEL          . . . . . . . . . . .
DEL AVG         0.7551   0.0085   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
DEL STUDENT     0.7550   0.0094   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

HEL      HELICITY OF DECAY ELECTRON.
HEL       (V-A THEORY PREDICTS HELICITY=+-1 FOR E+-, RESPECTIVELY)
HEL       WE HAVE FLIPPED THE SIGN FOR E- SO OUR PROGRAMS CAN AVERAGE
HEL D          (0.28)   (0.16)           DICK      63 CNTR +  ANNIHILATION       10/69
HEL D     IN DOUBT- POSITRONS POSSIBLY DEPOLARIZED IN BE MODERATOR.
HEL             1.05     0.30            BUHLER    63 CNTR +  ANNIHILATION       10/69
HEL             0.94     0.38            BLOOM     64 CNTR +  BREMS TRANSMISS    10/69
HEL             1.04     0.18            DUCLOS    64 CNTR +  BHABHA SCATT       10/69
HEL    29K      0.89     0.28            SCHWARTZ  67 OSPK  - MOLLER SCATT       10/69
HEL          . . . . . . . . . . .
HEL AVG         1.00     0.13     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
HEL STUDENT     1.00     0.14     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

GS       SCALAR COUPLING CONSTANT IN MUON DECAY  (IN UNITS OF GV)
GS              0.33  OR LESS            DERENZO   69 RVUE                      10/69

GA       AXIAL VECTOR COUPLING CONSTANT IN MUON DECAY (IN UNITS OF GV)
GA              0.86     0.33      0.11  DERENZO   69 RVUE                      10/69

FAV      PHASE BETWEEN VECTOR AND AXIAL VECTOR COUPLINGS  (DEGREES)
FAV          180.      15.               DERENZO   69 RVUE                      10/69

GT       TENSOR COUPLING CONSTANT IN MUON DECAY    (IN UNITS OF GV)
GT              0.28  OR LESS            DERENZO   69 RVUE                      10/69

GP       PSEUDOSCALAR COUPLING CONSTANT IN MUON DECAY  (IN UNITS OF GV)
GP              0.33  OR LESS            DERENZO   69 RVUE                      10/69

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REFERENCES FOR MUON


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COFFIN    58 PR 109 973          +GARWIN,PENMAN,LEDERMAN,SACHS     (COLUMBIA)
LUNDY     58 PRL 1 38            +SENS,SWANSON,TELEGDI,YOVANOVITCH (CHICAGO)
BARDON    59 PRL   2   56        M BARDON, D BERLEY, L LEDERMAN   (COLUMBIA)
DUDZIAK   59 PR   114  336       W DUDZIAK,R SAGANE, J VEDDER          (LRL)
GARWIN    60 PR 118 271          GARWIN,HUTCHINSON,PENMAN,SHAPIRO (COLUMBIA)
PLANO     60 PR   119 1400       R J PLANO                        (COLUMBIA)
ALI-ZADE  61 JETP  13  313       ALI-ZADE,GUREVICH,NIKOLSKI           (USSR)
KRUGER    61 UCRL-9322 (UNPUB)   H KRUGER                              (LRL)

ALIKHANO  62 CERN CONF 423       A I ALIKHANOV,A BABAEV +      (ITEP MOSCOW)
BLOCK     62 NC    23  1114      BLOCK,FIORINI,KIKUCHI+(DUKE,BOLOGNA,MILANO)
CHARPAK   62 PL     1  16        G CHARPAK,F J M FARLEY,R L GARWIN +  (CERN)
FARLEY    62 CERN CONF 415       FARLEY,MASSAM,MULLER,ZICHICHI        (CERN)
LUNDY     62 PR 125 1686         RICHARD A LUNDY .                     (EFI)
PARKER    62 NC   23  485        S PARKER,S PENMAN                     (EFI)

BABAEV    63 JETP 16 1397        BABAEV,BALATS,KAFTANOV,LANDSBERG +   (ITEP)
BINGHAM   63 NC 27 1352          G.MCD.BINGHAM                         (LRL)
BUHLER    63 PL    7  368        +CABIBBO,FIDECARO,MASSAM,MULLER+     (CERN)
DICK      63 PL    7  150        DICK,FEUVRAIS,SPIGHEL                (CERN)
ECKHAUSE  63 PR 132  422         M ECKHAUSE,T A FILIPPAS +       (CARNEGIE)
FEINBERG  63 ARNS 13 431         GERALD FEINBERG, L M LEDERMAN   (COLUMBIA)
FRANKEL1  63 NC   27  894        S FRANKEL,W FRATI,J HALPERN +        (PENN)
FRANKEL2  63 PR 130  351         S FRANKEL,W FRATI,J HALPERN +        (PENN)
HUTCHINS  63 PR 131 1351         HUTCHINSON,MENES,PATLACH,SHAPIRO (COLUMBIA)
MEYER     63 PR  132  2693       S L MEYER,ANDERSON,BLESER,LEDERMAN+  (COLU)

BARLOW    64 PPS   84  239       +BOOTH,CARROL,COURT,DAVIES,EDWARDS+  (LIVP)
BLOOM     64 PL    8   87        +DICK,FEUVRAIS,HENRY,MACQ,SPIGHEL    (CERN)
DUCLOS    64 PL    9   62        +HEINTZE,DE RUJULA,SOERGEL           (CERN)
GUREVICH  64 PL   11  185        GUREVICH,MAKARIYNA+     (KURCHATOV,MOSCOW)
PONTECOR  64 DUBNA CONF          PONTECORVO,SULYAEV                 (MOSCOW)
PARKER    64 PR 133B 768         S PARKER,H L ANDERSON,C REY           (EFI)

PEOPLES   66 NEVIS-147 (UNPUB)   J PEOPLES                        (COLUMBIA)
GUREVICH  67  IAE 1297           GUREVICH,MAKARIYNA,MISHAKOVA+   (KURCHATOV)
SCHWARTZ  67 PR   162 1306       D M SCHWARTZ                          (EFI)
SHERWOOD  67 PR   156 1475       B A SHERWOOD                          (EFI)
BAILEY    68 PL    28B  287      +BARTL,VON BOCHMANN,BROWN,FARLEY+    (CERN)
    ALSO  72 NC 9A 369           +BARTL,VON BOCHMANN,BROWN,FARLEY+    (CERN)
FRYBERGE  68 PR   166 1379       D FRYBERGER                           (EFI)

DERENZO   69 PR   181 1854       S DERENZO                             (EFI)
EHRLICH   69 PRL 23 513          +HOFER,MAGNON,STOWELL,SWANSON+    (CHICAGO)
TAYLOR    69 RMP 41 375          +PARKER,LANGENBERG           (PRIN+UCI+PENN)
THOMPSON  69 PRL 22 163          +AMATO,CRANE,HUGHES,MOBLEY+          (YALE)
HAGUE     70 PRL 25 628          +ROTHBERG,SCHENCK,WILLIAMS+      (WASH+LRL)
HUTCHINS  70 PRL 24 1254         HUTCHINSON,LARSON,SCHOEN,SOBER,+      (PPA)

CRANE     71 PRL 27 474          +CASPERSON,CRANE,EGAN,HUGHES+        (YALE)
DEVOE     71 PRL 25 1779(ER)     +MCINTGRE,MAGNON,STOWELL,SWANSON+ (CHICAGO)
    ALSO  71 PRL 26 213          DEVOE,MCINTGRE,MAGNON,STOWELL+    (CHICAGO)
FAVART    71 PRL 27 1336         +MCINTYRE,STOWELL,TELEGDI,DEVOE+  (CHICAGO)
KORENCH1  71 SJNP 13 190         KORENCHENKO,KOSTIN,MICELMACHER+      (JINR)
KORENCH2  71 SJNP 13 728         KORENCHENKO,KOSTIN,MICELMACHER+      (JINR)

CROWE     72 PR D5 2145          +HAGUE,ROTHBERG,SCHENCK+         (LBL+WASH)
WILLIAMS  72 PR D6 737           R W WILLIAMS,D L WILLIAMS      (WASHINGTON)
COHEN     73 J.PHYS.CHEM.REF.DATA 2, P.663, E.R.COHEN,B.N.TAYLOR
DUCLOS    73 PL 47B 491          +MAGNON,PICARD                       (SACL)
EICHTEN   73 PL 46B 281          +DEDEN+(AACH+BELG+CERN+EPOL+MILA+LALO+LOUC)
BALANDIN  74 JETP 40 811         +GREBENYUK,ZINOV,KONIN,PONOMAREV     (JINR)
POUTISSO  74 NP B80 221          POUTISSOU,FELAWKA,INGRAM +       (MONL+UBC)
BAILEY    75 PL 55B 420          +BORER+(CERN+DARE+BERN+SHEF+MANZ+RMCS+BIRM)
CASPERSO  75 PL 59B 397          D.E.CASPERSON ET AL.

                                 PAPERS NOT REFERRED TO IN DATA CARDS

FISHER    59 PRL  3  349         FISHER,LEONTIC,LUNDBY,MEUNIER,STROOT (CERN)
ASTBURY   60 ROCH CONF 60 542    ASTBURY,HATTERSLEY,HUSSAIN +  (LIVERPOOL)
DEVONS    60 PRL   5  330        DEVONS,GIDAL,LEDERMAN,SHAPIRO    (COLUMBIA)
LATHROP   60 NC    17 109        J LATHROP,R A LUNDY,V L TELEGDI +     (EFI)
LATHROP   60 NC    17 114        J LATHROP,R A LUNDY,S PENMAN +        (EFI)
REITER    60 PRL    5  22        REITER,ROMANOWSKI,SUTTON +      (CARNEGIE)
TELEGDI   60 ROCH CONF 60 713    V L TELEGDI                          (CERN)
CHARPAK   61 PRL   6 128         CHARPAK,FARLEY,GARWIN,MULLER,SENS +  (CERN)
HUTCHINS  61 PRL   7 129         D P HUTCHINSON,J MENES +         (COLUMBIA)
SHAPIRO   62 PR 125 1022         G SHAPIRO,L M LEDERMAN           (COLUMBIA)
FAIRLEY   66 NC 45A 281          FAIRLEY,BAILEY,BROWN,GIESCH +        (CERN)
VOSSLER   69 NC 63A 423          C VOSSLER                             (EFI)
RICH      72 RMP 44 250          A RICH,J C WESLEY                    (MICH)
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Stable Particles
$\pi^{\pm}$, π^{0}

Data Card Listings
For notation, see key at front of Listings.

$\pi^{\pm}$

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                 8  CHARGED PION(140,JPG=0--) I=1
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                 8  CHARGED PION MASS (MEV)

M          139.37      0.20            CROWE       54 CNTR  -
M          139.68      0.15            BARKAS      56 EMUL  +
M    S    (139.577)   (0.013)          SHAFER      67 CNTR  - MESONIC ATOMS       6/68
M    B    (139.549)   (0.008)          BACKENSTO  71 CNTR  - MESONIC ATOMS      10/71
M    S     139.566     0.013           SHAFER      72 CNTR  - MESONIC ATOMS       1/73
M    B     139.569     0.008           BACKENSTO  73 CNTR  - MESONIC ATOMS       1/73
M    S  SHAFER 72 UPDATES SHAFER67 WITH NEW ALPHA AND NEW CALIB. LINE ENER.      1/73
M    B  BACKENSTOSS 73 CORRECTS BACKENSTOSS 71 WITH NEW VACUUM POL. CALC.        1/73
M            . . . . . . . . . .
M    AVG      139.5682    0.0068  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    STUDENT 139.5682     0.0073  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
M    FIT      139.5688    0.0064 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*
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                 8  (PI+) - (MU+) MASS DIFFERENCE (MEV)

D           34.00      0.076           BARKAS      56 EMUL
D           33.89      0.076           BARKAS      56 EMUL
D      145  33.881     0.035           HYMAN       67 HEBC  + K-HE                2/71
D           33.925     0.025           BOOTH       70 CNTR  + MAGNETIC SPECT.     2/71
D            . . . . . . . . . .
D    AVG    33.915     0.019   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D    STUDENT 33.915    0.021   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
D    FIT    33.9093    0.0064 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*
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                 8  ((PI+) - (PI-))/AVG., MASS DIFFERENCE (PERCENT)

DM          0.02       0.05            AYRES       71 CNTR                        3/71
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                 8  CHARGED PION MEAN LIFE (UNITS 10**-9)

T           25.6       0.5      0.5    CROWE       57 RVUE
T           25.6       0.8      0.8    ANDERSON    60 CNTR
T     8000  25.46      0.32     0.32   ASHKIN      60 CNTR +
T           26.02      0.04            ECKHAUSE    65 CNTR +                      9/66
T           25.6       0.3             BARDON      66 CNTR                        6/66
T           25.9       0.3             DUNAITSEV   66 CNTR                        6/68
T    N     (26.40)    (0.08)           KINSEY      66 CNTR +                      6/66
T    N   SYSTEMATIC ERRORS IN CALIBR.IN THIS EXP.DISCUSSED BY NORDBERG 67         8/67
T           26.67      0.24            LOBKOWICZ   66 CNTR                        9/66
T           26.04      0.05            NORDBERG    67 CNTR +                      8/67
T           26.02      0.04            AYRES       71 CNTR +-                     3/71
T           26.09      0.08            DUNAITSEV   73 CNTR +                      3/74
T            . . . . . . . . . .
T    AVG    26.030     0.023    0.023  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T    STUDENT 26.028    0.025    0.025  AVG. USING STUDENT10(H/1.11) -- SEE TEXT
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                 8  ((PI+) - (PI-))/AVG., MEAN LIFE DIFF. (PERCENT)

DT   N   THIS QUANTITY IS A MEASURE OF CPT INVARIANCE IN W.I.

DT          0.23       0.40            LOBKOWICZ 66 CNTR       SEE NOTE L         9/66
DT   L   ABOVE IS THE MOST CONSERVATIVE VALUE QUOTED BY AUTHORS                   9/66
DT          0.4        0.7             BARDON      66 CNTR                        7/66
DT         -0.14       0.29            PETRUKHIN   68 CNTR                        8/68
DT          0.055      0.071           AYRES       71 CNTR                        3/71
DT           . . . . . . . . . .
DT   AVG    0.053      0.068   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
DT   STUDENT 0.053     0.073   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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                 8  CHARGED PION PARTIAL DECAY MODES

                                                         DECAY MASSES
P1       CHAR. PION INTO MU (MU-NEU)                     105+   0
P2       CHAR. PION INTO E ( E-NEU)                       .5+   0
P3       CHAR. PION INTO MU (MU-NEU) GAMMA               105+   0+    0
P4       CHAR. PION INTO PIO E (E-NEU)                   134+  .5+    0
P5       CHAR. PION INTO E NEU GAMMA                      .5+   0+    0
P6       CHAR. PION INTO E NEU E+ E-                      .5+   0+   .5+  .5
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                 8  CHARGED PION BRANCHING RATIOS

R1       CHAR. PION INTO MU NEU GAMMA (UNITS 10**-4)      (P3)/(P1)
R1        26     1.24       0.25          CASTAGNOL 58 EMUL     E(MU).LT.3.38 MV

R2       CHAR. PION INTO E NEU (UNITS 10**-4)             (P2)/(P1)
R2               1.21       0.07          ANDERSON   60 CNTR
R2  D           (1.247)    (0.028)        DI CAPUA   64 CNTR                    11/75*
R2 D             1.274      0.024         BRYMAN     75 RVUE                     9/75*
R2 D     BRYMAN 75 IS A RECALC. OF DICAPUA 64 EXPT USING LATEST PI LIFETIME.    9/75*
R2            . . . . . . . . . .
R2  AVG          1.267      0.023    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  STUDENT      1.268      0.025    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R3       CHAR. PION INTO PIO E NEU (UNITS 10**-8)         (P4)/(P1)
R3   D   52     (1.15)     (.22)          DEPOMMI1   63 CNTR +                   2/72
R3   D   36      0.97       0.20          BARTLETT   64 OSPK +
R3   D   38      1.07       0.21          BACASTOW   65 OSPK +
R3   D           1.10       0.26          BERTRAM    65 OSPK +                   6/66
R3   D   43      1.1        0.2           DUNAITSEV  65 CNTR +                   7/66
R3      332      1.00       0.08     0.10 DEPOMMIER  68 CNTR +                   3/68
R3            . . . . . . . . . .
R3  AVG          1.023      0.069    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  STUDENT      1.023      0.074    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
     D   DEPOMMIER 68 STATES THAT THE RESULT OF DEPOMMIER 63 IS AT LEAST         2/72
     D   10 PERCENT TOO LARGE BECAUSE OF A SYSTEMATIC ERROR IN THE PIO           2/72
     D   DETECTION EFFICIENCY.  THIS MAY BE TRUE OF ALL THE PREVIOUS             2/72
     D   MEASUREMENTS ACCORDING TO DEPOMMIER 68 AND V.SOERGEL, PRIVATE           2/72
     D   COMMUNICATION, 1972.

R4       CHAR. PION INTO E NEU GAMMA (UNITS 10**-8)       (P5)/(P1)
R4       143     3.0        0.5           DEPOMMI2   63 CNTR     GAM KE 50-90 MEV  6/66

R5       CHAR. PION INTO E NEU E+ E- (UNITS 10**-8)       (P6)/(P1)
R5               3.4    OR LESS  CL=.90   KORENCHEN 71 OSPK +                   10/71
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                              REFERENCES FOR CHARGED PION

CROWE      54 PR  96  470        K M CROWE,R H PHILLIPS                     (LRL)
BARKAS     56 PR 101  778        W H BARKAS,W BIRNBAUM,F M SMITH            (LRL)
CROWE      57 NC   5  541        K M CROWE                       (STANFORD HEPL)
CASTAGNO   58 PR 112 1779        C CASTAGNOLI,M MUCHNIK                     (ROMA)

ANDERSON   60 PR 119 2050        H L ANDERSON,T FUJII,R H MILLER +          (EFI)
ASHKIN     60 NC  16  490        ASHKIN,FAZZINI,FIDECARO,LIPMAN +          (CERN)
DEPOMMI1   63 PL 5 61            DEPOMMIER,HEINTZE,RUBBIA,SOERGEL          (CERN)
DEPOMMI2   63 PL 7 285           P DEPOMMIER,HEINTZE,RUBBIA,SOERGEL        (CERN)
BARTLETT   64 PR 136B 1452       BARTLETT,DEVONS,MEYER,ROSEN           (COLUMBIA)
DI CAPUA   64 PR 133B 1333       DI CAPUA,GARLAND,PONDROM,STRELZOFF        (COLU)

BACASTOW   65 PR 139 B407        +GHESQUIERE,WIEGAND,LARSEN           (LRL+SLAC)
BERTRAM    65 PR 139 B 617       BERTRAM,MEYER,CARRIGAN+          (MICH+CARNEGIE)
DUNAITSE   65 JETP 20 58         DUNAITSEV,PETRUKHIN,PROKOSHKIN +        (DUBNA)
ECKHAUSE   65 PL 19 348          ECKHAUSE,HARRIS,SHULER+      (WILLIAM AND MARY)

BARDON     66 PRL 16 775         BARDON,DORE,DORFAN,KRIEGER +          (COLUMBIA)
DUNAITSE   66 PL 23 283          +KUTYIN,PROKOSHKIN,RASUVAEV,SIMONOV (DUBNA)
KINSEY     66 PR 144    1132     KINSEY,LOBKOWICZ,NORDBERG  (ROCHESTER UNIV)
LOBKOWIC   66 PRL  17   548      LOBKOWICZ,MELISSINOS,NAGASHIMA+   (ROCH+BNL)

HYMAN      67 PL 25B 376         +LOKEN,PEWITT,DERRICK +          (ANL+CARN+NWES)
NORDBERG   67 PL 24B  594        NORDBERG,LOBKOWICZ,BURMAN  (ROCHESTER UNIV)
SHAFER     67 PR 163 1451        ROBERT E. SHAFER                           (LRL)
   ALSO    65 PRL 14 923         SHAFER,CROWE,JENKINS                       (LRL)

DEPOMMIE   68 NP 84 189          DEPOMMIER,DUCLOS,HEINTZE,KLEINKNECHT+(CERN)
PETRUKHI   68 JINR-P1-3862       PETRUKHIN,RYKALIN,KHAZINS,CISEK         (DUBNA)
BOOTH      70 PL 32B 723         +JOHNSON,WILLIAMS,WORMALD                (LIVP)
AYRES      71 PR 3D 1051         +CORMACK,GREENBERG,KENNEY +         (LRL,UCSB)
   ALSO    67 PR   157   1288    AYRES,CALDWELL,GREENBERG,KENNEY,KURZ+ (LRL)
   ALSO    68 PRL 21 261         AYRES,CORMACK,GREENBERG,KENNEY+   (LRL,UCSB)
   ALSO    69 UCRL-18369         DAVID S AYRES (THESIS)                     (LRL)
   ALSO    69 PRL 23 1267        GREENBERG,AYRES,CORMACK,KENNEY+   (LRL,UCSB)

BACKENST   71 PL 36B 403         BACKENSTOSS,DANIEL,KOCH+      (CERN,KARL,HEID)
   ALSO    70 THESIS             C. VON DER MALSBURG                (HEIDELBERG)
KORENCHE   71 SJNP 13 189        KORENCHENKO,KOSTIN,MICELMACHER+          (JINR)
SHAFER     72 PRIVATE COMM.      R. SHAFER, 1972                          (FNAL)
BACKENST   73 PL 43B 539         BACKENSTOSS,DANIEL,KOCH+ (CERN+KARL+MUNICH)
   ALSO    73 SUBMITTED TO NP    L. TAUSCHER
DUNAITSE   73 SJNP 16 292        DUNAITSEV,PROKOSHKIN,RAZUVAEV+           (SERP)
BRYMAN     75 PR D11 1337        +PICCIOTTO                   (UNIV OF VICTORIA)

                                 PAPERS NOT REFERRED TO IN DATA CARDS

MERRISON   62 ADVP 11 1          A W MERRISON                         (LIVERPOOL)
SHAPIRO    62 PR 125 1022        G SHAPIRO,L M LEDERMAN                (COLUMBIA)
CZIRR      63 PR 130  341        JOHN B CZIRR                               (LRL)
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                 9  NEUTRAL PION(135,JPG=0-+) I=1
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                 9  (PI+-) - (PIO) MASS DIFFERENCE (MEV)

D          (5.37)     (1.0)             PANOFSKY   51 CNTR  -
D           4.50       0.31             CHINOWSKY  54 CNTR  -
D           4.62       0.05             HADDOCK    59 CNTR  -
D           4.60       0.04             HILLMAN    59 CNTR
D           4.55       0.07             CASSELS    59 CNTR
D           4.69       0.07             SAMIOS     60 HBC                         2/72
D           4.6056     0.0055           CZIRR      63 CNTR
D           4.59       0.03             PETRUKHIN  63 CNTR  -
D           4.6034     0.0052           VASILEVSK  66 CNTR  -                      9/66
D            . . . . . . . . . .
D    AVG    4.6043     0.0037  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D    STUDENT 4.6043    0.0040  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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                 9  NEUTRAL PION MEAN LIFE (UNITS 10**-16)

T    N   76   (1.9)      (0.5)     (0.5)  GLASSER   61 EMUL
T    N   45   (2.3)      (1.1)     (1.0)  TIETGE    62 EMUL
T    N   88   (2.8)      (0.9)     (0.9)  KOLLER    63 EMUL      SEE STAMER 66
T              1.05       0.18      0.18  VON DARDE 63 CNTR
T    N   75   (1.7)      (0.5)            SHWE      64 EMUL
T              0.730      0.105           BELLETTIN 65 CNTR                       6/66
T    N   67   (1.6)      (0.6)     (0.5)  EVANS     65 EMUL                       6/66
T   K   232    1.0        0.5             STAMER    66 EMUL                       8/67
T              0.56       0.06            BELLETTIN 70 CNTR     PRIM.EFF. ON NUC  7/70
T              0.9        0.068           KRYSHKIN  70 CNTR     PRIMAKOFF EFFECT 12/70
T   B          0.82       0.04            BROWMAN   74 CNTR     PRIMAKOFF EFFECT  7/75*
T    N   OLD EMULSION MEASUREMENTS NOT USED BECAUSE OF POSSIBLE SYSTEMATIC
T    N   SHIFT TO LARGER MEAN LIFE VALUES.
T    K   INCLUDES EVENTS OF KOLLER 63.                                            8/67
T    B   BROWMAN GIVES PIO WIDTH=8.02+-.42EV.  MEAN LIFE IS HBAR/WIDTH.          11/75*
T            . . . . . . . . . .
T    AVG       0.828      0.057     0.053  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.8)
T    STUDENT   0.835      0.038     0.035  AVG. USING STUDENT10(H/1.11) -- SEE TEXT
                                   (SEE IDEOGRAM BELOW )
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                 9  NEUTRAL PION PARTIAL DECAY MODES

                                                         DECAY MASSES
P1       PIO INTO 2GAMMA                                  0+   0
P2       PIO INTO E+ E- GAMMA                            .5+  .5+   0
P3       PIO INTO 4ELECTRONS                             .5+  .5+  .5+  .5
P4       PIO INTO 3 GAMMA                                 0+   0+   0
P5       PIO INTO 4 GAMMA                                 0+   0+   0+   0
P6       PIO INTO E+ E-                                  .5+  .5
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                 9  NEUTRAL PION BRANCHING RATIOS

R1       PIO INTO (GAMMA E+ E-)/(2GAMMA) (PERCENT)          (P2)/(P1)
R1              (1.196)   THEORET. CALC.  JOSEPH      60          QUANTUM ELECT.   9/66
R1        27     1.17       0.15          BUDAGOV     60 HBC
R1      3071     1.166      0.047         SAMIOS      61 HBC       PI-P TO PIO N
R1   S   SAMIOS VALUE USES PANOFSKY RATIO = 1.62
R1            . . . . . . . . . .
R1   AVG         1.166      0.045    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1   STUDENT     1.166      0.048    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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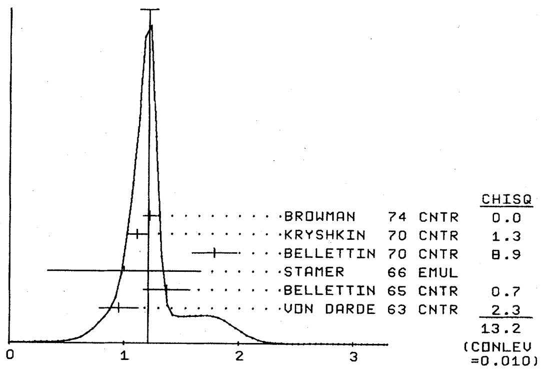
Data Card Listings

For notation, see key at front of Listings.

Stable Particles

π^0, $K^{\pm}$

WEIGHTED AVERAGE = 1.207 ± 0.080
ERROR SCALED BY 1.8



NEUTRAL PI DECAY RATE(UNITS 10**16SEC-1)

R2		PIO INTO (3 GAMMA)/(2 GAMMA) (UNITS 10**-6)				(P4)/(P1)	
R2	0	5.0 OR LESS CL=.90		DUCLOS	65 CNTR		6/66
R2		5.0 OR LESS CL=.90		KUTIN	65 CNTR		3/68
R3		PIO INTO (E+E+E-E-)/(2 GAMMA) (UNITS 10**-5)				(P3)/(P1)	
R3	146	3.18	0.30	SAMIOS	62 HBC	SEE NOTE N BELOW	6/66
R3		3.28	THEORET. CALC.	MIYAZAKI	73	QUANTUM ELECT.	2/76*
R3 N		ABOVE VALUE USES PANOFSKY RATIO = 1.62					
R4		PIO INTO (4 GAMMA)/(2 GAMMA) (UNITS 10**-5)				(P5)/(P1)	8/73
R4	0	6.1 OR LESS CL=.90		ABRAMS	73 ASPK		8/73
R5		PIO INTO (E+ E-)/TOTAL (UNITS 10**-6)				(P6)/(P1)	12/75*
R5 D		2.0 OR LESS CL=.90		DAVIES	74 RVUE		12/75*
R5 D		DAVIES 74 EXTRACTS THIS INFORMATION FROM BLOCH 75 K+ EXPERIMENT.					12/75*

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REFERENCES FOR NEUTRAL PION

PANOFSKY 51 PR 81 565 — W K H PANOFSKY,R L AAMODT,J HADLEY (LRL)
CHINOWSK 54 PR 93 586 — W CHINOWSKY,J STEINBERGER (COLUMBIA)
CASSELS 59 PPS 74 92 — CASSELS,JONES,MURPHY,O.NEILL (LIVERPOOL)
HADDOCK 59 PRL 3 478 — HADDOCK,ABASHIAN,CROWE,CZIRR (LRL)
HILLMAN 59 NC 14 887 — HILLMAN,MIDDELKOOP,YAMAGATA,ZAVATTINI(CERN)

BUDAGOV 60 JETP 11 755 — BUDAGOV,VIKTOR,DZHELEPOV,ERMOLOV + (JINR)
JOSEPH 60 NC 16 997 — D W JOSEPH (EFI)
SAMIOS 60 NC 18 154 — N P SAMIOS (COLUMBIA)
GLASSER 61 PR 123 1014 — R G GLASSER,N SEEMAN,B STILLER (NRL)
SAMIOS 61 PR 121 275 — N P SAMIOS (COLUMBIA+BNL)
SAMIOS 62 PR 126 1844 — SAMIOS,PLANO,PRODELL + (COLUMBIA+BNL)
TIETGE 62 PR 127 1324 — J TIETGE,W PUESCHEL (MAX PLANCK INST)

CZIRR 63 PR 130 341 — JOHN B CZIRR (LRL)
KOLLER 63 NC 27 1405 — E L KOLLER,S TAYLOR,T HUETTER (STEVENS)
ALSO 66 STAMER
PETRUKHI 63 SIENA CONF 208 — V I PETRUKHIN,YU D PROKOSHKIN (JINR)
VON DARD 63 PL 4 51 — VON DARDEL,DEKKERS,MERMOD,VAN PUTTEN+(CERN)

SHWE 64 PR 136B 1839 — H SHWE,F M SMITH,W H BARKAS (LRL)
BELLETTI 65 NC 40 A 1139 — BELLETTINI,BEMPORAD,BRACCINI+(PISA+FIRENZE)
DUCLOS 65 PL 19 253 — DUCLOS,FREYTAG,HEINTZE + (CERN+HEIDELBERG)
EVANS 65 PR 139 B 982 — D A EVANS (OXFORD)
KUTIN 65 JETP LETT 2 243 — KUTIN,PETRUKHIN,PROKOSHKIN (JINR)

STAMER 66 PR 151 1108 — STAMER,TAYLOR,KOLLER,HUETTER+ (STEVENS)
VASILEVS 66 PL 23 281 — VASILEVSKY,VISHNYAKOV,DUNAITSEV + (DUBNA)
BELLETTI 70 NC 66A 243 — BELLETTINI,BEMPORAD,LUBELSMEY+ (PISA+BONN)
KRYSHKIN 70 JETP 30 1037 — +STERLIGOV,USOV (TOMSK POLYTECH.INST.)
ABRAMS 73 PL 45B 66 — +CARROLL,KYCIA,LI,MICHAEL,MOCKETT + (BNL)
MIYAZAKI 73 PR D8 2051 — T.MIYAZAKI,E.TAKASUGI (TOKY)
BROWMAN 74 PRL 33 1400 — +DEWIRE,GITTELMAN,HANSON+ (CORN+BING)
DAVIES 74 NC 24A 324 — +GUY,ZIA (BIRM+RHEL+SHMP)

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$K^{\pm}$

10 CHARGED K(494,JP=0-) I=1/2

10 CHARGED K MASS (MEV)

M		493.9	0.2	COHEN	57 RVUE +		
M		493.7	0.3	BARKAS	63 EMUL -		
M		493.78	0.17	GREINER	65 EMUL +	VIA TAU DECAY	7/66
M	A	(493.87)	(0.19)	KUNSELMAN	71 CNTR	- KAONIC ATOMS	10/71
M		493.691	0.040	BACKENSTO	73 CNTR	- KAONIC ATOMS	1/73
M	A	493.662	0.19	KUNSELMAN	74 CNTR	- KAONIC ATOMS	3/74
M	A	KUNSELMAN 74 UPDATES KUNSELMAN 71 WITH IMPROVED KAONIC ATOM CALC.					3/74
M		. . . .					
M	AVG	493.702	0.037	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)			
M	STUDENT	493.701	0.040	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT			
M	FIT	493.707	0.037	FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)			2/76*

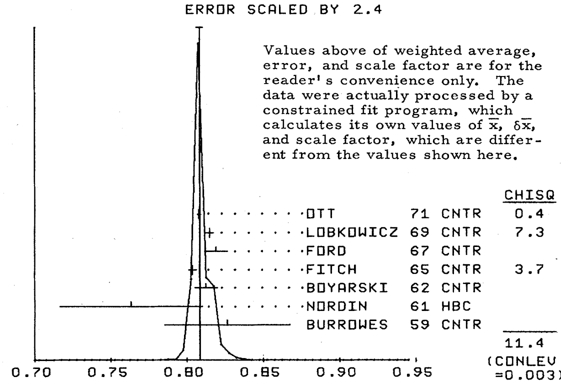
10 (K+) - (K-) MASS DIFFERENCE (MEV)

DM F	1.5M	-0.032	0.090	FORD	72 ASPK +-	4/72
DM F	FORD 72 USES M(PI+)-M(PI-) = +28+-70 KEV.					1/73

10 CHARGED K MEAN LIFE (UNITS 10**-8)

T			CHAR. K MEAN LIFE							
T	0		(0.95)	(0.36)	(0.25)	ILOFF	56 EMUL			
T	0	52	(1.60)	(0.3)	(0.3)	EISENBERG	58 EMUL			
T			1.21	0.06	0.06	BURROWES	59 CNTR			
T	0	33	(1.38)	(0.24)	(0.24)	FREDEN	60 EMUL			
T	0		(1.25)	(0.22)	(0.17)	BARKAS	61 EMUL			
T	0	51	(1.27)	(0.36)	(0.23)	BHOWMIK	61 EMUL			
T		293	1.31	0.08	0.08	NORDIN	61 HBC	-		
T			(1.24)	(0.07)		NORDIN	61 RVUE	-		
T			1.231	0.011	0.011	BOYARSKI	62 CNTR	+		
T			1.2443	0.0038		FITCH	65 CNTR	+	K AT REST	6/66
T			1.221	0.011		FORD	67 CNTR	+-		8/67
T			1.2272	0.0036		LOBKOWICZ	69 CNTR	+	K IN FLIGHT	9/66
T		3M	1.2380	0.0016		OTT	71 CNTR	+	STOPPING K	2/71
T	0	OLD EXPERIMENTS WITH LARGE ERRORS EXCLUDED FROM AVERAGING								2/71
T			. . . .							
T	AVG		1.2370	0.0032	0.0032	AVERAGE (ERROR INCL. SCALE FACTOR OF 2.4)				
T	STUDENT		1.2374	0.0016	0.0016	AVG. USING STUDENT10(H/1.11) -- SEE TEXT				
T	FIT		1.2371	0.0026	FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.9) (SEE IDEOGRAM BELOW)					

WEIGHTED AVERAGE = 0.8084 ± 0.0021
ERROR SCALED BY 2.4



CHARGED K DECAY RATE (UNITS 10**8 SEC-1)

10 ((K+) - (K-))/AVG., MEAN LIFE DIFFERENCE (PERCENT)

DT N THIS QUANTITY IS A MEASURE OF CPT INVARIANCE IN W.I.

DT		0.47	0.30	FORD	67 CNTR	8/67
DT		0.090	0.078	LOBKOWICZ	69 CNTR	12/70
DT		. . . .				
DT	AVG	0.114	0.093	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)		
DT	STUDENT	0.112	0.083	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT		

10 CHARGED K PARTIAL DECAY MODES

			DECAY MASSES
P1	CHAR. K INTO MU NEU	K MU2	105+ 0
P2	CHAR. K INTO PI PIO	K PI2	139+ 134
P3	CHAR. K INTO PI PI+ PI-	TAU	139+ 139+ 139
P4	CHAR. K INTO PI 2PIO	TAU PRIME	139+ 134+ 134
P5	CHAR. K INTO MU PIO NEU	K MU3	105+ 134+ 0
P6	CHAR. K INTO E PIO NEU	K E3	.5+ 134+ 0
P7	K+ INTO PI+ PI- E+ NEU	K E+ 4	139+ 139+ .5+ 0
P8	K+ INTO PI+ PI+ E- NEU	K E- 4	139+ 139+ .5+ 0
P9	K+ INTO PI+ PI- MU+ NEU	K+MU+ 4	139+ 139+ 105+ 0
P10	K+ INTO PI+ PI+ MU- NEU	K+MU- 4	139+ 139+ 105+ 0
P11	CHAR. K INTO E NEU	K E2	.5+ 0
P12	CHAR. K INTO MU NEU GAMMA	K MU RAD	105+ 0+ 0
P13	CHAR. K INTO PI PIO GAMMA	K PI RAD	139+ 134+ 0
P14	CHAR. K INTO PI PI+ PI- GAMMA	TAU RAD	139+ 139+ 139+ 0
P15	CHAR. K INTO PI E+ E-	PI E E	139+ .5+ .5
P16	CHAR. K INTO PI MU+ MU-	PI MU MU	139+ 105+ 105
P17	CHAR. K INTO PI GAMMA GAMMA	PI GAM GAM	139+ 0+ 0
P18	CHAR. K INTO PIO E NEU GAMMA	PI E NEU GAM	134+ .5+ 0+ 0
P19	K- INTO PI+ E- E-	PI+E-E-	139+ .5+ .5
P20	CHAR. K INTO PI NEU NEU	PI NEU NEU	139+ 0+ 0
P21	CHAR. K INTO E NEU GAMMA	K E2 RAD	.5+ 0+ 0
P22	CHAR. K INTO PI GAMMA	K PI GAM	139+ 0
P23	CHAR. K INTO PI 3GAMMA	PI 3GAM	139+ 0+ 0+ 0
P24	CHAR. K INTO PIO PIO E NEU	K E4 2PIO	134+ 134+ .5+ 0
P25	K+ INTO PI- E+ MU+	PI-E+MU+	139+ .5+ 105
P26	K+ INTO PI+ E+ MU-	PI+E+MU-	139+ .5+ 105
P27	CHAR. K INTO MU NEU NEU NEUBAR	MU 3NEU	105+ 0+ 0+ 0
P28	CHAR. K INTO PIO MU NEU GAMMA	PI MU NEU GAM	134+ 105+ 0+ 0

CHARGED K CONSTRAINED FIT
OVERALL FIT OF MEAN LIFE, WIDTHS AND BRANCHING
RATIOS USES 57 DATA POINTS TO DETERMINE SIX 2/76*
QUANTITIES. OVERALL FIT HAS CHISQ=78.2. MAIN 2/76*
CONTRIBUTION (13.3) COMES FROM R19 OF HAIDT
71 (WE SEE NO REASON TO REJECT THIS EXPERIMENT
AT THIS TIME)

Stable Particles
K±

Data Card Listings
For notation, see key at front of Listings.

FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
         P 1        P 2        P 3        P 4        P 5        P 6
P 1 .6361+-.0016
P 2   -.7186  .2105+-.0014
P 3   -.1988     -.0362  .0559+-.0003
P 4   -.1859      .0420     .2008  .0173+-.0005
P 5   -.2784     -.2485    -.1118     -.3299  .0320+-.0009
P 6   -.3526     -.1416     .1487      .0230     .2158  .0482+-.0005
```

FITTED PARTIAL DECAY MODE RATES

The matrix below is the branching fraction matrix above, transformed into rate space; i.e., $G_i \equiv \Gamma_i = \Gamma_{total} P_i$, in appropriate units. In analogy to the matrix above, the diagonal elements are $G_i \pm \delta G_i$, where $\delta G_i = \sqrt{\langle \delta G_i \delta G_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta G_i \delta G_j \rangle / (\delta G_i \cdot \delta G_j)$. Note that, because of the error in Γ_{total}, the errors and correlations here are not directly derivable from those above.

```
         G 1        G 2        G 3        G 4        G 5        G 6
G 1 .5142+-.0017
G 2   -.2961  .1702+-.0012
G 3   -.1003     -.0015  .0452+-.0002
G 4   -.1062      .0568     .2045  .0140+-.0004
G 5   -.1676     -.2140    -.1189     -.3265  .0258+-.0007
G 6   -.1606     -.0816     .1522      .0289     .2218  .0390+-.0004
```

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                    10   CHARGED K DECAY RATES

W1      CHAR. K INTO MU NEU (UNITS 10**6 SEC-1)              (G1)
W1            51.2       0.8              FORD        67 CNTR +-            8/67
W1          . . . . . . . . .
W1   FIT      51.42      0.17   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

W2      CHAR. K INTO PI PI+ PI- (UNITS 10**6 SEC-1)          (G3)
W2   F       (4.496)   (0.030)            FORD        67 CNTR +- SEE NOTE F   8/67
W2   F 3.2M  (4.529)   (0.032)            FORD        70 ASPK    SEE NOTE F  11/70
W2            4.511     0.024             FORD        70 ASPK    SEE NOTE F  11/70
W2   F   THE LAST IS THE COMBINED RESULT OF FORD 67 AND FORD 70
W2          . . . . . . . . .
W2   FIT      4.516     0.023   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

W3      CHAR. K INTO (TAU) - (TAU PRIME) (UNITS 10**6 SEC-1)
W3                                                           (G3-G4)
W3       USED FOR DELTA I = 1/2 TEST.
W3          . . . . . . . . .
W3   FIT      3.117     0.039   FROM FIT

W4      CHAR. K INTO (MU PIO NEU) + (E PIO NEU) (UNITS 10**6 SEC-1)
W4                                                           (G5+G6)
W4       USED FOR DELTA I = 1/2 TEST.
W4          . . . . . . . . .
W4   FIT      6.483     0.090   FROM FIT

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                    10   ((K+) - (K-))/AVG., DECAY RATE DIFFERENCE (PERCENT)

D1      DIFFERENCE IN K MU2 RATES      ((G1+)-(G1-))/G1         (PERCENT)
D1           -0.54      0.41             FORD        67 CNTR                8/67

D2      DIFFERENCE IN TAU RATES        ((G3+)-(G3-))/G3         (PERCENT)
D2           -0.50      0.90             FLETCHER  67 OSPK                  8/67
D2   F      (-0.04)    (0.21)            FORD      67 CNTR    SEE NOTE F    8/67
D2   F 3.2M  (0.10)    (0.14)            FORD      70 ASPK    SEE NOTE F   11/70
D2   F        0.08      0.12             FORD      70 ASPK    SEE NOTE F   11/70
D2   S      (-0.02)    (0.16)            SMITH     73 ASPK +-              11/73
D2   F   SECOND FORD 70 VALUE IS FIRST FORD 70 COMBINED WITH FORD 67.
D2   S   SMITH 73 VALUE OF D2 IS DERIVED FROM SMITH 73 VALUE OF D3.       11/73
D2          . . . . . . . . .
D2   AVG      0.07      0.12    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D2   STUDENT  0.07      0.13    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

D3      DIFFERENCE IN TAU PRIME RATES ((G4+)-(G4-))/AVERAGE     (PERCENT)
D3     1802  -1.1       1.8              HERZO     69 OSPK                  5/70
D3            0.08      0.58             SMITH     73 ASPK +-              11/73
D3          . . . . . . . . .
D3   AVG     -0.03      0.55    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D3   STUDENT -0.03      0.60    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

D4      DIFFERENCE IN K PI2 RATES      ((G2+)-(G2-))/AVERAGE    (PERCENT)
D4            0.8       1.2              HERZO     69 OSPK                  5/70

D5      DIFFERENCE IN K PI RAD RATES  ((G13+)-(G13-))/AVERAGE (PERCENT)
D5       24   0.0      24.0              EDWARDS   72 OSPK    PI KE 58-90 MEV   8/72
D5     4000   1.0       4.0              ABRAMS    73 ASPK +- PI KE 51-100 MEV  3/74
D5          . . . . . . . . .
D5   AVG      1.0       3.9     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D5   STUDENT  1.0       4.3     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    10   CHARGED K BRANCHING RATIOS

R    0       OLD DATA EXCLUDED

R1      CHAR. K INTO (MU NEU)/TOTAL (UNITS 10**-2)          (P1)
R1   0      (58.5)     (3.0)             BIRGE      56 EMUL +
R1   0      (56.9)     (2.6)             ALEXANDER 57 EMUL +
R1   0    OLD EXPERIMENTS NOT INCLUDED IN AVERAGING                           1/71
R1      62K  63.24      0.44             CHIANG     72 OSPK +  1.84 GEV/C K+  9/72
R1          . . . . . . . . .
R1   FIT     63.61      0.16    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      CHAR. K INTO (PI PIO)/TOTAL (UNITS 10**-2)          (P2)
R2   0      (27.7)     (2.7)             BIRGE      56 EMUL +
R2   0      (23.2)     (2.2)             ALEXANDER 57 EMUL +
R2   0    EARLIER EXPERIMENTS NOT AVERAGED
R2          (21.0)     (0.6)             CALLAHAN   65 HLBC     SEE R17
R2          (21.6)     (0.6)             TRILLING   65 RVUE                   6/66
R2      16K  21.18      0.28             CHIANG     72 OSPK +  1.84 GEV/C K+  9/72
R2          . . . . . . . . .
R2   FIT     21.05      0.14    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3      CHAR. K INTO (PI PI+ PI-)/TOTAL (UNITS 10**-2)      (P3)
R3   0       (5.6)     (0.4)             BIRGE      56 EMUL +
R3   0       (6.8)     (0.4)             ALEXANDER 57 EMUL +
R3   0       (5.2)     (0.3)             TAYLOR     59 EMUL +
R3   0    EARLIER EXPERIMENTS NOT AVERAGED
R3            5.7       0.3              ROE        61 HLBC +                 9/66
R3     2332   5.54      0.12             CALLAHAN   64 HLBC +
R3      540   5.1       0.2              SHAKLEE    64 HLBC +                 9/66
R3            5.71      0.15             DE MARCO   65 HBC                    6/66
R3       44   6.0       0.4              YOUNG      65 EMUL +                 6/66
R3 P    693   5.34      0.21             PANDOULAS 70 EMUL +                 10/70
R3  C 2330   (5.56)    (0.20)            CHIANG     72 OSPK +  1.84 GEV/C K+  9/72
R3  C    THIS VALUE IS NOT INDEPENDENT OF CHIANG 72 R1,R2,R4,R5, AND R6       9/72
R3 P     INCLUDES EVENTS OF TAYLOR 59.
R3          . . . . . . . . .
R3   AVG      5.521     0.098   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R3   STUDENT  5.533     0.089   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R3   FIT      5.587     0.030  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                        (SEE IDEOGRAM BELOW )
```
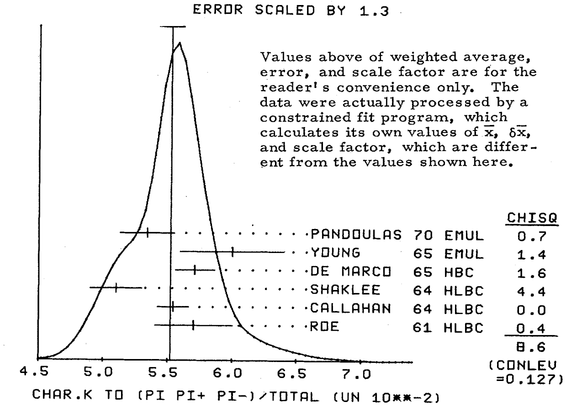

WEIGHTED AVERAGE = 5.521 ± 0.098
ERROR SCALED BY 1.3

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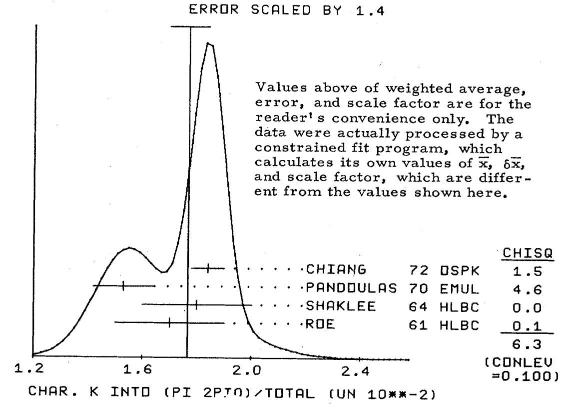
R4      CHAR. K INTO (PI 2PIO)/TOTAL (UNITS 10**-2)         (P4)
R4   0       (2.1)     (0.5)             BIRGE      56 EMUL +
R4   0       (2.2)     (0.4)             ALEXANDER 57 EMUL +
R4   0       (1.5)     (0.2)             TAYLOR     59 EMUL +
R4   0    EARLIER EXPERIMENTS NOT AVERAGED
R4            1.7       0.2              ROE        61 HLBC +                11/67
R4      108   1.8       0.2              SHAKLEE    64 HLBC +                11/67
R4 P    198   1.53      0.11             PANDOULAS 70 EMUL +                 10/70
R4     1307   1.84      0.06             CHIANG     72 OSPK +  1.84 GEV/C K+  9/72
R4 P     INCLUDES EVENTS OF TAYLOR 59.
R4          . . . . . . . . .
R4   AVG      1.767     0.071   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R4   STUDENT  1.778     0.063   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R4   FIT      1.731     0.045  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.4)
                        (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 1.767 ± 0.071
ERROR SCALED BY 1.4



Data Card Listings

For notation, see key at front of Listings.

Stable Particles

K±

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R5     CHAR. K INTO (MU PIO NEU)/TOTAL (UNITS 10**-2)    (P5)
R5  O       (2.8)     (1.0)           BIRGE      56 EMUL +
R5  O       (5.9)     (1.3)           ALEXANDER  57 EMUL +
R5  O       (2.8)     (0.4)           TAYLOR     59 EMUL +
R5  O   EARLIER EXPERIMENTS NOT AVERAGED
R5    2345    3.33      0.16          CHIANG     72 OSPK +  1.84 GEV/C K+     9/72
R5           . . . . . . . . .
R5  FIT       3.197     0.087  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)

R6     CHAR. K INTO (E PIO NEU)/TOTAL (UNITS 10**-2)     (P6)
R6  O       (3.2)     (1.3)           BIRGE      56 EMUL +
R6  O       (5.1)     (1.3)           ALEXANDER  57 EMUL +
R6  O   EARLIER EXPERIMENTS NOT AVERAGED
R6            5.0       0.5           ROE        61 HLBC +                   11/67
R6     429    4.7       0.3           SHAKLEE    64 HLBC +                   11/67
R6    3516    4.86      0.10          CHIANG     72 OSPK +  1.84 GEV/C K+     9/72
R6           . . . . . . . . .
R6  AVG       4.849     0.093   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R6  STUDENT   4.85      0.10    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R6  FIT       4.823     0.052  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R7     CHAR. K INTO (PI2 + MU3)/TOTAL (UNITS 10**-2)     (P2+P5)             11/67
R7      WE COMBINE THESE TWO MODES FOR EXPTS MEASURING THEM IN XENON BC
R7      BECAUSE OF DIFFICULTIES OF SEPARATING THEM THERE
R7            23.4      1.1           ROE        61 HLBC +                   11/67
R7     886    25.4      0.9           SHAKLEE    64 HLBC +                   11/67
R7           . . . . . . . . .
R7  AVG       24.60     0.98    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R7  STUDENT   24.61     0.83    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R7  FIT       24.25     0.15   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R8     K+ INTO (PI+ PI+ E- NEU)/TOTAL (UNITS 10**-7)     (P8)
R8            20.    OR LESS  CL=.95  BIRGE      65 FBC  +                    8/66
R8       0    6.9    OR LESS  CL=.95  ELY        69 HLBC +                   10/69
R8       0    9.0    OR LESS  CL=.95  SCHWEINBE  71 HLBC +                    9/71

R9     K+ INTO (PI+ PI- MU+ NEU)/TOTAL (UNITS 10**-5)    (P9)
R9       1    0.77      0.54      0.50  CLINE    65 FBC  +                    8/66

R10    K+ INTO (PI+ PI+ MU- NEU)/TOTAL (UNITS 10**-6)    (P10)
R10      0    3.0    OR LESS  CL=.95  BIRGE      65 FBC  +                    8/66

R11    CHAR. K INTO (E NEU)/TOTAL (UNITS 10**-5)         (P11)
R11         160.0    OR LESS  CL=.95  BORREANI   64 HBC  +                   11/67
R11      4    2.1       1.8       1.3  BOWEN     67 OSPK +                    8/67
R11     BOWEN RESULT SHOULD BE CORRECTED TO 1.9(+1.7,-1.2) BECAUSE OF
R11     K+ TO E+ NEU GAMMA DECAYS BEFORE COMPARING WITH BOTTERILL 67 R28

R12    CHAR. K INTO (PI GAMMA GAMMA)/TOTAL (UNITS 10**-4)
R12                                                       (P17)
R12     ALL VALUES GIVEN HERE ASSUME A PHASE SPACE PION ENERGY SPECTRUM     2/72
R12           -0.1      0.6           CHEN       68 OSPK +  T(PI) 60-90 MEV    9/73
R12      0    0.5    OR LESS  CL=.90  KLEMS      71 OSPK +  T(PI)GT 117 MEV    8/71
R12      0    0.35   OR LESS  CL=.90  LJUNG      73 HLBC +  6-102,114-127MEV   9/73

R13    CHAR. K INTO (PI PIO GAMMA)/TOTAL (UNITS 10**-4) (P13)
R13     18    2.2       0.7           CLINE      64 FBC  +  PI+ KE 55-80 MEV   8/66
R13      0    1.9    OR LESS  CL=.90  EMMERSON   69 OSPK    PI+ KE 55-80 MEV  10/69
R13 M    0    1.0    OR LESS          MALTSEV    70 HLBC +  PI+ KE LT 55 MEV  12/75*
R13 A2100     2.71      0.19          ABRAMS     72 ASPK +- PI+ KE 55-90 MEV   1/73
R13     24    2.4       0.8           EDWARDS    72 OSPK    PI+ KE 58-90 MEV   8/72
R13 L        (1.5)     (1.1)     (0.6) LJUNG     73 HLBC +  PI+ KE 55-80 MEV   9/73
R13 L        (2.6)     (1.5)     (1.1) LJUNG     73 HLBC +  PI+ KE 55-90 MEV   9/73
R13   L 17    6.8       3.7       2.1  LJUNG     73 HLBC +  PI+ KE 55-102MEV   9/73
R13 M  MALTSEV 70 SELECTS LOW PI+ ENERGY TO ENHANCE DIRECT EMISSION CONTR.   1/76*
R13 L  THE LJUNG 73 VALUES ARE NOT INDEPENDENT.                               9/73
R13 A  ABRAMS 72 OBSERVES DIRECT EMISSION BR. RATIO OF (1.56+-0.35)*10**-5    1/73
R13 A  +-0.5*10**-5 ADDNL. SYST. ERROR  AND INNER BREMSSTRAHLUNG BR. RATIO    1/73
R13 A  OF (2.55+-0.18)*10**-4.  WE QUOTE THE SUM OF THESE BR. RATIOS.         1/73
R13          . . . . . . . . .
R13 AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R14    CHAR. K INTO (PI PI+ PI- GAMMA)/TOTAL (UNITS 10**-4)
R14                                                       (P14)
R14           1.0       0.4           STAMER     65 EMUL +  EGAM GT 11MEV      8/66

R15    CHAR. K INTO (PI E+ E-)/TOTAL (UNITS 10**-6)      (P15)
R15      1    2.45   OR LESS  CL=.90  CAMERINI   64 FBC  +                    8/66
R15           4.4    OR LESS  CL=.90  BISI       67 DBC  +                   11/67
R15  C       (0.4)   OR LESS          CLINE1     67 FBC  +                  .11/67
R15  C        0.88   OR LESS  CL=.90  CLINE2     67 FBC  +                  . 2/74
R15          32.0    OR LESS  CL=.90  BEIER      72 OSPK +-                   9/72
R15           1.7    OR LESS  CL=.90  CENCE      74 ASPK +  THREE TRACK EVTS 10/74*
R15           0.27   OR LESS  CL=.90  CENCE      74 ASPK +  TWO TRACK EVENTS 10/74*
R15  C  CLINE2 REPLACES CLINE1.  CLINE1 IS NOT FOR CL=.90 .                   2/74

R16    CHAR. K INTO (PI MU+ MU-)/TOTAL (UNITS 10**-6)    (P16)
R16           3.0    OR LESS  CL=.90  CAMERINI   65 FBC  +                    8/66
R16           2.4    OR LESS  CL=.90  BISI       67 DBC  +                   11/67

R17    CHAR. K INTO (PI PIO)/TAU                          (P2)/(P3)
R17    134    3.24      0.34          YOUNG      65 EMUL +                  . 8/66
R17   1045    3.96      0.15          CALLAHAN   66 FBC  +                    9/66
R17          . . . . . . . . .
R17 AVG       3.84      0.27    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
R17 STUDENT   3.86      0.16    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R17 FIT       3.768     0.033  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R18    CHAR. K INTO (PI 2PIO)/TAU                         (P4)/(P3)
R18   2027    0.303     0.009         BISI       65 H+HL +                  . 8/66
R18     17    0.393     0.099         YOUNG      65 EMUL +                    8/66
R18          . . . . . . . . .
R18 AVG       0.3037    0.0090  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R18 STUDENT   0.3037    0.0097  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R18 FIT       0.3098    0.0079 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R19    CHAR. K INTO (MU PIO NEU)/TAU                      (P5)/(P3)
R19   2845    0.632     0.035         BISI 1     65 H+HL +                  . 8/66
R19     38    0.90      0.16          YOUNG      65 EMUL +                    8/66
R19 H 1505   (0.510)   (0.017)        EICHTEN    68 HLBC +                   11/68
R19  H1505    0.503     0.019         HAIDT      71 HLBC +                   12/70
R19  H  HAIDT 71 IS A REANALYSIS OF EICHTEN 68.
R19          . . . . . . . . .
R19 AVG       0.536     0.054   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.2)
R19 STUDENT   0.527     0.025   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R19 FIT       0.572     0.016  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.8)
                        (SEE IDEOGRAM BELOW )
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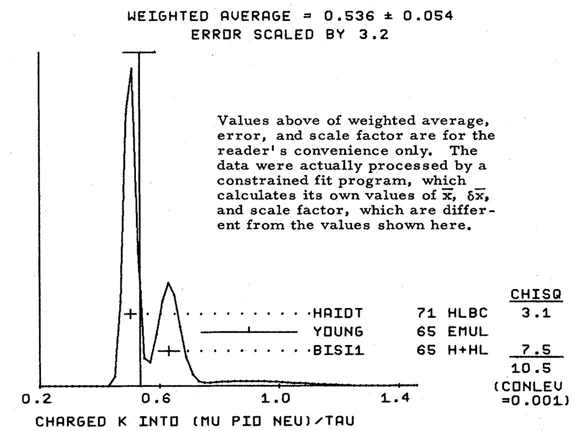


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R20    CHAR. K INTO (E PIO NEU)/TAU                       (P6)/(P3)
R20    230    0.90      0.06          BORREANI   64 HBC  +                  . 8/66
R20     37    0.90      0.16          YOUNG      65 EMUL +                  . 8/66
R20    854    0.94      0.09          BELLOTT2   67 HLBC                     11/67
R20 H 4385   (0.846)   (0.021)        EICHTEN    68 HLBC +                   11/68
R20  H4385    0.850     0.019         HAIDT      71 HLBC +                   12/70
R20   2827    0.856     0.040         BRAUN      75 HLBC +                   12/75*
R20  H  HAIDT 71 IS A REANALYSIS OF EICHTEN 68.
R20          . . . . . . . . .
R20 AVG       0.858     0.016   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R20 STUDENT   0.858     0.018   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R20 FIT       0.8632    0.0098 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R21    K+ INTO (PI+ PI- E+ NEU)/TAU (UNITS 10**-4)        (P7)/(P3)
R21     69    6.7       1.5           BIRGE      65 FBC  +                    8/66
R21    269    5.83      0.63          ELY        69 HLBC +                   11/68
R21    500    7.36      0.68          BOURQUIN   71 ASPK                     12/71
R21    106    7.0       0.9           SCHWEINBE  71 HLBC +                    9/71
R21          . . . . . . . . .
R21 AVG       6.64      0.40    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R21 STUDENT   6.66      0.48    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R22    K+ INTO (PI+ PI- MU+ NEU)/TAU (UNITS 10**-4)       (P9)/(P3)
R22      1   (2.5)    APPROX          GREINER    64 EMUL +                    8/66
R22      7    2.57      1.55          BISI       67 DBC  +                   11/67

R23    CHAR. K INTO (E PIO NEU)/(MU2+PI2) (UNITS 10**-2)(P6)/(P1+P2)
R23   1679    5.89      0.21          CESTER     66 OSPK +                    8/67
R23   5110    6.16      0.22          ESCHSTRUT  68 OSPK +                    3/68
R23          . . . . . . . . .
R23 AVG       6.02      0.15    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R23 STUDENT   6.02      0.17    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R23 FIT       5.697     0.067  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R24    CHAR. K INTO (PI PIO)/(MU NEU)                     (P2)/(P1)
R24  A4517    0.3277    0.0065        AUERBACH   67 OSPK +                    1/74
R24   1600    0.305     0.018         ZELLER     69 ASPK +                   10/69
R24    25K    0.328     0.005         WEISSENBE  74 STRC +                    7/74*
R24  A  AUERBACH 67 CHANGED FROM .3253+-.0065.  SEE COMMENT WITH RATIO R26.  1/74
R24          . . . . . . . . .
R24 AVG       0.3268    0.0039  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R24 STUDENT   0.3269    0.0042  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R24 FIT       0.3309    0.0029 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R25    CHAR. K INTO (E PIO NEU)/(MU NEU)                  (P6)/(P1)
R25  A 295    0.0791    0.0054        AUERBACH   67 OSPK +                    1/74
R25    960     .0775     .0033        BOTTERI1   68 ASPK +                    5/68
R25    561    0.069     0.006         GARLAND    68 OSPK +                    4/68
R25    350    0.069     0.006         ZELLER     69 ASPK +                   10/69
R25  A  AUERBACH 67 CHANGED FROM .0797+-.0054.  SEE COMMENT WITH RATIO R26.  1/74
R25  A  THE VALUE .0785+-.0025 GIVEN IN AUERBACH 67 IS AN AVERAGE OF         3/74
R25  A  AUERBACH 67 R25 AND CESTER 66 R23.                                    3/74
R25          . . . . . . . . .
R25 AVG       0.0752    0.0024  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R25 STUDENT   0.0753    0.0027  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R25 FIT       0.07582   0.00091 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R26    CHAR. K INTO (MU PIO NEU)/(MU NEU)                 (P5)/(P1)
R26  A 307    0.0486    0.0040        AUERBACH   67 OSPK +                    1/74
R26  G 424    0.0480    0.0037        GARLAND    68 OSPK                      1/74
R26    240    0.054     0.009         ZELLER     69 ASPK +                   10/69
R26  A  AUERBACH 67 CHANGED FROM .0602+-.0046 BY ERRATUM WHICH BRINGS THE    1/76*
R26  A  MU-SPECTRUM CALCULATION INTO AGREEMENT WITH GAILLARD 70 APPENDIX B.  1/74
R26  G  GARLAND 68 CHANGED FROM .055+-.004 IN AGREEMENT WITH MU-SPECTRUM     1/74
R26  G  CALCULATION OF GAILLARD 70 APPENDIX B.  L.G.PONDROM, PRIV.COMM.(73)  1/74
R26          . . . . . . . . .
R26 AVG       0.0488    0.0026  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R26 STUDENT   0.0487    0.0028  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R26 FIT       0.0503    0.0014 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)

R27    CHAR. K INTO (MU NEU)/TAU                          (P1)/(P3)
R27 R  427  (10.38)    (0.82)         YOUNG      65 EMUL +                    9/66
R27 R   DELETED FROM OVERALL FIT BECAUSE YOUNG 65 CONSTRAINS HIS RESULTS.
R27 R   TO ADD UP TO 1.  ONLY YOUNG MEASURED MU2 DIRECTLY.
R27          . . . . . . . . .
R27 FIT       11.385    0.072   FROM FIT

R28    CHAR. K INTO (E NEU)/(MU NEU) (UNITS 10**-5)       (P11)/(P1)
R28     10    1.9       0.7       0.5  BOTTERILL 67 ASPK +                   11/67
R28      8    1.8       0.8       0.6  MACEK     69 ASPK +                    4/69
R28    112    2.42      0.42           CLARK     72 OSPK +                    1/73
R28    534    2.37      0.17           HEARD2    75 SPEC +                   11/75*
R28    404    2.51      0.15           HEINTZE   76 SPEC +                    2/76*
R28          . . . . . . . . .
R28 AVG       2.42      0.11    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R28 STUDENT   2.42      0.12    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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Stable Particles

$K^{\pm}$

Data Card Listings

For notation, see key at front of Listings.

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R29     CHAR. K INTO (MU PIO NEU)/(E PIO NEU)                    (P5)/(P6)
R29  C1509     0.703     0.056             CALLAHA1  66 HLBC                          6/68
R29   5601     0.667     0.017             BOTTERI2  68 ASPK +                        6/68
R29 H 1398    (0.604)   (0.022)            EICHTEN   68 HLBC                         10/68
R29 H         (0.596)   (0.025)            HAIDT     71 HLBC +                       12/70
R29  D3480     0.698     0.025             CHIANG    72 OSPK +  1.84 GEV/C K+         9/72
R29  L 554     0.705     0.063             LUCAS2    73 HBC  -  DALITZ PRS ONLY      11/73
R29 B 1585    (0.608)   (0.014)            BRAUN     75 HLBC +                        1/76*
R29                COMMENTS
R29  C   FROM CALLAHAN1 66 WE USE ONLY THE MU3/E3 RATIO AND DO NOT
R29  C   INCLUDE IN THE FIT THE RATIOS MU3/TAU AND E3/TAU, SINCE THEY SHOW
R29  C   LARGE DISAGREEMENTS WITH THE REST OF THE DATA.
R29 H    HAIDT 71 IS A REANALYSIS OF EICHTEN 68.
R29 H    ONLY INDIVIDUAL RATIOS INCLUDED IN FIT (SEE R19 AND R20).                   11/68
R29  D   CHIANG 72 R29 IS STATISTICALLY INDEPENDENT OF CHIANG 72 R5 AND R6.           9/72
R29  L   LUCAS 73 GIVES N(MU3)=554+-7.6PCT, N(E3)=786+-3.1PCT.  WE DIVIDE.           11/73
R29 B    BRAUN 75 VALUE IS FROM FORM FACTOR FIT.  ASSUMES MU-E UNIVERSALITY.          1/76*
R29         . . . . . . . . . .
R29 AVG        0.680     0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R29 STUDENT    0.680     0.015   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R29 FIT        0.663     0.018  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)

R30     CHAR. K INTO (PIO E NEU GAMMA)/(PIO E NEU) (UNITS 10**-2)
R30                                                              (P18)/(P6)
R30            1.2       0.8               BELLOTT1  67 HLBC +  EGAM GT 30MEV        11/67
R30  R  13     0.76      0.28              ROMANO    71 HLBC    EGAM GT 10MEV        10/71
R30 R         (0.53)    (0.22)             ROMANO    71 HLBC +  EGAM GT 30 MEV        9/73
R30  L  16     0.48      0.20              LJUNG     73 HLBC +  EGAM GT 30 MEV        9/73
R30 L         (0.22)    (0.15)    (0.10)   LJUNG     73 HLBC +  EGAM GT 30 MEV        9/73
R30 L    FIRST LJUNG VALUE IS FOR COS(ELECT-GAMMA)L.T. 0.9, SECOND VALUE IS           9/73
R30 L    FOR COS(ELECT-GAMMA) BETW 0.6 AND 0.9 FOR COMPARISON WITH ROMANO.            9/73
R30 R    BOTH ROMANO VALUES ARE FOR COS(ELECT-GAMMA) BETW 0.6 AND 0.9.                9/73
R30 R    SECOND VALUE IS FOR COMPARISON WITH SECOND LJUNG VALUE.                      9/73
R30 R    WE USE LOWEST EGAM CUT FOR TABLE VALUE. SEE ROMANO FOR EGAM DEPEND.          9/73
R30         . . . . . . . . . .
R30 AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R31     K- INTO (PI+ E- E-)/TOTAL (UNITS 10**-5)                 (P19)
R31      TEST OF LEPTON NUMBER CONSERVATION.
R31            1.5    OR LESS              CHANG     68 HBC  -                        3/68

R32     CHAR. K INTO (PI NEU NEU)/TOTAL (UNITS 10**-6)    (P20)
R32 C         (1.4)   OR LESS  CL=.90   KLEMS     71 OSPK +  T(PI) 117-127MEV         3/74
R32 C         (0.94)  OR LESS  CL=.90   CABLE     73 CNTR +  T(PI) 60-105 MEV         2/74
R32  C         0.56   OR LESS  CL=.90   CABLE     73 CNTR +  T(PI) 60-127 MEV         2/74
R32  L   0    57.0    OR LESS  CL=.90   LJUNG     73 HLBC +                           9/73
R32  C   KLEMS 71 AND CABLE 73 ASSUME PI SPECTRUM SAME AS KE3 DECAY.                  3/74
R32  C   SECOND CABLE LIMIT COMBINES CABLE AND KLEMS DATA FOR VECTOR INT.             2/74
R32  L   LJUNG 73 ASSUMES VECTOR INTERACTION.                                         9/73

R33     CHAR. K INTO (E NEU GAMMA)/TOTAL  (UNITS 10**-5) (P21)
R33  M         7.1    OR LESS              MACEK     70 OSPK +  P(E) 234 TO 247      12/70
R33  M   ABOVE IS MEASUREMENT OF STRUCTURE-DEPENDENT DECAY ONLY.

R34     CHAR. K INTO (PI GAMMA)/TOTAL (UNITS 10**-6)      (P22)
R34            4.0    OR LESS  CL=.90   KLEMS     71 OSPK +                           8/71

R35     CHAR. K INTO (TAU)/(TAU PRIME)                           (P3/P4)
R35      USED FOR DELTA I=1/2 TEST.
R35         . . . . . . . . . .
R35 FIT        3.227     0.083   FROM FIT

R36     CHAR. K INTO (PI 3GAMMA)/TOTAL (UNITS 10**-4)     (P23)
R36            3.0    OR LESS  CL=.90   KLEMS     71 OSPK +  T(PI) GT 117MEV          8/71

R37     K+ INTO (PI+ PI+ E- NEU)/(PI+ PI- E+ NEU)               (P8)/(P7)            2/72
R37      0     0.013 OR LESS   CL=.95   BOURQUIN  71 ASPK                            12/71

R38     CHAR. K INTO (PIO PIO E NEU)/KE3 (UNITS 10**-4)  (P24)/(P6)
R38      0    37.0    OR LESS  CL=.90   ROMANO    71 HLBC +                          12/71
R38      2     3.8       5.0       1.2  LJUNG     73 HLBC +                           9/73

R39     K+ INTO (PI- E+ MU+)/TOTAL (UNITS 10**-8)                (P25)
R39     K- INTO (PI+ E- MU-)/TOTAL IS ALSO INCLUDED HERE
R39            2.8    OR LESS  CL=.90   BEIER     72 OSPK +-                          9/72

R40     K+ INTO (PI+ E+ MU-)/TOTAL (UNITS 10**-8)                (P26)
R40     K- INTO (PI- E- MU+)/TOTAL IS ALSO INCLUDED HERE
R40            1.4    OR LESS  CL=.90   BEIER     72 OSPK +-                          9/72

R41     CHAR. K INTO (MU 3NEU)/TOTAL (UNITS 10**-6)              (P27)
R41  P   0     6.0    OR LESS  CL=.90   PANG      73 CNTR +                          11/73
R41  P   PANG 73 ASSUMES MU SPECTRUM FROM NEU-NEU INTERACTION OF BARDIN 70.           3/74

R42     CHAR. K INTO (PIO MU NEU GAM)/TOTAL(UNITS 10**-5)(P28)                        9/73
R42      0     6.1    OR LESS  CL=.90   LJUNG     73 HLBC +  EGAM GT 30 MEV           9/73

R43     CHAR. K INTO (E PIO NEU)/(PI PIO)                        (P6)/(P2)
R43  L 786     0.221     0.012             LUCAS2    73 HBC  -  DALITZ PRS ONLY      11/73
R43  L   LUCAS 73 GIVES N(E3)=786+-3.1PCT, N(PI2)=3564+-3.1PCT.  WE DIVIDE.          11/73
R43         . . . . . . . . . .
R43 FIT        0.2291    0.0031 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R44     CHAR. K INTO (PI 2PIO)/(PI PIO)                          (P4)/(P2)
R44  L 574     0.081     0.005             LUCAS2    73 HBC  -  DALITZ PRS ONLY      11/73
R44  L   LUCAS 73 GIVES N(PI 2PIO)=574+-5.9 PCT, N(PI2)=3564+-3.1 PCT.               11/73
R44  L   WE QUOTE 0.5*N(PI 2PIO)/N(PI2) WHERE 0.5 IS BECAUSE ONLY DALITZ             11/73
R44  L   PAIR PIO'S WERE USED.                                                       11/73
R44         . . . . . . . . . .
R44 FIT        0.0822    0.0022 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R45     CHAR. K INTO(MU NEU GAMMA)/TOTAL  (UNITS 10**-3) (P12)                        7/74*
R45      12    5.8       3.5               WEISSENBE 74 STRC +  E-GAMMA GT 9 MEV      7/74*

R46     CHAR. K INTO (PI E+ E-)/(PI+ PI- E NEU) (UNITS 10**-3)  (P15)/(P7)
R46  B  41     7.0       1.3               BLOCH     75 SPEC +                       11/75*
R46  B   BLOCH 75 QUOTES THIS RESULT MULTIPLIED BY OUR 1974 KE4 BR.FRAC.             11/75*

R47     CHAR. K INTO (E NEU GAM)/(E NEU)                         (P21)/(P11)
R47  H  56     1.05      0.25      0.30 HEARD1    75 SPEC +  P(E) 236 TO 247      11/75*
R47  H   ABOVE IS SENSITIVE ONLY TO STRUCTURE DECAY TERM.                            11/75*

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Note on Slope Parameter for $K \to 3\pi$ Decays

As was discussed in Section VI B.1 of the text, for the 3π decays of the K mesons we list the slope parameter "g" which is defined, as in that section, by

$$|M|^2 \propto 1 + g\,\frac{(s_3 - s_0)}{m_{\pi^+}^2} + h\left(\frac{s_3 - s_0}{m_{\pi^+}^2}\right)^2 + j\,\frac{(s_2 - s_1)}{m_{\pi^+}^2} + k\left(\frac{s_2 - s_1}{m_{\pi^+}^2}\right)^2 + \ldots, \qquad (1)$$

where

$$s_i = (\underline{p}_K - \underline{p}_i)^2 = (m_K - m_i)^2 - 2m_K T_i \qquad (2)$$

$$s_0 = \frac{1}{3}\sum s_i = \frac{1}{3}\,(m_K^2 + m_1^2 + m_2^2 + m_3^2) \qquad (3)$$

$\underline{p}_K$, $\underline{p}_i$ are the four-vectors for the K and the i^{th} pion, and the index 3 refers to the odd pion, i.e., the third pion in the decays listed below. (4)

We refer to the three possible charged decays as τ, τ', and τ^0:

$\tau^{\pm}$	$K^{\pm} \to \pi^{\pm}\pi^{\pm}\pi^{\mp}$
$\tau'^{\pm}$	$K^{\pm} \to \pi^0\pi^0\pi^{\pm}$
τ^0	$K_L^0 \to \pi^+\pi^-\pi^0$

The measurements of g vary considerably beyond the authors' quoted errors as can be seen in the ideograms associated with the GT+, GT-, and GTP subsections of the $K^{\pm}$ Data Card Listings and the GT0 subsection of the K_L^0 Listings. Appendix I discusses tests of the $\Delta I = 1/2$ rule utilizing these slopes.

There is no indication of a CP-violating asymmetry in K_L^0 decay as measured by the asymmetry parameter $\sigma_{\pm}$ (equivalent to j) given in subsection A of the K_L^0 Listings.

There is conflicting evidence regarding the presence or absence of the second order terms in Eq. (1), even when only the high-statistics experiments are considered. In $K_L^0 \to \pi^+\pi^-\pi^0$, MESSNER 74 find a significant h and k, while others find them smaller or consistent with zero. The results on h for the high-statistics experiments are as follows:

Data Card Listings

For notation, see key at front of Listings.

Stable Particles

$K^{\pm}$

Experiment	Number of events	Value of h
MESSNER 74	509 K	+0.079 ± 0.007
BUCHANAN 75	56 K	+0.041 ± 0.024
BUCHANAN 70	36 K	consistent with 0
ALBROW 70	29 K	−0.009 ± 0.016
BISI 74	20 K	0.000 ± 0.009

All values other than MESSNER 74 have been converted by us from the authors' parametrizations into the parametrization of Eq. (1) above.

FORD 72 (1.5M events) have studied $K^{\pm} \to \pi^{\pm}\pi^{\pm}\pi^{\mp}$ and find that the χ^2/DF goes from 1.38 to 1.20 for DF ≈ 150 when the second order and the CP violation terms are added. However, the authors state that since their Coulomb correction is larger than the experimental errors and is not well known, it is difficult to interpret these results. LUCASI 73 (81K $K^- \to \pi^-\pi^-\pi^+$ events) note a quadratic behavior in their data, but find that it can be explained by normal measurement error and subsequent fitting, which together result in a depletion of events in the center of the Dalitz plot and a bunching of events near the kinematic limit. Because of this they state that it is not appropriate for them to quote a value of the quadratic coefficient. MAST 69 (51K $K^- \to \pi^-\pi^-\pi^+$ events), HOFFMASTER 72 (40K $K^+ \to \pi^+\pi^+\pi^-$ events) and SMITH 75 (27K $K^{\pm}\to\pi^0\pi^0\pi^{\pm}$ events) also find no evidence for quadratic behavior.

HEUSSE 70 have studied the $K_L^0 \to \pi^0\pi^0\pi^0$ decay where only a second order term could explain deviation from uniformity of the Dalitz plot. They also get results consistent with a zero coefficient.

We list the value of g obtained when the quadratic terms were dropped from the fit unless otherwise noted in the data card footnotes.

In the literature other definitions of slope parameters have appeared. We have converted to the definition of g in Eq. (1) whatever experimental quantity has been reported. We give the conversion to the definition (1) for the most widely used parametrizations and tabulate the conversion factors for the reader's convenience.

a) For analysis of charged K's the expression often used is:

$$|M|^2 = 1 + a_y Y$$

with

$$Y = \frac{3T_3 - Q}{Q} \ , \qquad Q = m_K - \sum m_i \ .$$

The relevant formulae are:

$$Y = -\frac{3}{2}\,\frac{s_3 - s_0}{m_K Q} + \Delta$$

with

$$\Delta = \frac{m_1 - m_3}{Q}\left(2 - \frac{m_3 + m_1}{m_K}\right)$$

and

$$\boxed{g = \frac{-c_y a_y}{1 + a_y \Delta}} \ , \qquad \text{with} \quad c_y = \frac{3}{2}\,\frac{m_{\pi^+}^2}{m_K Q} \ .$$

b) For the analysis of K^0 decay the expression often used is:

$$|M|^2 = 1 + 2a_t \frac{m_K}{m_{\pi^+}^2}(2T_3 - T_{3max})$$

with

$$T_{3max} = \frac{m_K^2 + m_3^2 - 4m_{12}^2}{2m_K} - m_3 \ .$$

The relevant transformations are

$$T_3 = -\frac{s_3 - s_0}{2m_K} + \frac{Q}{3}(1 + \Delta)$$

and

$$\boxed{g = \frac{-2a_t}{1 + a_t c_t}} \ ,$$

with

$$c_t = \frac{2m_K}{m_{\pi^+}^2}\left[\frac{2}{3}Q(1+\Delta) - T_{3max}\right] \ .$$

c) Other K^0 authors use the same form of matrix element as given in b) above, but define

$$T_{3max} = \frac{2}{3}Q \ .$$

Stable Particles

$K^{\pm}$

The relevant transformation is then

$$\boxed{g = \frac{-2a_u}{1 + a_u c_u}} \quad , \text{ with } \quad c_u = \frac{4m_K}{3m_{\pi^+}^2} Q\Delta \ .$$

d) Older K^0 analyses were done using

$$|M|^2 = 1 + a_v \frac{T_3}{m_K} \ .$$

The relevant transformation is then

$$\boxed{g = \frac{-c_v a_v}{1 + d_v a_v}} \quad , \text{ with } \quad c_v = \frac{m_{\pi^+}^2}{2m_K^2}$$

and

$$d_v = \frac{Q}{3m_K}(1 + \Delta) \ .$$

For the reader's convenience we give a table of numerical values for Q, T_{3max}, Δ, c_y, and c_t, obtained using the masses from the current edition.

	$\tau^{\pm}$	$\tau'^{\pm}$	τ^0
Q	75.00	84.21	83.60
T_{3max}	48.10	53.22	53.91
Δ	0.0	−0.0789	0.0798
c_y	0.7891	0.7028	0.7023
c_t	0.0963	−0.0768	0.3204
c_u	0.0	−0.2247	0.2272
c_v	0.0400	0.0400	0.0393
d_v	0.0506	0.0524	0.0605

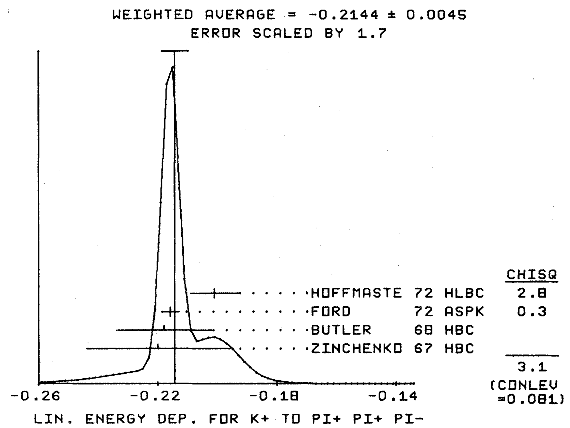
10 CHARGED K ENERGY DEPENDENCE OF DALITZ PLOT

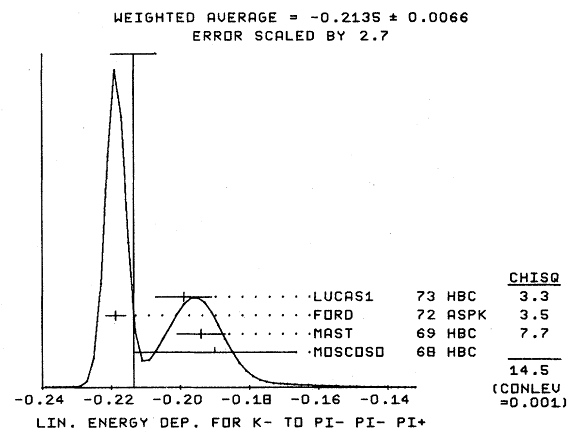
RELATED TEXT SECTION VI B.1, APPENDIX I, AND MINI-REVIEW ABOVE

MATRIX ELEMENT SQUARED = 1 + G (S3-S0)/(MPI**2)

```
GT+  LINEAR ENERGY DEPENDENCE (G) FOR TAU DECAYS  K+ INTO PI+ PI+ PI-
GT+     THESE EXPTS FIT M**2=1+AY*Y. WE LIST G IN THE MAIN LISTING AND
GT+     GIVE AY AT RIGHT. G=-1.5*AY*(MPI**2)/(MK*Q). SEE NOTE ABOVE.
GT+Z  5428   -0.22    0.024          ZINCHENKO 67 HBC  +  AY=0.28+-.03      10/69
GT+   9994   -0.218   0.016          BUTLER    68 HBC  +  AY=0.277+-.020    10/69
GT+ G17898  (-0.196)  (0.012)        GRAUMAN   70 HLBC +  AY=0.228+-.030     8/70
GT+Q  750K   -0.2158  0.0028         FORD      72 ASPK +  AY=0.2734+-.0035   4/72
GT+  39819   -0.201   0.008          HOFFMASTE 72 HLBC +  INCLUDES GRAUMAN   1/71
GT+ Q   THIS VALUE OF AY IS FROM A QUADRATIC FIT WITH Y**2 COEF=.030+-.010.  4/72
GT+ Q   A LINEAR FIT IS QUOTED ONLY FOR THEIR COMBINED K+ AND K- SAMPLE.     4/72
GT+ Q   IT GIVES AY=0.2737+-.0032 .  THE QUADRATIC FIT TO THE COMBINED       4/72
GT+ Q   SAMPLE GIVES AY=0.2752+-.0033 AND Y**2 COEFF=0.025+-.010 .           4/72
GT+ Q   (CHISQ/DF)=1.38 FOR LINEAR FIT AND 1.20 FOR QUADRATIC FIT.           1/73
GT+ G   EMULS. DATA ADDED - ALL EVENTS INCLUDED BY HOFFMASTER 72             1/71
GT+ Z   ALSO INCLUDES DBC EVENTS.
GT+        . . . . . . . . .
GT+ AVG       -0.2144   0.0045  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
GT+ STUDENT   -0.2146   0.0029  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                        (SEE IDEOGRAM BELOW )

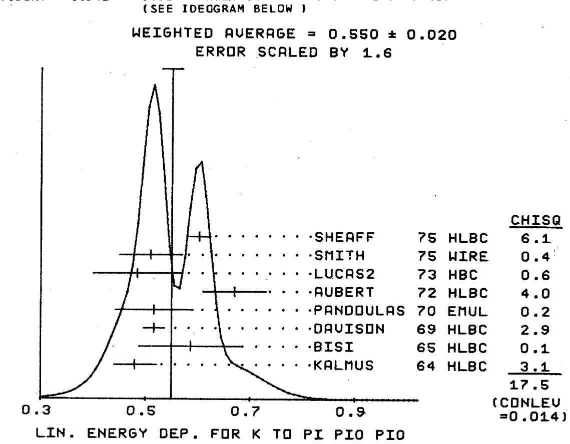
GT-  LINEAR ENERGY DEPENDENCE (G) FOR TAU DECAYS  K- INTO PI- PI- PI+
GT-     FOR DEFINITION OF AY SEE NOTE IN ABOVE SECTION GT+.
GT- F 1347  (-0.220)  (0.035)        FERRO-LUZ 61 HBC  - AY=0.28+-.045     10/69
GT-M  5778   -0.190   0.023          MOSCOSO   68 HBC  - AY=0.242+-.029    10/69
GT-  50919   -0.194   0.007          MAST      69 HBC  - AY=0.247+-.009    10/69
GT-Q  750K   -0.2187  0.0028         FORD      72 ASPK - AY=0.2770+-.0035   4/72
GT-    81K   -0.199   0.008          LUCAS1    73 HBC  - AY=0.252+-.011    10/72
GT- Q   THIS VALUE OF AY IS FROM A QUADRATIC FIT WITH Y**2 COEF=.020+-.010.  4/72
GT- Q   SEE ALSO THE NOTE Q IN THE GT+ SECTION ABOVE.                       4/72
GT- F   NO RADIATIVE CORRECTIONS INCLUDED.
GT- M   ALSO INCLUDES DBC EVENTS.
GT-        . . . . . . . . .
GT- AVG       -0.2135   0.0066  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.7)
GT- STUDENT   -0.2142   0.0039  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                        (SEE IDEOGRAM BELOW )
```






```
DG  ((GT+)-(GT-))/((GT+)+(GT-)) IN PERCENT
DG      A NON-ZERO VALUE FOR THIS QUANTITY INDICATES CP VIOLATION
DG    3.2M   -0.70    0.53           FORD      70 ASPK                       11/70

GTP  LINEAR ENERGY DEPENDENCE (G) FOR TAU PRIME DECAY CHA.K INTO PI PIOPIO
GTP   1792    0.48    0.04           KALMUS    64 HLBC +                     10/69
GTP   1874    0.586   0.098          BISI      65 HLBC +  ALSO HBC           10/69
GTP   4048    0.516   0.020          DAVISON   69 HLBC +  ALSO EMUL          10/69
GTP    198    0.516   0.074          PANDOULAS 70 EMUL +                     10/70
GTP  A1365    0.67    0.06           AUBERT    72 HLBC                        1/73
GTP    574    0.484   0.084          LUCAS2    73 HBC  -  DALITZ PRS ONLY     9/73
GTP  S 27K    0.510   0.060          SMITH     75 WIRE +                     12/75*
GTP   5635    0.602   0.021          SHEAFF    75 HLBC +                      2/76*
GTP  A  WE GIVE LINEAR TERM OF HIGHER ORDER FIT. EQ.I OF APP.II,AUBERT 72.    1/73
GTP  S  SMITH 75 MEASURES QUADRATIC COEFFICIENT H=0.009+-0.040.              12/75*
GTP        . . . . . . . . .
GTP AVG       0.550    0.020   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
GTP STUDENT   0.542    0.019   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                       (SEE IDEOGRAM BELOW )
```



Note on $K^{\pm}_{\ell 3}$ and $K^{0}_{\ell 3}$ Form Factors

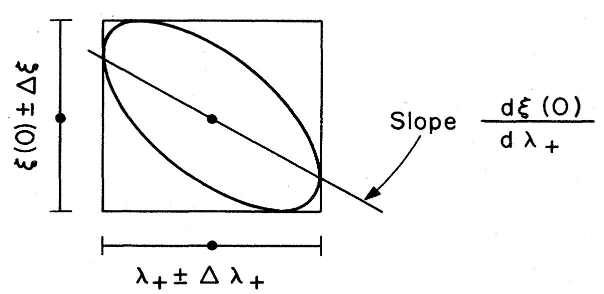
Definitions of the parameters λ_+, $\xi(0)$, λ_0, $|f_S/f_+|$ and $|f_T/f_+|$ and a general discussion of the methods of analysis are given in Section VI B.2 of the text.

This note describes the contents of the Data Card Listings for the two $K_{\mu 3}$ parametrizations, (λ_+, $\xi(0)$) and (λ_+, λ_0), which were discussed in the text. Problems related to our data entries for individual experiments are discussed and a comparison of results is given.

$K_{\mu 3}$ Experiments

The matrix element for $K_{\mu 3}$ decay, assuming a pure vector current, is given by Eq. (2) in Section VI B.2 of the text. Most experiments appear to be compatible with the assumption that f_+ depends linearly on t and that f_- is constant. Only DALLY 72 ($K^0_{\mu 3}$) appears to require $\lambda_- \neq 0$ (by about three standard deviations). A single data bin at low q^2 seems to be responsible. The effect is not observed in the high-statistics experiment of DONALDSON2 74 (also $K^0_{\mu 3}$).

λ_+, $\xi(0)$ Parametrization: λ_+ data from $K_{\mu 3}$ decay are entered into the $K^{\pm}$ and K^0_L sections of the Data Card Listings in subsection L+M. The corresponding $\xi(0)$ values are entered in subsection XIA, XIB, or XIC, depending on whether Method A, B, or C, discussed below and in the text, was used. The data cards contain the values, one-standard-deviation errors $\Delta\lambda_+$ and $\Delta\xi(0)$, as well as the correlation $d\xi(0)/d\lambda_+$, all indicated on the $e^{-1/2}$ likelihood contour below. The correlations are given on the right side of the $\xi(0)$ data cards.



XBL 743-2682

λ_+, λ_0 Parametrization: This parametrization is used in recent $K_{\mu 3}$ analyses. To facilitate comparison between experiments, we convert earlier experiments from the (λ_+,$\xi(0)$) parametrization to (λ_+,λ_0) whenever possible (i.e., when λ_+ and $\xi(0)$ values, errors, and correlations are given). The transformation between these parametrizations is:

$$\lambda_0 = \lambda_+ + a\xi(0) ,$$

$$\Delta\lambda_0^2 = (1 + 2a \frac{d\xi(0)}{d\lambda_+}) \Delta\lambda_+^2 + a^2\Delta\xi^2 ,$$

$$\frac{d\lambda_0}{d\lambda_+} = 1 + a \frac{d\xi(0)}{d\lambda_+} ,$$

where $a = m_\pi^2/(m_K^2 - m_\pi^2)$. The λ_0 value, the one-standard-deviation error $\Delta\lambda_0$, and the correlation $d\lambda_0/d\lambda_+$ are given in subsection L0 of the data cards.

We also convert (λ_+,λ_0) results into the (λ_+, $\xi(0)$) parametrization whenever possible so that subsection L0 is essentially equivalent to the three subsections XIA, XIB, and XIC.

Individual analyses have used a variety of parametrizations. Problems arise when trying to express their results in terms of the parametrizations used here. The discussion of these problems is divided into three sections corresponding to the three methods of analyses discussed in the text.

Method A: Dalitz plot analyses and pion spectrum analyses usually determine λ_+ and $\xi(0)$ (or λ_0) values, errors, and correlation. Such measurements are entered in the L+M, XIA, and L0 subsections. They give rise to the error ellipses shown in Figs. 1 and 2.

Some analyses of this type fix λ_+ and determine $\xi(0)$, e.g., CARPENTER 66 and PEACH 73 (both $K^0_{\mu 3}$). We enter $\xi(0)$ and $d\xi(0)/d\lambda_+$ in the XIA section and give the fixed λ_+ value in the data card footnote. The $\xi(0)$ error is parenthesized because it does not include the uncertainty in the value of λ_+. These results, transformed to λ_0 measurements, give rise to bands in Fig. 2.

In some cases, we alter an error from its published value in order to obtain an error ellipse with a width which matches the error in $\xi(0)$ for

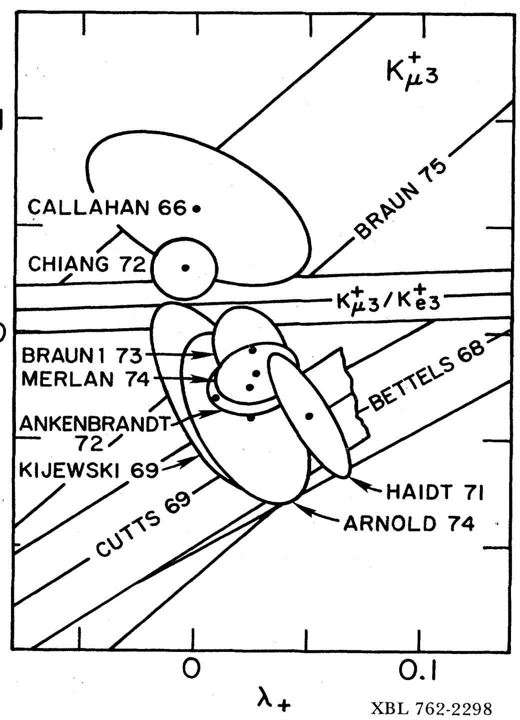


Fig. 1. One-standard-deviation ($e^{-1/2}$) likelihood contours in the (λ_+,λ_0) plane for $K^+_{\mu 3}$.

fixed λ_+. These adjustments are noted in the $\xi(0)$ data card footnotes, e.g., for CALLAHAN1 66 and HAIDT 71 (K^+ subsection XIA), where the published errors and correlation violate the constraint $|c_{\lambda\xi}| < 1$ on the normalized correlation coefficient $c_{\lambda\xi}$ given by

$$c_{\lambda\xi} = \frac{\Delta\lambda_+}{\Delta\xi}\,\frac{d\xi(0)}{d\lambda_+} \quad .$$

In some cases, e.g., BRAUN1 73, the parametrization used is λ_+, $\xi(0)$, $\xi(t^*)$, where t^* is the weighted average of t with weighting according to the sensitivity to ξ. In this case we do not use $\xi(0)$. It is a badly determined parameter comparable to λ_- or the slope of $\xi(t)$. Instead, we use

$$\xi(0) = \xi(t^*)(1 + \lambda_+ t^*) \quad ,$$

$$\frac{d\xi(0)}{d\lambda_+} = \frac{d\xi(t^*)}{d\lambda_+}(1 + \lambda_+ t^*) + \xi(t^*)t^* \quad .$$

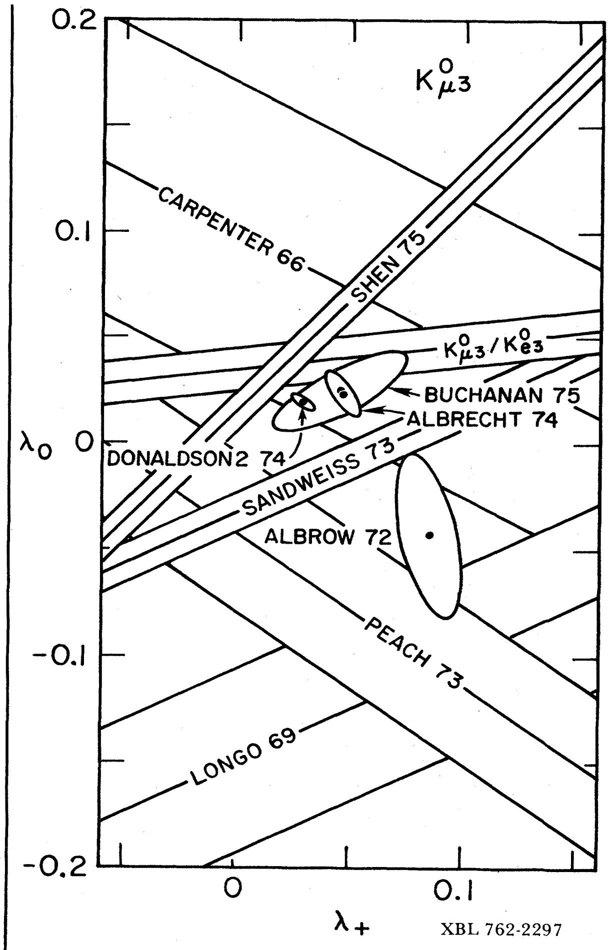


Fig. 2. One-standard-deviation ($e^{-1/2}$) likelihood contours in the (λ_+,λ_0) plane for $K^0_{\mu 3}$.

With the BRAUN1 73 values, $\lambda_+ = 0.027$, $\xi(6.6) = -0.34 \pm 0.20$, and $d\xi(6.6)/d\lambda_+ = -14$, we obtain

$$\xi(0) = (-0.40 \pm 0.24) - 19(\lambda_+ - 0.027) \quad ;$$

or for their fitted $\lambda_+ = 0.025 \pm 0.017$, we get $\xi(0) = -0.36 \pm 0.40$.

Method B: Branching ratio experiments cannot determine λ_+ and $\xi(0)$ simultaneously, but simply fix a relationship between them, given in Section VI B.2 of the text. Results are usually quoted as values of $\xi(0)$ at fixed λ_+. We list these results in subsection XIB, but we do not average them because the λ_+ values differ. Instead, we compute a combined result by using the relations in the

Data Card Listings

For notation, see key at front of Listings.

Stable Particles

$K^{\pm}$

text and our fitted values of $\Gamma(K^{\pm}_{\mu3})/\Gamma(K^{\pm}_{e3})$ and $\Gamma(K^{0}_{\mu3})/\Gamma(K^{0}_{e3})$, which include the branching ratios from these experiments. The branching ratios from our current edition and the results for $\xi(0)$ and λ_0 evaluated at $\lambda_+ = 0.030$ are

	$K^{\pm}$	K^0_L
$\Gamma(K_{\mu3})/\Gamma(K_{e3})$	0.663 ± .018(S=1.7)	0.696 ± .017
$\xi(0)$	−0.20 ± .15 (S=1.7)	+0.09 ± .13
$d\xi(0)/d\lambda_+$	−11.9	−10.3
λ_0	+0.014 ± .012(S=1.7)	+0.038 ± .011
$d\lambda_0/d\lambda_+$	+0.04	+0.12

The scale factor S is the amount by which the error has been multiplied in order to compensate for discrepancies in the branching ratios. These λ_0 results give rise to the $K_{\mu3}/K_{e3}$ bands in Figs. 1 and 2.

Method C: Polarization experiments measure $\langle\xi(t)\rangle$, the weighted average of $\xi(t)$ over the t range of the experiment, where the weighting accounts for the variation with t of the sensitivity to $\xi(t)$. Such measurements are entered in subsection XIC.

To reinterpret these results in the $(\lambda_+,\xi(0))$ parametrization, we recognize that $\lambda_+ = 0$ corresponds to $\xi(t)$ constant (always assuming $\lambda_- = 0$) so that

$$\xi(0)\Big|_{\lambda_+=0} \equiv \langle\xi(t)\rangle \ .$$

The correlation with λ_+ is given by the following relations (valid for small λ_+):

$$\xi(0) \approx \langle\xi(t)\rangle\left(1 + \lambda_+\left\langle\frac{t}{m_\pi^2}\right\rangle\right) ,$$

$$\frac{d\xi(0)}{d\lambda_+} \approx \langle\xi(t)\rangle\left\langle\frac{t}{m_\pi^2}\right\rangle ,$$

where $\langle t/m_\pi^2\rangle$ is the average value of t weighted by the sensitivity to $\xi(t)$. These results, transformed to λ_0 and $d\lambda_0/d\lambda_+$ values, are entered in subsection L0 and give rise to bands in Figs. 1 and 2.

In Figs. 1 and 2, we disregard those polarization measurements for which $d\xi(0)/d\lambda_+$ is not obtainable. Also we disregard MERLAN 73 because the signs of $\xi(0)$ and $d\xi(0)/d\lambda_+$ are opposite, whereas the above equation requires them to be the same (since $t > 0$).

Comparison of $K_{\mu3}$ Experiments: Figures 1 and 2 show the likelihood contours in the (λ_+,λ_0) plane for $K^{+}_{\mu3}$ and $K^{0}_{\mu3}$ respectively.

The $K^{+}_{\mu3}$ Dalitz plot results (ellipses) shown are fairly consistent and appear to cluster between the $K_{\mu3}/K_{e3}$ result and the polarization results of BETTELS 68 and CUTTS 69. The $K^{0}_{\mu3}$ results are much less consistent with a small cluster appearing in the neighborhood of the DONALDSON2 74 result.

χ^2 fits to the results shown in Fig. 1 and Fig. 2 yield the following values for λ_+ and λ_0. The corresponding values of $\xi(0)$ are also given.

	$K^{+}_{\mu3}$	$K^{0}_{\mu3}$
λ_+	+0.027 ± .008*	+0.034 ± .006*
λ_0	−0.009 ± .007*	+0.021 ± .006*
$d\lambda_0/d\lambda_+$	−0.15	−0.24
χ^2/DF	34/18	72/12
S	1.4	2.5
$\xi(0)$	−0.45 ± .14*	−0.17 ± .10*
$d\xi(0)/d\lambda_+$	−14.	−15.

*All errors have been increased by the scale factor $S = (\chi^2/DF)^{1/2}$ to take into account the discrepancies between measurements.

In view of the large χ^2/DF of these fits, especially $K^{0}_{\mu3}$, the fit results should be taken with a grain of salt. The largest contributors to χ^2 in the $K^{+}_{\mu3}$ case are CHIANG 72 with 10.4, and the polarization results, BETTELS 68 with 5.4 and CUTTS 69 with 4.2. In the $K^{0}_{\mu3}$ case the largest contributors are the polarization results of SANDWEISS 73 with 17, LONGO 69 with 14, and SHEN 75 with 12, and the Dalitz plot results of ALBROW 72 with 11, ALBRECHT 74 with 7.3, and PEACH 73 with 5.3. All other χ^2 values were less than 4.

The DONALDSON2 74 result

$$\lambda_+ = .030 \pm .003$$

$$\lambda_0 = .019 \pm .004$$

Stable Particles

$K^{\pm}$

Data Card Listings

For notation, see key at front of Listings.

clearly dominates the statistics in the $K^0_{\mu 3}$ case. The λ_+ value is consistent with the K_{e3} value of λ_+, and with the pole approximation

$$f_+(t) = f_+(0)\,\frac{m^2_{K^*}}{m^2_{K^*} - t}\ .$$

Their $f_0(t)$ extrapolates linearly to the Callan-Treiman point. It is less than two standard deviations from the $K_{\mu 3}/K_{e3}$ result.

K_{e3} Experiments

The f_- term of the matrix element [Eq. (2) text Section VI B.2] can be neglected for K_{e3} because it is proportional to the lepton mass. The f_+ term is usually assumed to be linear in $t = q^2 = (P_K - P_\pi)^2$, the square of the four-momentum transfer, i.e., the effective mass of the lepton pair. We quote the linear coefficient λ^e_+ (L+E on the data cards). There has been some suggestion of departure from linearity [CHIEN 71 (K^0_{e3}) and Chounet, Gaillard, and Gaillard[1]—Review] but no compelling evidence. The λ_+ results are fairly consistent and the average values are

$$K^+_{e3}:\quad \lambda_+ = 0.0285 \pm 0.0043$$

$$K^0_{e3}:\quad \lambda_+ = 0.0288 \pm 0.0028 \quad (S = 1.4)$$

where the K^0_{e3} error has been multiplied by the scale factor 1.4 to compensate for inconsistencies (see ideogram in K^0_L section L+E).

Many of the changes in this section were stimulated by the comments and criticism of L. M. Chounet, and by the excellent reviews of Gaillard and Chounet[1] and Chounet, Gaillard, and Gaillard.[2]

References

1. M. K. Gaillard and L. M. Chounet, $K_{\ell 3}$ Form Factors, CERN 70-14 (May 1970), and Phys. Letters 32B, 505 (1970).
2. L. M. Chounet, J. M. Gaillard, and M. K. Gaillard, Physics Reports 4C, 199 (1972).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                10  CHARGED K FORM FACTORS                                            8/67

        RELATED TEXT SECTION VI B.2 AND MINI-REVIEW ABOVE.

        IN THE FORM FACTOR COMMENTS, THE FOLLOWING ABBREVIATIONS ARE USED.
        F+ AND F- ARE FORM FACTORS FOR THE VECTOR MATRIX ELEMENT.
        FS AND FT REFER TO THE SCALAR AND TENSOR TERM.
        FO = (F+) + (F-)*T/(MK**2-MPI**2)
        L+, L- AND LO ARE THE LINEAR EXPANSION COEFFS. OF F+, F- AND FO.
        L+ REFERS TO THE KMU3 VALUE EXCEPT IN THE KE3 SECTIONS.
        DXI/DL IS THE CORRELATION BETWEEN XI(0) AND L+ IN KMU3.
        DLO/DL+ IS THE CORRELATION BETWEEN LO AND L+ IN KMU3.
        T  = MOMENTUM TRANSFER TO THE PI IN UNITS OF MPI**2.
        DP = DALITZ PLOT ANALYSIS
        PI = PI SPECTRUM ANALYSIS
        MU = MU SPECTRUM ANALYSIS
        POL= MU POLARIZATION ANALYSIS
        BR = KMU3/KE3 BRANCHING RATIO ANALYSIS
        E  = POSITRON OR ELECTRON SPECTRUM ANALYSIS
        RC = RADIATIVE CORRECTIONS

XIA    XIA = F-/F+ (DETERMINED FROM SPECTRA)   ----------------------------
XIA     76  (+1.8)    (0.6)           BROWN      62 XEBC +  DP+BR, L+=0          1/74
XIA     87  (+0.7)    (0.5)           GIACOMELL  64 EMUL +  MU+BR RVUE, L+=0     1/74
XIA J       (-0.08)   (0.7)           JENSEN     64 XEBC +  DP+BR(KMU3,KE3)      1/74
XIA   2648  (0.0)     (1.1)    (0.9)  CALLAHA1   66 FRBC +  MU, L+=0, T UNKN     1/74
XIA  C 444  +0.72      0.93           CALLAHA1   66 FRBC +  PI, DXI/DL=-17       1/74
XIA     78  (-0.5)    (0.9)           EISLER     68 HLBC +  PI,L+=0,NO DX/DL     1/74
XIA  K2041  -0.5       0.8            KIJEWSKI   69 OSPK +  PI, DXI/DL=-26       1/74
XIA  H3240  -1.1       0.56           HAIDT      71 HLBC +  DP, DXI/DL=-29       1/74
XIA  A4025  -0.62      0.28           ANKENBRAN  72 ASPK +  PI, DXI/DL=-12       1/74
XIA  B3480  +0.45      0.28           CHIANG     72 OSPK +  DP, DXI/DL=-15       1/74
XIA  D1897  -0.36      0.40           BRAUN1     73 HLBC +  DP, DXI/DL=-19       3/74
XIA  N 490  -0.8       0.8            ARNOLD     74 HLBC +  DP, DXI/DL=-20      11/75*
XIA  M6527  -0.57      0.24           MERLAN     74 ASPK +  DP, DXI/DL= -9       3/74
XIA J   JENSEN 64 GIVES L+M=L+E=-.020+-.027. DXI/DL UNKNOWN. INCLUDES            1/74
XIA J   SHAKLEE 64 XIB(KMU3/KE3).                                                1/74
XIA  C  CALLAHAN 66 TABLE 1 (PI ANAL) GIVES DXI/DL=(.72-.05)/(0-.04)=-17,        1/74
XIA  C  ERROR RAISED FROM .80 TO AGREE WITH DXIO=.37 FOR FIXED L+.               1/74
XIA  K  KIJEWSKI 69 FIG. 17 WAS USED TO OBTAIN DXI/DL AND ERRORS.                1/74
XIA  H  HAIDT 71 TABLE 8 (DP ANAL) GIVES DXI/DL=(-1.1+0.5)/(.050-.029)=-29,      1/74
XIA  H  ERROR RAISED FROM .50 TO AGREE WITH DXIO=.20 FOR FIXED L+.               1/74
XIA  A  ANKENBRANDT 72 FIG. 3 WAS USED TO OBTAIN DXI/DL.                         1/74
XIA  B  CHIANG 72 FIG. 10 WAS USED TO OBTAIN DXI/DL.                             1/74
XIA  B  FIT HAD L-=L+ BUT WOULD NOT CHANGE FOR L-=0.  L.PONDROM,PRIV.COM.74      1/74
XIA  D  BRAUN1 73 GIVES XI(T)=-.34+-.20, DXI(T)/DL+=-14 FOR L+=.027, T=6.6.      3/74
XIA  D  WE CALCULATE ABOVE XI(0) AND DXI(0)/DL+ FOR THEIR L+=.025+-.017 .        3/74
XIA  N  ARNOLD 74 FIG. 4 WAS USED TO OBTAIN XIA AND DXI/DL.                     11/75*
XIA  M  MERLAN 74 FIG.5 WAS USED TO OBTAIN DXI/DL.                               3/74
XIA         . . . . . . . . . .
XIA FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS ABOVE.

XIB    XIB = F-/F+ (DETERMINED FROM KMU3/KE3)   ---------------------------
XIB     THE KMU3/KE3 BRANCHING RATIO FIXES A RELATIONSHIP BETWEEN XI(0)          1/74
XIB     AND L+.  WE QUOTE THE AUTHORS XI(0) AND ASSOCIATED L+ BUT DO NOT         1/74
XIB     AVERAGE BECAUSE THE L+ VALUES DIFFER.  THE FIT RESULT AND SCALE          1/74
XIB     FACTOR GIVEN IN THE ABOVE NOTE ON KL3 FORM FACTORS ARE NOT OBTAINED      2/76*
XIB     FROM THESE XIB VALUES.  INSTEAD THEY ARE OBTAINED DIRECTLY FROM THE      2/76*
XIB     FITTED KMU3/KE3 RATIO (R29).                                             2/76*
XIB         -0.17      0.75     0.99  SHAKLEE    64 XEBC +  BR, L+=0             1/74
XIB         +0.6       0.5            BISI 1     65 HBC  +  BR, L+=0             1/74
XIB    500  +0.8       0.6            CUTTS      65 OSPK +  BR, L+=0             1/74
XIB    636  +0.4       0.4            CALLAHA1   66 FRBC +  BR, L+=0             1/74
XIB    306  +0.75      0.50           AUERBACH   67 OSPK +  BR, L+=0             1/74
XIB B 5601  (-0.08)   (0.15)          BOTTERIL2  68 ASPK +  BR,L+=.023+-.008     1/74
XIB E 1398  (-0.60)   (0.20)          EICHTEN    68 HLBC +  BR, SEE NOTE E       1/74
XIB    986  +1.0       0.6            GARLAND    68 OSPK +  BR, L+=0             1/74
XIB         +0.91      0.82           ZELLER     69 ASPK +  BR, L+=.023          1/74
XIB  B      -0.35      0.22           BOTTERIL   70 OSPK +  BR,L+=.045+-.015     1/74
XIB  E1505  -0.81      0.27           HAIDT      71 HLBC +  BR,L+=.028,FIG.8     1/74
XIB   5825   0.0       0.15           CHIANG     72 OSPK +  BR,L+=.03,FIG.10     1/74
XIB  B  BOTTERIL 70 IS REEVALUATION OF BOTTERIL 2 68 WITH DIFFERENT L+.          1/74
XIB E   EICHTEN 68 HAS L+=.023+-.008, T=4, INDEP. OF L-. REPL. BY HAIDT 71.      1/74
XIB         . . . . . . . . . .
XIB FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS ABOVE.

XIC    XIC = F-/F+ (DETERMINED FROM MU POLARIZATION IN KMU3)   ------------
XIC     THE MU POLARIZATION IS A MEASURE OF XI(T). NO ASSUMPTIONS ON L+-
XIC     NECESSARY, T (WEIGHTED BY SENSITIVITY TO XIO) SHOULD BE SPECIFIED.
XIC    IN L+,XI(0) PARAMETERIZATION THIS IS XI(0) FOR L+=0.  DXI/DL=XI*T.
XIC     FOR RAD. CORR. TO MUON POLARIZATION IN KMU3 SEE GINSBERG 71.
XIC T 2100  (+1.2)    (2.4)    (1.8)  BORREANI   65 HLBC +  POLARIZATION         8/67
XIC T  500 BTWN -4.0 AND +1.7         CUTTS      65 OSPK +  LONG. POL.           1/74
XIC T  397  (-1.4)    (1.8)           CALLAHA1   66 FRBC +  TOTAL POL.           8/67
XIC T 2950  (-0.7)    (0.9)    (3.3)  CALLAHA1   66 FRBC +  LONG. POL.           8/67
XIC  B6000  -1.0       0.3            BETTELS    68 HLBC +  TOTAL POL. T=4.9     1/74
XIC  C3133  -0.95      0.3            CUTTS      69 OSPK +  TOTAL POL. T=4.0     1/74
XIC M  40K  (-0.64)   (0.27)          MERLAN     74 ASPK +  POL,DXI/DL=+1.7      3/74
XIC  D1585  -0.25      1.20           BRAUN      75 HLBC +  POL. T=4.2           1/76*
XIC T   T VALUE NOT GIVEN.
XIC  B  BETTELS 68 DXI/DL=XI*T=-1.0*4.9=-4.9 .
XIC  C  CUTTS 69 T=4.0 WAS CALCULATED FROM FIG.8. DXI/DL=XI*T=-.95*4=-3.8 .      1/74
XIC M   MERLAN 74 POLARIZATION RESULT (FIG.5) NOT POSSIBLE.  SEE DISCUSSION      1/76*
XIC M   OF POLARIZATION EXPERIMENTS IN NOTE ON KL3 FORM FACTORS ABOVE.           1/76*
XIC  D  BRAUN 75 DXI/DL=XI*T=-.25*4.2=-1.0 .                                     1/76*
XIC         . . . . . . . . . .
XIC FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS ABOVE.

IXI          IMAGINARY PART OF XI (TEST OF T REVERSAL)   -------------------
IXI   2648   0.0       1.0            CALLAHA1   66 FRBC +  MU                   1/74
IXI    397  +1.6       1.3            CALLAHA1   66 FRBC +  TOTAL POL.           1/74
IXI   2950   0.5       1.4      0.5   CALLAHA1   66 FRBC +  LONG. POL.           1/74
IXI   6000  -0.1       0.3            BETTELS    68 HLBC +  TOTAL POL.           1/74
IXI   3133  -0.3       0.3      0.4   CUTTS      69 OSPK +  TOTAL POL. FIG.7     1/74
IXI         . . . . . . . . . .
IXI AVG     -0.09      0.21    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
IXI STUDENT -0.10      0.23    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

L+M    LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KMU3 DECAY)   ---------
L+M     SEE ALSO THE CORRESPONDING ENTRIES AND FOOTNOTES IN SECTIONS XIA,
L+M     XIC, AND LO.
L+M     FOR RAD.COR. OF KMU3 DP SEE GINSBURG 70 AND BECHERRAWY 70.               3/74
L+M    444   0.0       0.05           CALLAHA1   66 FRBC +  PI                   1/74
L+M   2041   0.009     0.026          KIJEWSKI   69 OSPK +  PI                   1/74
L+M   3240   0.050     0.018          HAIDT      71 HLBC +  DP                   1/74
L+M  A4025   0.024     0.019          ANKENBRAN  72 ASPK +  PI                   1/74
L+M   3480  -0.006     0.015          CHIANG     72 OSPK +  DP                   1/74
L+M   1897   0.025     0.017          BRAUN1     73 HLBC +  DP                   3/74
L+M    490   0.025     0.030          ARNOLD     74 HLBC +  DP                   7/74*
L+M   6527   0.027     0.019          MERLAN     74 ASPK +  DP                   3/74
L+M  A  ANKENBRANDT 72 L+ FROM FIG.3 TO MATCH DXI/DL. TEXT GIVES .024+-.022      1/74
L+M         . . . . . . . . . .
L+M FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS ABOVE.
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

$K^{\pm}$

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LO        LAMBDA 0 (LINEAR ENERGY DEPENDENCE OF F0 IN KMU3 DECAY)   ----------
LO        WHEREVER POSSIBLE, WE HAVE CONVERTED THE ABOVE VALUES OF XI(0) INTO
LO        VALUES OF L0 USING THE ASSOCIATED L+M AND DXI/DL.
LO W    444    +0.058     0.036              CALLAHA1  66 FRBC +  PI,DLO/DL+=-0.37   1/74
LO L   6000    -0.081    (0.024)             BETTELS   68 HLBC +  POL,DLO/DL+=+.60   1/74
LO W   2041    -0.031     0.045              KIJEWSKI  69 OSPK +  PI,DLO/DL+=-1.10   1/74
LO L   3133    -0.077    (0.024)             CUTTS     69 OSPK +  POL,DLO/DL+=+.69   1/74
LO W   3240    -0.039     0.029              HAIDT     71 HLBC +  DP,DLO/DL+=-1.34   1/74
LO W   4025    -0.026     0.013              ANKENBRAN 72 ASPK +  PI,DLO/DL+=+0.03   1/74
LO W   3480    +0.030     0.014              CHIANG    72 OSPK +  DP,DLO/DL+=-0.21   1/74
LO    D1897    -0.008     0.020              BRAUN1    73 HLBC +  DP,DLO/DL+=-0.53   1/76*
LO      490    -0.040     0.040              ARNOLD    74 HLBC +  DP,DLO/DL+=-0.62   7/74*
LO  B         (-0.017)   (0.011)             BRAUN     74 HLBC +  KMU3/KE3 VS. T    11/75*
LO M   6527    -0.019     0.015              MERLAN    74 ASPK +  DP,DLO/DL+=+0.27   3/74
LO L   1585    -0.020     0.097              BRAUN     75 HLBC +  POL,DLO/DL+=+.92   1/76*
LO W      LO CALCULATED BY US FROM XI0, L+M, AND DXI/DL.                              1/74
LO L      LO VALUE IS FOR L+=0.  CALCULATED BY US FROM XI0 AND DXI/DL.                1/74
LO     D  THIS VALUE AND ERROR ARE TAKEN FROM BRAUN 75 BUT CORRESPOND TO THE          1/76*
LO     D  BRAUN1 73 L+M RESULT.  DLO/DL+ IS FROM BRAUN1 73 DXI/DL IN XIA ABV.         1/76*
LO   B    BRAUN 74 IS A COMBINED KMU3-KE3 RESULT.  IT IS NOT INDEPENDENT OF          11/75*
LO   B    BRAUN1 73 (KMU3) AND BRAUN2 73 (KE3) FORM FACTOR RESULTS.                  11/75*
LO   M    MERLAN 74 LO AND DLO/DL+ WERE CALCULATED BY US FROM XIA, L+M, AND           3/74
LO   M    DXI/DL.  THEIR FIG.6 GIVES LO=-0.025+-0.012 AND NO DLO/DL+.                 3/74
LO            . . . . . . . .
LO   FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS ABOVE.

L+E       LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KE3 DECAY)   ---------
L+E       FOR RAD.COR. OF KE3 DP SEE GINSBURG 67 AND BECHERRAWY 70.                   3/74
L+E     217    +0.036      .045              BROWN     62 XEBC +  PI, NO RC
L+E     407    -0.010      .029              JENSEN    64 XEBC +  PI, NO RC           8/67
L+E     230    -0.04       .05               BORREANI  64 HBC  +  E+, NO RC           8/67
L+E     854     0.045     0.017      0.018   BELLOTT2  67 FBC  +  DP, USES RC        11/67
L+E    1393    +0.016      .016              IMLAY     67 OSPK +  DP, NO RC           8/67
L+E     515    +0.028      .013       .014   KALMUS    67 FBC  +  E+, PI, NO RC       8/67
L+E     960      .08       .04               BOTTERIL1 68 ASPK +  E+, USES RC       . 6/68
L+E      90    -0.02      0.08       0.12    EISLER    68 HLBC +  PI, USES RC         6/68
L+E    1458     .045       .015              BOTTERIL  70 OSPK    PI, USES RC        10/69
L+E    2707    0.027      0.010              STEINER   71 HLBC +  DP, USES RC        11/71
L+E    4017    0.029      0.011              CHIANG    72 OSPK +  DP, RC NEGLIGBLE    9/72
L+E  A         0.027      0.008              BRAUN2    73 HLBC +  DP, NO RC           3/74
L+E B         (0.025)    (0.007)             BRAUN     74 HLBC +  KMU3/KE3 VS. T     11/75*
L+E   A   BRAUN2 73 STATES THAT RC OF GINSBERG 67 WOULD LOWER L+E BY .002 BUT         3/74
L+E   A   THAT RC OF BECHERRAWY DISAGREES AND WOULD RAISE L+E BY .005 .               1/76*
L+E B     BRAUN 74 IS A COMBINED KMU3-KE3 RESULT.  IT IS NOT INDEPENDENT OF          11/75*
L+E B     BRAUN1 73 (KMU3) AND BRAUN2 73 (KE3) FORM FACTOR RESULTS.                  11/75*
L+E           . . . . . . . .
L+E AVG         0.0285    0.0043    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
L+E STUDENT     0.0284    0.0047    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

FS        FS/F+  RATIO OF SCALAR TO F+ COUPLINGS FOR KE3 DECAY(ABS. VALUE)----
FS               .18  OR LESS  CL=.90    BELLOTT2  67 HLBC                           10/69
FS               .30  OR LESS  CL=.95    KALMUS    67 HLBC +                         10/69
FS              0.23  OR LESS  CL=.90    BOTTERIL1 68 ASPK                            8/66
FS     2707     0.14      0.03      0.04 STEINER   71 HLBC +  L+,FS,FT,PHI FIT        2/72
FS     4017     0.13  OR LESS  CL=.90    CHIANG    72 OSPK +                          9/72
FS     2827     0.00      0.10           BRAUN     75 HLBC +                         12/75*
FS            . . . . . . . .
FS   AVG        0.125     0.044     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
FS   STUDENT    0.126     0.037     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

FT        FT/F+  RATIO OF TENSOR TO F+ COUPLINGS FOR KE3 DECAY(ABS. VALUE)----
FT               .58  OR LESS  CL=.90    BELLOTT2  67 HLBC                           10/69
FT              1.1   OR LESS  CL=.95    KALMUS    67 HLBC +                         10/69
FT              0.58  OR LESS  CL=.90    BOTTERIL1 68 ASPK                            8/66
FT     2707     0.24      0.16      0.14 STEINER   71 HLBC +  L+,FS,FT,PHI FIT        2/72
FT     4017     0.75  OR LESS  CL=.90    CHIANG    72 OSPK +                          9/72
FT     2827     0.07      0.37           BRAUN     75 HLBC +                         12/75*
FT            . . . . . . . .
FT   AVG        0.22      0.14      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
FT   STUDENT    0.22      0.15      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

FTM       FT/F+  RATIO OF TENSOR TO F+ COUPLINGS FOR KMU3 DECAY   ------------
FTM    1585     0.02      0.12           BRAUN     75 HLBC                            1/76*

KE4       KE4 DECAY FORM FACTORS ARE GIVEN IN THE FOLLOWING PAPERS
KE4                                      BASILE    71 ASPK +                         11/75*
KE4                                      BEIER     73 OSPK +-                        11/75*

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REFERENCES FOR CHARGED K


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BIRGE    56 NC    4    834      BIRGE,PERKINS,PETERSON,STORK,WHITEHEA (LRL)
ILOFF    56 PR 102    927       ILOFF,GOLDHABER,LANNUTTI,GILBERT +     (LRL)
ALEXANDE 57 NC    6   478       ALEXANDER,JOHNSTON,OCEALLAIGH (DUBLIN INST)
COHEN    57 FUND.CONS.PHYS.     +CROWE,DUMOND        (ATOMICS INTER.+LRL+CIT)
EISENBER 58 NC    8  663        EISENBERG,KOCH,LOHRMANN,NIKOLIC +     (BERN)
BURROWES 59 PRL   2  117        BURROWES,CALDWELL,FRISCH,HILL +        (MIT)
TAYLOR   59 PR 114   359        S TAYLOR,HARRIS,OREAR,LEE,BAUMEL (COLUMBIA)

FREDEN   60 PR 118   564        S C FREDEN,F C GILBERT,R S WHITE       (LRL)
BARKAS   61 PR 124 1209         BARKAS,DYER,MASON,NORRIS,NICKOLS,SMIT (LRL)
BHOWMIK  61 NC   20  857        B BHOWMIK,P C JAIN,P C MATHUR  (DELHI UNIV)
FERRO-LU 61 NC    22  1087      FERRO-LUZZI,MILLER,MURRAY,ROSENFELD+   (LRL)
NORDIN   61 PR 123 2166         PAUL NORDIN JR                         (LRL)
ROE      61 PRL   7  346        ROE,SINCLAIR,BROWN,GLASER +       (MICH+LRL)
BOYARSKI 62 PR 128 2398         BOYARSKI,LOH,NIEMELA,RITSON            (MIT)
BROWN    62 PRL   8  450        BROWN,KADYK,TRILLING,ROE+        (LRL,MICH)
BARKAS   63 PRL 11    26        W H BARKAS,J N DYER,H H HECKMAN        (LRL)

BORREANI 64 PL     12 123       G BORREANI,G RINAUDO,A WERBROUCK    (TURIN)
CALLAHAN 64 PR   136 B 1463     A CALLAHAN,R MARCH,R STARK      (WISCONSIN)
CAMERINI 64 PRL   13 318        CAMERINI,CLINE,FRY,POWELL   (WISCONSIN+LRL)
CLINE    64 PRL   13 101        D CLINE, W F FRY                (WISCONSIN)
GIACOMEL 64 NC 34   1134        GIACOMELLI,MONTI,QUARENI+  (BOLOGNA,MUNICH)
GREINER  64 PRL   13 284        D GREINER, W OSBORNE, W BARKAS         (LRL)
JENSEN   64 PR   136 B1431      JENSEN,SHAKLEE,ROE,SINCLAIR           (MICH)
KALMUS   64 PRL    13   99      +KERNAN,PU,POWELL,DOWD            (LRL,WISC)
SHAKLEE  64 PR   136 B 1423     SHAKLEE,JENSEN,ROE,SINCLAIR           (MICH)

BIRGE    65 PR 139 B 1600       BIRGE,ELY,GIDAL,CAMERINI,CLINE + (LRL+WISC)
BISI     65 NC    35  768       BISI,BORREANI,CESTER,FERRARO +      (TORINO)
BISI 1   65 PR 139 B 1068       BORREANI,MARZARI-CHIESA,RINAUDO+    (TORINO)
BORREANI 65 PR 140 B1686        BORREANI,GIDAL,RINAUDO,CAFORIO+ (BARI,TORI)
CALLAHAN 65 PRL   15  129       A CALLAHAN,D CLINE              (WISCONSIN)
CAMERINI 65 NC 37 1795          +CLINE,GIDAL,KALMUS,KERNAN       (WISC+LRL)
CLINE    65 PL    15  293       A CLINE,W F FRY                 (WISCONSIN)
CUTTS    65 PR 138 B969         CUTTS,ELIOFF,STIENING                  (LRL)

DE MARCO 65 PR 140 B 1430       DE MARCO,GROSSO,RINAUDO        (TORINO+CERN)
FITCH    65 PR 140 B 1088       FITCH,QUARLES,WILKINS(PRINCETON+MT HOLYOKE)
GREINER  65 ARNS  15  67        QUOTED BY BARKAS                       (LRL)
STAMER   65 PR   138 B 440      STAMER,HUETTER,KOLLER,TAYLOR,GRAUMAN (STEV)
TRILLING 65 UCRL 16473          GEORGE H TRILLING                      (LRL)
    UPDATED FROM 1965 ARGONNE CONF., PAGE 5.
YOUNG    65 UCRL 16362          POH-SHIEN YOUNG (THESIS,BERKELEY)      (LRL)
    ALSO 67 PR 156 1464         P-S YOUNG,W.Z.OSBORNE,W.H.BARKAS       (LRL)

CALLAHA1 66 PR 150 1153         CALLAHAN,CAMERINI+(WISC,LRL,RIVERSIDE,BARI)
CALLAHAN 66 NC  44A 90          A C CALLAHAN                    (WISCONSIN)
CESTER   66 PL 21 343           CESTER,ESCHSTRUTH,ONEILL+  (PRINCETON-PENN)
    ALSO 67 AUERBACH, FOOTNOTE 1.

AUERBACH 67 PR 155  1505        +DOBBS,MANN,MCFARLANE,WHITE+     (PENN,PRIN)
    ALSO 74 PR D9 3216          ERRATUM
BELLOTT1 67 HEIDELBERG CONF     BELLOTTI,PULLIA                      (MILAN)
BELLOTT2 67 NC 52A   1287       BELLOTTI,FIORINI,PULLIA              (MILAN)
    ALSO 66 PL   20   690       BELLOTTI,FIORINI,PULLIA+             (MILAN)
BISI     67 PL 25B   572        BISI,CESTER,CHIESA,VIGONE           (TORINO)
BOTTERIL 67 PRL   19  982       BOTTERILL,BROWN,CORBETT,CULLIGAN + (OXFORD)
    ALSO 68 BOTTERIL
BOWEN    67 PR 154 1314         BOWEN,MANN,MCFARLANE,HUGHES+(PENN-PRINCETO)

CLINE1   67 HEIDELBERG CONF     CLINE,HAGGERTY,SINGLETON,FRY+   (WISCONSIN)
CLINE2   67 HERCEG NOVI TBL.4   D.CLINE,PROC.INTL.SCH.ON ELEM.PART.PHYSICS
FLETCHER 67 PRL   19   98       FLETCHER,BEIER,EDWRADS,+          (ILLINOIS)
FORD     67 PRL 18 1214         +LEMONICK,NAUENBERG,PIROUE       (PRINCETON)
IMLAY    67 PR 160   1203       IMLAY,ESCHSTRUTH,FRANKLIN+       (PRINCETON)
KALMUS   67 PR   159   1187     KALMUS,KERNAN                          (LRL)
ZINCHENK 67 RUTGERS(THESIS)     ZINCHENKO                          (RUTGERS)

BETTELS  68 NC 56A 1106         AACHEN-BARI-BERGEN-CERN-EP-NIJMEGEN-ORSAY+
    ALSO 71 HAIDT
BOTTERIL 68 PR 171 1402         BOTTERILL,BROWN,CLEGG,CORBETT +     (OXFORD)
BOTTERI1 68 PR 174 1661         BOTTERILL,BROWN,CLEGG,CORBETT +     (OXFORD)
BOTTERI2 68 PRL 21 766          BOTTERILL,BROWN,CLEGG,CORBETT +     (OXFORD)
BUTLER   68 UCRL-18420          +BLAND,GOLDHABER,GOLDHABER,HIRATA+     (LRL)
CHANG    68 PRL 20   510        CHANG,YODH,EHRLICH,PLAND+(MARYLAND,RUTGERS)

CHEN     68 PRL 20 73           CHEN,CUTTS,KIJEWSKI,STIENING +     (LRL,MIT)
EICHTEN  68 PL 27B 586          AACHEN-BARI-CERN-EP-ORSAY-PADOVA-VALENCIA
EISLER   68 PR   169   1090     EISLER,FUNG,MARATECK,MEYER,PLANO  (RUTGERS)
ESCHSTRU 68 PR   165   1487     ESCHSTRUTH,FRANKLIN,HUGHES+(PRINCETON,PENN)
GARLAND  68 PR   167   1225     +TSIPIS,DEVONS,ROSEN+  (COLUMBIA,RUTG,WISC)
MOSCOSO  68  THESIS             M L MOSCOSO              (UNIV PARIS ORSAY)

CUTTS    69 PR 184 1380         +STIENING,WIEGAND,DEUTSCH          (LRL,MIT)
    ALSO 68 PRL 20 955          CUTTS,STIENING,WIEGAND,DEUTSCH     (LRL,MIT)
DAVISON  69 PR   180 1333       +BACASTOW,BARKAS,EVANS,FUNG,PORTER+    (UCR)
ELY      69 PR   180 1319       ELY,GIDAL,HAGOPIAN,KALMUS+  (LOUC+WISC+LRL)
EMMERSON 69 PRL 23 393          EMMERSON,QUIRK                      (OXFORD)

HERZO    69 PR 186 1403         +BANNER,BEIER,BERTRAM,EDWARDS +        (ILL)
KIJEWSKI 69 UCRL-18433 THESIS   P K KIJEWSKI                           (LBL)
LOBKOWIC 69 PR 185 1676         +MELISSINOS,NAGASHIMA,TEWKSBURY+ (ROCH,BNL)
    ALSO 66 PRL 17 548          LOBKOWICZ,MELISSINOS,NAGASHIM+   (ROCH+BNL)
MACEK    69 PRL   22    32      MACEK,MANN,MC FARLANE,ROBERTS+(PENN,TEMPLE)
MAST     69 PR   183 1200       +GERSHWIN,ALSTON-GARNJOST,BANGERTER+   (LRL)
ZELLER   69 PR   182 1420       ZELLER,HADDOCK,HELLAND,PAHL+      (UCLA,LRL)

BOTTERIL 70 PL 31B 325          +BROWN,CLEGG,CORBETT,CULLIGAN+         (OXF)
FORD     70 PRL 25 1370         +PIROUE,REMMEL,SMITH,SOUDER           (PRIN)
GRAUMAN  70 PR D1 1277          +KOLLER,TAYLOR,PANDOULAS+  (STEV,SETO,LEHI)
    ALSO 69 PRL 23 737          +KOLLER,TAYLOR,PANDOULAS+  (STEV,SETO,LEHI)
MACEK    70 PR D1 1249          +MANN,MCFARLANE,ROBERTS               (PENN)
MALTSEV  70 SJNP 10 678         +PESTOVA,SOLODOVNIKOVA,FADEEV +       (JINR)
PANDOULA 70 PR D2 1205          +TAYLOR,KOLLER,GRAUMAN +         (STEV,SETO)

BASILE   71 PL 36B 619          +BREHIN,DIAMANT-BERGER,KUNZ+     (SACL+GEVA)
BOURQUIN 71 PL 36B 615          +BOYMOND,EXTERMANN,MARASCO+      (GEVA,SACL)
HAIDT    71 PR D3 10            AACHEN+BARI+CERN+EP+NIJMEGEN+ORSAY+PADOVA+
    ALSO 69 PL   29B 691        +(AACH,BARI,CERN,EPOL,NIJM,ORSAY,PADO,TORI)
KLEMS    71 PR D4 66            +HILDEBRAND,STIENING              (CHIC,LRL)
    ALSO 70 PRL 24 1086         KLEMS,HILDEBRAND,STIENING         (LRL,CHIC)
    ALSO 70 PRL 25 473          KLEMS,HILDEBRAND,STIENING         (LRL,CHIC)

KUNSELMA 71 PL 34B 485          R. KUNSELMAN                       (WYOMING)
OTT      71 PR D3 52            OTT,PRITCHARD                         (LOQM)
ROMANO   71 PL 36B 525          +RENTON,AUBERT,BURBAN-LUTZ (BARI,CERN,ORSA)
SCHWEINB 71 PL 36B 246          AACHEN+BELGIUM+CERN+NIJMEGEN+PADOVA COLLAB
STEINER  71 PL 36B 521          AACHEN+BARI+CERN+EPOL+ORSA+NIJM+PADO+TORIN

ABRAMS   72 PRL 29 1118         +CARROLL,KYCIA,LI,MENES,MICHAEL +      (BNL)
ANKENBRA 72 PRL 28 1472         ANKENBRANDT,LARSEN+    (BNL+LASL+FNAL+YALE)
AUBERT   72 NC 12A 509          +HEUSSE,PASCAUD,VIALLE+     (ORSA+BRUX+EPOL)
BEIER    72 PRL 29 678          +BUCHHOLZ,MANN,PARKER       (PENNSYLVANIA)
CHIANG   72 PR D6 1254          +ROSEN,SHAPIRO,HANDLER,OLSEN+    (ROCH+WISC)

CLARK    72 PRL 29 1274         +CORK,ELIOFF,KERTH,MCREYNOLDS,NEWTON+ (LBL)
EDWARDS  72 PR D5 2720          +BEIER,BERTRAM,HERZO,KOESTER +         (ILL)
FORD     72 PL 38B 335          +PIROUE,REMMEL,SMITH,SOUDER      (PRINCETON)
HOFFMAST 72 NP B36 1            HOFFMASTER,KOLLER,TAYLOR+  (STEV+SETO+LEHI)

ABRAMS   73 PRL 30 500          +CARROLL,KYCIA,LI,MENES,MICHAEL +      (BNL)
BACKENST 73 PL 43B 431          BACKENSTOSS,BAMBERGER+(CERN+KARL+HEID+STOH)
BEIER    73 PRL 30 399          +BUCHHOLZ,MANN,PARKER,ROBERTS         (PENN)
BRAUN1   73 PL 47B 182          AACHEN+BARI+BRUSSELS+CERN COLLABORATION
    ALSO 75 BRAUN
BRAUN2   73 PL 47B 185          AACHEN+BARI+BRUSSELS+CERN COLLABORATION
    ALSO 75 BRAUN
CABLE    73 PR D8 3807          +HILDEBRAND,PANG,STIENING          (EFI+LBL)

LJUNG    73 PR D8 1307          D.LJUNG,D.CLINE                       (WISC)
    ALSO 72 PRL 28 523          D.LJUNG                               (WISC)
    ALSO 72 PRL 28 1287         D.CLINE,D.LJUNG                       (WISC)
    ALSO 69 PRL 23 326          CAMERINI,LJUNG,SHEAFF,CLINE           (WISC)
LUCAS1   73 PR D8 719           LUCAS,TAFT,WILLIS                     (YALE)
LUCAS2   73 PR D8 727           LUCAS,TAFT,WILLIS                     (YALE)
PANG     73 PR D8 1989          +HILDEBRAND,CABLE,STIENING    (EFI+ARIZ+LBL)
    ALSO 72 PL 40B 699          CABLE,HILDEBRAND,PANG,STIENING     (EFI+LBL)
SMITH    73 NP B60 411          +BOOTH,RENSHALL,JONES+ (GLAS+LIVP+OXF+RHEL)
ARNOLD   74 PR D9 1221          C L ARNOLD,B P ROE,D SINCLAIR         (MICH)
BRAUN    74 PL 51B 393          +CORNELSSEN,MARTYN +  (AACH+BARI+BRUX+CERN)
CENCE    74 PR D10 776          +HARRIS,JONES,MORGADO +      (HAWA+LBL+WISC)
    ALSO 73 THESIS (UNPUBL.)    D B CLARKE                            (WISC)
KUNSELMA 74 PR C9 2469          R.KUNSELMAN                           (WYOM)
MERLAN   74 PR D9 107           +KASHA,WANDERER,ADAIR+      (YALE+BNL+LASL)
WEISSENB 74 PL 48B 474          WEISSENBERG,EGOROV,MINERVINA +  (ITEP+LEBD)
BLOCH    75 PL 56B 201          +BREHIN,BUNCE,DEVAUX+            (SACL+GEVA)
BRAUN    75 NP B89 210          +CORNELSSEN,MARTYN+   (AACH+BARI+BRUX+CERN)
HEARD1   75 PL 55B 324          +HEINTZE,HEINZELMANN+            (CERN+HEID)
HEARD2   75 PL 55B 327          +HEINTZE,HEINZELMANN+            (CERN+HEID)
SHEAFF   75 PR D12 2570         M. SHEAFF                             (WISC)
SMITH    75 NP B91 45           +BOOTH,RENSHALL,JONES+ (GLAS+LIVP+OXF+RHEL)
HEINTZE  76 PL (TO BE PUBL.)    +HEINZELMANN,IGO-KEMENES,MUNDHENKE+  (HEID)

         QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

BLOCK    62 CERN CONF 371       BLOCK,LENDINARA,MONARI        (NWES+BOLOGNA)

                                PAPERS NOT REFERRED TO IN DATA CARDS

BRENE    61 NP 22 553           BRENE,EGARDT,QVIST                    (NORD)
BIRGE    63 PRL   11  35        BIRGE,ELY,GIDAL,CAMERINI +  (LRL+WISC+BARI)
ADAIR    64 PL 12  67           ADAIR,LEIPUNER                    (YALE,BNL)
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Stable Particles

$K^{\pm}$, K^0, K^0_S

Data Card Listings

For notation, see key at front of Listings.


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CABIBBO  64 PL   9 352          CABIBBO,MAKSYMOWICZ                         (CERN)
    ALSO 64 PL  11 360          CABIBBO,MAKSYMOWICZ                         (CERN)
    ALSO 65 PL  14  72          CABIBBO,MAKSYMOWICZ                         (CERN)
CABIBBO  66 BERKELEY CONF 33    CABIBBO                                     (CERN)
GINSBERG 67 PR 162  1570        EDWARD S GINSBERG                (U. MASS BOSTON)
WILLIS   67 HEIDELBERG 273      W J WILLIS -RAPPORTEUR TALK                 (YALE)
CRONIN   68 VIENNA CONF 241     RAPPORTEUR TALK                        (PRINCETON)
HAIDT 2  69 PL 29B 696          + (AACH,BARI,CERN,EPOL,NIJM,ORSA,PADO,TORI)
BARDIN   70 PL 32B 121          BARDIN,BILENKY,PONTECORVO                   (JINR)
BECHERRA 70 PR D1 1452          T.BECHERRAWY                                (ROCH)
FEARING  70 PR D3 542           +FISCHBACK,SMITH                       (STON+BOHR)
GAILLARD 70 CERN 70-14          M K GAILLARD, L M CHOUNET              (CERN+ORSA)
GINSBERG 70 PR D1 229           E S GINSBERG                           (IIT HAIFA)
GINSBERG 71 PR D4 2893          E S GINSBERG                                 (MIT)
CHOUNET  72 PL 4C 199           (PHYS. REPTS.)CHOUNET,2*GAILLARD(ORSA+CERN)
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K^0

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              11  NEUTRAL K(498,JP=0-) I=1/2
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              11  NEUTRAL K MASS (MEV)

M             498.1      0.4              CHRISTENS 64 OSPK
M       2223  497.44     0.33             KIM       65 HBC    KO FROM PBAR P    6/66
M       4500  498.9      0.5              BALTAY    66 HBC    KO FROM PBAR P    6/66
M             497.44     0.50             FITCH     67 OSPK                    11/67
M             . . . . . . . . .
M   AVG       497.87     0.32    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
M   STUDENT   497.83     0.26    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
M   FIT       497.70     0.13   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  2/76*
                        (SEE IDEOGRAM BELOW )
```
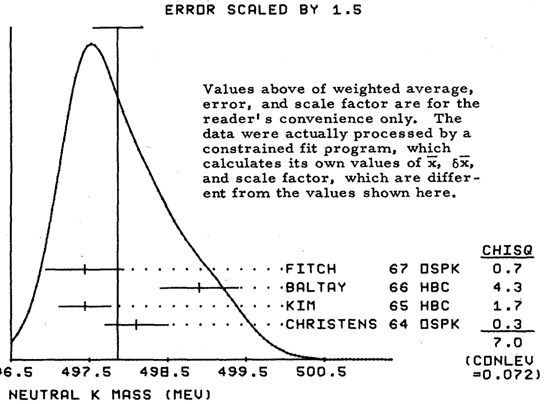

WEIGHTED AVERAGE = 497.87 ± 0.32
ERROR SCALED BY 1.5

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              11  (KO) - (K+-) MASS DIFFERENCE (MEV)

D             3.9       0.6             ROSENFELD 59 HBC  -
D             5.4       1.1             CRAWFORD  59 HBC  +
D        9    3.90      0.25            BURNSTEIN 65 HBC  -
D        7    3.71      0.35            KIM       65 HBC  -  K- P TO KO N     6/68
D      417    3.95      0.21            HILL      68 DBC  +  K+D TO KOPP      3/68
D             . . . . . . . . .
D   AVG       3.92      0.14   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D   STUDENT   3.91      0.15   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
D   FIT       3.99      0.13  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  2/76*

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REFERENCES FOR NEUTRAL K


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CRAWFORD 59 PRL   2  112       CRAWFORD,CRESTI,GOOD,STEVENSON,TICHO  (LRL)
ROSENFEL 59 PRL   2  110       A H ROSENFELD,F SOLMITZ,R D TRIPP     (LRL)
CHRISTEN 64 PRL 13 138         CHRISTENSON,CRONIN,FITCH,TURLAY (PRINCETON)
BURNSTEI 65 PR  138 B 895      R A BURNSTEIN,H A RUBIN          (MARYLAND)
KIM      65 PR 140 B 1334      J K KIM,L KIRSCH,D MILLER        (COLUMBIA)
BALTAY   66 PR 142   932       BALTAY,SANDWEISS,STONEHILL +     (YALE+BNL)
FITCH    67 PR 164  1711       FITCH,ROTH,RUSS,VERNON          (PRINCETON)
HILL     68 PR 168  1534       HILL,ROBINSON,SAKITT,CANTER  (BNL,CARNEGIE)
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K^0_S

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              12  SHORT-LIVED NEUTRAL K(498, JP=0-) I=1/2
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Note on the K^0_S Mean Life

From 1968 until 1972 our average value for the K^0_S mean life was $(0.862 \pm 0.006) \times 10^{-10}$ second. Since then three high-precision experiments, SKJEGGESTAD 72 (Oslo, CERN, Saclay), GEWENIGER 74 (CERN, Heidelberg), and CARITHERS 75 (Columbia, NYU) have obtained results compatible with each other which average $(0.8930 \pm 0.0023) \times 10^{-10}$ second. This is about five standard deviations above the previous average. The origin of this discrepancy is not known.

The corrections for systematic biases in SKJEGGESTAD 72 and HILL 68 (including the correction for the new value of η_{+-}) amount to +1% and 0.7%, respectively. Similar corrections, if applied to the older bubble chamber results, would probably increase the old average by only about one standard deviation and would not account for the discrepancy.

The two experiments which contribute most to the χ^2 (see ideogram below) are KIRSCH 66 and DONALD 68. The combined result of all other experiments is $(0.8914 \pm 0.0021) \times 10^{-10}$ second with a χ^2 of 11.5 for 10 degrees of freedom. This value does not differ significantly from the average of the newer (post-1971) experiments.

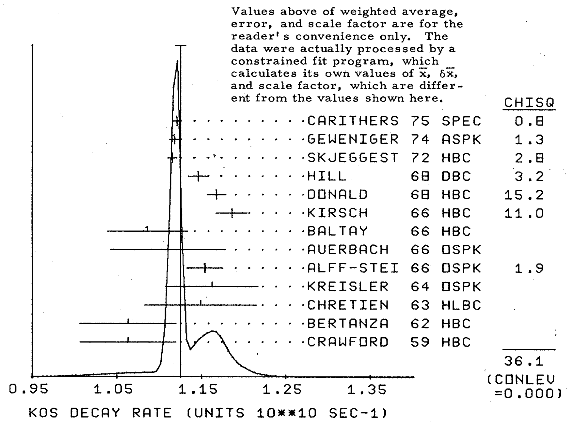
Since the newer experiments are in principle superior — that is, they have higher statistics, better acceptance, and easier trigger conditions — we have chosen to average them separately from the older experiments as is seen in the Data Card Listings below. In the Stable Particle Table, we quote the new value, but give the old value in a warning footnote.

```
              12  KOS MEAN LIFE (UNITS 10**-10 SEC)

T      KOS MEAN LIFE (PRE-1971 EXPERIMENTS)
T  O   90   (1.07)   (0.13)   (0.13) BOLDT      58 CC
T     512    0.94     0.05     0.05  CRAWFORD   59 HBC
T  O   63   (1.09)   (0.18)   (0.15) BOWEN      60 CC
T  O   OLD EXPTS WITH LOW STATISTICS NOT INCLUDED IN AVERAGE.              6/68
T     378    0.94     0.05     0.05  BERTANZA   62 HBC
T     503    0.87     0.05           CHRETIEN   63 HLBC
T     545    0.86     0.04           KREISLER   64 OSPK
T            0.866    0.016          ALFF-STEI  66 OSPK                    9/66
T     572    0.90     0.06     0.05  AUERBACH   66 OSPK                    8/67
T    4500    0.92     0.04           BALTAY     66 HBC                     6/66
T  B        (0.904)  (0.024)         BOTT-BODE  66 OSPK                    9/66
T    5000    0.843    0.013          KIRSCH     66 HBC                     6/66
T   19994    0.856    0.008          DONALD     68 HBC                     6/68
T  H 20000   0.872    0.009          HILL       68 DBC                    11/72
T            . . . . . . . . .
T   AVG      0.8641   0.0065   0.0065 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.3)
T   STUDENT  0.8642   0.0060   0.0059 AVG. USING STUDENT10(H/1.11) -- SEE TEXT
                      (SEE IDEOGRAM BELOW )

T      KOS MEAN LIFE (POST-1971 EXPERIMENTS)
T       THESE VALUES ARE USED TO DETERMINE THE STABLE PARTICLE TABLE
T       VALUES OF THE KOS MEAN LIFE AND RATES.
T  H   50K   0.8958   0.0045         SKJEGGEST  72 HBC                     1/73
T   F 2173  (0.867)  (0.024)         FACKLER    73 OSPK                   11/73
T       6M   0.8937   0.0048         GEWENIGER  74 ASPK                    3/74
T  C         0.8913   0.0032         CARITHERS  75 SPEC                    7/75*
T            . . . . . . . . .
T   AVG      0.8930   0.0023   0.0023 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T   STUDENT  0.8930   0.0025   0.0025 AVG. USING STUDENT10(H/1.11) -- SEE TEXT
T   FIT      0.8930   0.0023 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
                      (SEE IDEOGRAM BELOW )

                  COMMENTS
T  H   HILL 68 HAS BEEN CHANGED BY THE AUTHORS FROM THE PUBLISHED VALUE   11/72
T  H   (0.865+-0.009) BECAUSE OF A CORRECTION IN THE SHIFT DUE TO ETA+-.  11/72
T  H   SKJEGGESTAD 72 AND HILL 68 GIVE DETAILED DISCUSSIONS OF SYSTEMATICS
T  H   ENCOUNTERED IN THIS TYPE OF EXPERIMENT.
T   B  KOS MEAN LIFE NOT THE PRIMARY QUANTITY MEASURED IN THIS EXPT.       6/68
T   F  FACKLER 73 DOES NOT INCLUDE SYSTEMATIC ERRORS.                    11/73
T  C   CARITHERS 75 VALUE IS FOR KOL-KOS MASS DIFFERENCE DM=.5348+-.0021.  11/75*
T  C   THE DM DEPENDENCE OF THE TOTAL DECAY RATE (INVERSE MEAN LIFE) IS    11/75*
T  C   GAMMA(KOS)=((1.122+-.004)+.16*(DM-.5348)/DM)*10**10 /SEC.           11/75*
T  C   VALUE WOULD NOT CHANGE WITH OUR CURRENT DM=.5349+-.0022.            2/76*
```

Data Card Listings
For notation, see key at front of Listings.

Stable Particles
K^0_S

WEIGHTED AVERAGE = 1.1257 ± 0.0065
ERROR SCALED BY 2.5

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                  12  KOS PARTIAL DECAY MODES

                                                       DECAY MASSES
P1    KOS INTO PI+ PI-                                139+ 139
P2    KOS INTO PIO PIO                                134+ 134
P3    KOS INTO MU+ MU-                                105+ 105
P4    KOS INTO E+ E-                                   .5+  .5
P5    KOS INTO PI+ PI- GAMMA                          139+ 139+   0
P6    KOS INTO GAMMA GAMMA                              0+   0
P7    KOS INTO 3PIO                                   134+ 134+ 134

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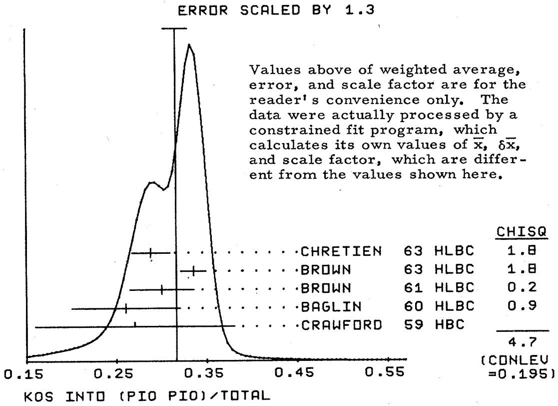
                  12  KOS BRANCHING RATIOS

R1     KOS INTO (PI+ PI-)/TOTAL                        (P1)
R1            0.68      0.04          CRAWFORD  59 HBC
R1            0.70      0.08          COLUMBIA  60 HBC
R1  U        (0.740)   (0.024)        ANDERSON  62 HBC
R1 U  1648    0.670     0.010         DOYLE     69 HBC     PI- P TO LAM KO    1/76*
R1  U  ANDERSON RESULT NOT PUBLISHED, EVENTS ADDED TO DOYLE SAMPLE              2/71
R1         . . . . . . . . . .
R1  AVG       0.6710    0.0096  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  STUDENT   0.671     0.010   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1  FIT       0.6867    0.0025 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R2     KOS INTO (PIO PIO)/TOTAL                        (P2)
R2            0.27      0.11          CRAWFORD  59 HBC
R2            0.26      0.06          BAGLIN    60 HLBC
R2            0.30      0.035         BROWN     61 HLBC
R2    1066    0.335     0.014         BROWN     63 HLBC
R2     198    0.288     0.021         CHRETIEN  63 HLBC
R2         . . . . . . . . . .
R2  AVG       0.316     0.014   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R2  STUDENT   0.316     0.014   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2  FIT       0.3133    0.0025 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                        (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.316 ± 0.014
ERROR SCALED BY 1.3

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R3     KOS INTO (PI+ PI-)/(PIO PIO)          BOZOKI    69 HLBC            (P1)/(P2)
R3  N  267    (2.12)    (0.17)         BOZOKI    69 HLBC                      5/70
R3  G 3016    (2.285)   (0.055)        GOBBI     69 OSPK    K+N TO KOP        5/69
R3    3700     2.10      0.06          MORFIN    69 HLBC    K+N TO KOP       10/69
R3 G  7944     2.282     0.043         MOFFETT   70 OSPK    K+N TO KOP        2/72
R3 B  6150     2.22      0.095         BALTAY    71 HBC  K-P TO KO +NEUTRALS 12/71
R3 A  3068     2.22      0.10          ALITTI    72 HBC     K+P TO PI+ P KO   6/72
R3    6380     2.22      0.08          MORSE     72 DBC     K+N TO KOP        2/72
R3 N   701     2.10      0.11          NAGY      72 HLBC    K+N TO KOP        1/73
R3    4799     2.16      0.08          HILL      73 DBC     K+D TO KO P P     9/73
R3     16K     2.169     0.094         COWELL    74 OSPK    PI- P TO LAM KO   7/75*
R3 N    NAGY 72 IS A FINAL RESULT WHICH INCLUDES BOZOKI 69.                  11/73
R3 G    MOFFETT 70 IS A FINAL RESULT WHICH INCLUDES GOBBI 69.                 2/72
R3 B    THE DIRECTLY MEASURED QUANTITY IS KS TO PI+PI-/ALL KOBAR=.345+-.005 12/71
R3 A    THE DIRECTLY MEASURED QUANTITY IS KOS TO PI+ PI-/ALL KO=.345+-.005   6/72
R3         . . . . . . . . . .
R3  AVG        2.204     0.027   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R3  STUDENT    2.201     0.032   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R3  FIT        2.192     0.026  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R4     (KOS INTO PI+ PI- PIO, CP VIOLATING)/(KOL INTO PI+ PI- PIO)
R4      TEST OF CP VIOLATION - SEE TEXT SECTION VI B.3A FOR DEFINITIONS
R4      CPT ASSUMED VALID - (I.E. RE(A)=0) - ONLY (IMA)**2 QUOTED HERE
R4      18    (3.8)   OR LESS  CL=.90   ANDERSON  65 HBC                     10/69
R4             0.45   OR LESS  CL=.90   BEHR      66 HLBC                     8/66
R4      53    (1.7)   OR LESS  CL=.90   WEBBER    70 HBC                      8/70
R4 C    71     0.8    OR LESS  CL=.90   WEBBER    70 HBC                      8/70
R4      99     1.2    OR LESS  CL=.90   CHO       71 DBC                      4/71
R4  J   98    (1.0)   OR LESS  CL=.90   JAMES     71 HBC                      6/71
R4  M   50    (1.2)   OR LESS  CL=.95   MEISNER   71 HBC   CL=.9 NOT AVAIL.   2/71
R4 J   180     0.66   OR LESS  CL=.90   JAMES     72 HBC                      1/73
R4      99     1.2    OR LESS  CL=.90   JONES     72 OSPK                    10/72
R4     384     0.12   OR LESS  CL=.90   METCALF   72 ASPK                     2/74
R4     148     0.71   OR LESS  CL=.90   MALLARY   73 OSPK  RE(A)=-.05+-.17    8/73
R4     192     1.2    OR LESS  CL=.90   BALDOCEOL 75 HLBC                    12/75*
R4 C    THIS IS THE COMBINED RESULT OF ANDERSON 65 AND WEBBER 70
R4 J    JAMES 72 IS A FINAL RESULT WHICH INCLUDES JAMES 71.                  11/73
R4  M   THESE AUTHORS FIND REAL(A)= 2.75+-.65, ABOVE VALUE AT RE(A)=0         2/71

R5     KOS INTO (MU+ MU-)/CHARGED (UNITS 10**-5)           (P3)/(P1)
R5            10.0    OR LESS  CL=.90   BOTT-BODE 67 OSPK                     8/67
R5            20.0    OR LESS  CL=.90   BOHM      69 OSPK                     2/71
R5             1.07   OR LESS  CL=.90   HYAMS     69 OSPK                    10/69
R5   S        32.6    OR LESS  CL=.90   STUTZKE   69 OSPK                     5/69
R5             0.047  OR LESS  CL=.90   GJESDAL   73 ASPK                     7/73
R5   S  VALUE CALCULATED BY US, USING 2.3 INSTEAD OF 1 EVENT, 90 PERC.CL

R6     KOS INTO (PI+ PI- GAMMA)/(PI+ PI-) (UN.10**-3)    (P5)/(P1)
R6      27       NO RATIO GIVEN         BELLOTTI  66 HBC    PG GT 50 MEV/C   10/69
R6      10     3.3       1.2            WEBBER    70 HBC    PG GT 50 MEV/C   10/69
R6 B           2.8       0.6            BURGUN    73 HBC    PG GT 50 MEV/C   11/73
R6 C    29    (3.0)     (0.6)           BOBISUT   74 HLBC   PG GT 40 MEV/C   12/75*
R6 B    BURGUN 73 ESTIMATES THAT DIRECT EMISSION CONTRIBUTION IS .3+-.6 .    11/73
R6 C    BOBISUT 74 NOT INCLUDED IN AVERAGE BECAUSE P(GAMMA) CUT DIFFERS.      1/76*
R6 C    ESTIMATES DIRECT EMISSION CONTRIBUTION TO BE 0.5 OR LESS, CL=.95.     1/76*
R6         . . . . . . . . . .
R6  AVG        2.90      0.54    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R6  STUDENT    2.90      0.58    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R7     KOS INTO (E+ E-)/CHARGED (UNITS 10**-5)             (P4)/(P1)
R7            50.0    OR LESS  CL=.90   BOHM      69 OSPK                     2/71

R8     KOS INTO 2 GAMMA/TOTAL (UNITS 10**-3)               (P6)
R8 R     0    21.0    OR LESS  CL=.90   BANNER    69 OSPK                    12/71
R8 R     0     2.2    OR LESS  CL=.90   REPELLIN  71 OSPK                    12/71
R8 R     0     0.71   OR LESS  CL=.90   BANNER    72 OSPK                     8/72
R8       0     2.0    OR LESS  CL=.90   MORSE     72 DBC                      2/72
R8       0     0.4    OR LESS  CL=.90   BARMIN2   73 HLBC                     2/74
R8 R    THESE LIMITS ARE FOR MAXIMUM INTERFERENCE IN KS-KL TO 2 GAMMAS       12/71

R9     (KOS INTO PI+ PI- PIO, CP CONSERVING)/(KOL INTO PI+ PI- PIO)
R9     384     0.42   OR LESS  CL=.90   METCALF   72 ASPK                    11/72

R10    (KOS INTO 3PIO,CP VIOLATING)/(KOL INTO 3PIO)
R10    SEE COMMENTS UNDER BRANCHING RATIO R4
R10     22     1.2    OR LESS  CL=.90   BARMIN1   73 HLBC                    11/73
R10  G         0.28   OR LESS  CL=.90   GJESDAL   74 SPEC                    11/75*
R10  G  GJESDAL 74 USES K2PI, KMU3 AND KE3 DECAY RESULTS AND UNITARITY.      11/75*
R10  G  CALCULATES ABS(ETA000)=.26+-.20.  WE CONVERT TO CL=.90 UPPER LIMIT.  11/75*

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REFERENCES FOR KOS


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BOLDT    58 PRL    1  150      E BOLDT,D O CALDWELL,Y PAL                  (MIT)
CRAWFORD 59 PRL    2  266      CRAWFORD,CRESTI,DOUGLASS,GOOD,TICHO + (LRL)

BAGLIN   60 NC    18 1043      BAGLIN,BLOCH,BRISSON,HENNESSY +         (EPOL)
BOWEN    60 PR   119 2030      BOWEN,HARDY,REYNOLDS,SUN,MOORE+   (PRIN+BNL)
COLUMBIA 60 ROCH CONF 727      M SCHWARTZ +                        (COLUMBIA)

BROWN    61 NC    19 1155      BROWN,BRYANT,BURNSTEIN,GLASER,KADYK+ (MICH)
ANDERSON 62 CERN CONF 836      J A ANDERSON,F S CRAWFORD +              (LRL)
BERTANZA 62  PREPRINT D105     BERTANZA,CONNOLLY,CULWICK,EISLER +      (BNL)
    UNPUBLISHED, BUT RECERTIFIED BY AUTHORS, AUGUST 66.

CHRETIEN 63 PR  131 2208       CHRETIEN+       (BRANDEIS+BROWN+HARVARD+ MIT)
BROWN    63 PR  130  769       BROWN,KADYK,TRILLING,ROE +          (LRL+MICH)
KREISLER 64 PR  136 B 1074     M KREISLER,O OVERSETH,J CRONIN   (PRINCETON)
ANDERSON 65 PRL 14 475         +CRAWFOR,GOLDEN,STERN,BINFORD +    (LRL+WISC)

ALFF-STE 66 PL 21 595          ALFF-STEINBERGER,HEUER,KLEINKNECHT + (CERN)
AUERBACH 66 PR 149 1052        AUERBACH,DOBBS,LANDE,MANN,SCIULLI+    (PENN)
    ALSO 65 AUERBACH
BALTAY   66 PR 142   932       BALTAY,SANDWEISS,STONEHILL +       (YALE+BNL)
BEHR     66 PL   22  540       BEHR,BRISSON,PETIAU+ (EPOL,MILA,PADO,ORSAY)
BELLOTTI 66 NC 45A 737         +PULLIA,BALDO-CEOLIN +         (MILAN+PADUA)
BOTT-BOD 66 PL   23 277        BOTT-BODENHAUSEN,DE BOUARD +            (CERN)
KIRSCH   66 PR   147  939      L KIRSCH,P SCHMIDT                  (COLUMBIA)

BOTT-BOD 67 PL 24B 194         BOTT-BODENHAUSEN,DE BOUARD,CASSEL+     (CERN)
DONALD   68 PL 27B  58         DONALD,EDWARDS,NISAR+ (LIVP,CERN,IPNP,CDEF)
HILL     68 PR 171 1418        HILL,ROBINSON,SAKITT +        (BNL,CARNEGIE)

BANNER   69 PR 188 2033        +CRONIN,LIU,PILCHER                (PRINCETON)
BOHM     69 THESIS             A. BOHM                                 (AACH)
BOZOKI   69 PL 30B 498         +FENYVES,GOMBOSI,NAGY,SURANYI+    (BUDAPEST)
DOYLE    69 UCRL 18139-THESIS J.C. DOYLE                                (LRL)
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Stable Particles

K^0_S, K^0_L

Data Card Listings

For notation, see key at front of Listings.


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GOBBI     69 PRL 22 682           GOBBI,GREEN,HAKEL,MOFFETT,ROSEN+(ROCHESTER)
HYAMS     69 PL  29B 521          +KOCH,POTTER,VON LINDERN,LORENZ+ CERN(MPIM)
MORFIN    69 PRL   23  660        MORFIN,SINCLAIR                     (MICH)
STUTZKE   69 PR   177  2009       +ABASHIAN,JONES,MANTSCH,ORR,SMITH(ILLINOIS)

MOFFETT   70 BAPS 15 512          +GOBBI,GREEN,HAKEL,ROSEN       (ROCHESTER)
WEBBER    70 PR D1 1967           +SOLMITZ,CRAWFORD,ALSTON-GARNJOST    (LRL)
   ALSO   69 UCRL 19226 THESIS B R WEBBER                              (LRL)
BALTAY    71 PRL 27 1678          +BRIDGEWATER,COOPER,GERSHWIN,HABIBI+ (COLU)
   ALSO   71 NEVIS-187 THESIS  WILLIAM A. COOPER                  (COLUMBIA)
CHO       71 PR D3 1557           +DRALLE,CANTER,ENGLER,FISK+ (CARN+BNL+CASE)
JAMES     71 PL 35B 265           +MONTANET,PAUL,PAULI+      (CERN+SACL+OSLO)
MEISNER   71 PR D3 59             +MANN,HERTZBACH,KOFLER +    (MASA+BNL+YALE)
REPELLIN  71 PL 36B 603           +WOLFF,CHOLLET,GAILLARD,JANE+   (ORSA+CERN)

ALITTI    72 PL 39B 568           J ALITTI,E LESQUOY,A MULLER        (SACLAY)
BANNER    72 PRL 29 237           +CRONIN,HOFFMAN,KNAPP,SHOCHET   (PRINCETON)
JAMES     72 NP B49 1             +MONTANET,PAUL,SAETRE+     (CERN+SACL+OSLO)
JONES     72 NC 9A 151            +ABASHIAN,GRAHAM,MANTSCH,ORR,SMITH+   (ILL)

METCALF   72 PL 40B 703           +NEUHOFER,NIEBERGALL+      (CERN+IPN+WIEN)
MORSE     72 PRL 28 388           +NAUENBERG,BIERMAN,SAGER+  (COLO+PRIN+UMD)
NAGY      72 NP B47 94            +TELBISZ,VESZTERGOMBI           (BUDAPEST)
   ALSO   69 PL 30B 498           BOZOKI,FENYVES,GOMBOSI,NAGY+    (BUDAPEST)
SKJEGGES  72 NP B48 343           SKJEGGESTAD,JAMES,MONTANET+(OSLO+CERN+SACL)

BARMIN1   73 PL 46B 465           +BARYLOV,DAVIDENKO,DEMIDOV+         (ITEP)
BARMIN2   73 PL 47B 463           +BARYLOV,DAVIDENKO,DEMIDOV+         (ITEP)
BURGUN    73 PL 46B 481           +BERTRANET,LESQUOY,MULLER,PAULI+(SACL+CERN)
FACKLER   73 PRL 31 847           +FRISCH,MARTIN,SMOOT,SOMPAYRAC       (MIT)
GJESDAL   73 PL 44B 217           +PRESSER,STEFFEN,STEINBERGER+  (CERN+HEID)
HILL      73 PR D8 1290           +SAKITT,SAMIOS,BURRIS,ENGLER+   (BNL+CARN)
MALLARY   73 PR D7 1953           +BINNIE,GALLIVAN,GOMEZ,PECK,SCIULLI+ (CIT)
BOBISUT   74 LNC 11 646           +HUZITA,MATTIOLI,PUGLIERIN          (PADO)
COWELL    74 PR D10 2083          +LEE-FRANZINI,ORCUTT,FRANZINI + (STON+COLU)
GEWENIGE  74 PL 48B 487           GEWENIGER,GJESDAL,PRESSER+     (CERN+HEID)
GJESDAL   74 PL 52B 119           +PRESSER,STEFFEN,STEINBERGER +  (CERN+HEID)
BALDOCEO  75 NC 25A 688           BALDO-CEOLIN,BOBISUT,CALIMANI+  (PADO+WISC)
CARITHER  75 PRL 34 1244          CARITHERS,MODIS,NYGREN,PUN +     (COLU+NYU)

                                  PAPERS NOT REFERRED TO IN DATA CARDS

BIRGE     60 ROCH CONF 601        R W BIRGE,P P ELY +        (LRL+WISCONSIN)
MULLER    60 PRL    4  418        MULLER,BIRGE,FOWLER,GOOD,PICCIONI+(LRL+BNL)
FITCH     61 NC    22 1160        V FITCH,P PIROUE,R PERKINS      (PRIN+LASL)
GOOD      61 PR  124 1223         GOOD,MATSEN,MULLER,PICCIONI +        (LRL)
CRAWFORD 62 CERN CONF 827         F S CRAWFORD                         (LRL)
AUERBACH 65 PRL 14 192            AUERBACH,LANDE,MANN,SCIULLI,UTO +   (PENN)
TRILLING 65 UCRL 16473            GEORGE H TRILLING                    (LRL)
   UPDATED FROM 1965 ARGONNE CONF., PAGE 115.
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K^0_L

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          13  LONG-LIVED NEUTRAL K(498, JP=0-) I=1/2
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                13  (KOL) - (KOS) MASS DIFFERENCE
    WE GIVE (KOL-KOS MASS DIFFERENCE / HBAR) IN UNITS OF 10**10 SEC-1

D  TX       (2.20)   (0.35)           FITCH     61 CNTR
D   X       (0.84)   (0.29)   (0.22)GOOD        61 HLBC
D  TXC      (1.02)   (0.23)           CAMERINI  62 HLBC                     8/67
D  TX       (0.55)   (0.24)           AUBERT    65 HLBC                     6/66
D   X       (0.26)   (0.36)   (0.26)BALDO-CEO   65 HLBC   ASSUMES CP CONS.
D  TXA      (0.64)   (0.12)           CHRISTENS 65 OSPK                     6/66
D  TX       (0.70) OR LESS            FITCH     65 OSPK   CF. MEISNER 66    7/66
D   V  130  (0.89)   (0.15)           VISHNEVSK 65 OSPK   CU AND AL REGEN   8/67
D   X       (0.514)  (0.039)          ALFF-STEI 66 OSPK                     6/66
D   X   84  (0.42)   (0.24)   (0.36)  BALDO-CEO 66 HLBC   KO+N INTO HYPER.  8/67
D   B       (0.531)  (0.027)          BOTT-BODE 66 OSPK   C REGEN           9/66
D  TX   77  (0.58)   (0.17)           CAMERINI  66 HBC, DBC KO+N INTO HYPER 8/67
D   N   72 (+0.64)   (0.18)           CANTER    66 DBC    KO SCATTER IN D2 11/66
D   X   95  (0.62)   (0.10)   (0.16)  CHANG     66 HBC    KO+P INTO HYPER.  8/67
D   X       (0.81)   (0.17)           FUJII     66 OSPK   IRON REGENERATOR  9/66
D   X   59  (0.74)   (0.34)           MEISNER1  66 HBC                      6/66
D          + SIGN FAVORED             MEISNER2  66 HBC                      9/66
D   X       (0.38)   (0.16)           JOVANOVIC 66 OSPK   C+URANIUM REGEN. 11/66
D  TX  136 (+0.64)   (0.19)           CANTER    67 DBC    KO+D INTO HYPER. 11/67
D   X       (0.65)   (0.11)           MISCHKE   67 OSPK                   .11/67
D   X  590  (0.59)   (0.13)           BALATZ    68 OSPK   AL REGENERATOR    3/68
D   X       (0.520)  (0.044)          CARNEGIE  68 HBC    GAP METHOD        3/68
D  TX      (+0.487)  (0.046)          MELHOP    68 OSPK   ST.STEEL REGEN    6/68
D  BX       (0.547)  (0.024)          BOTT-BODE 69 OSPK   C REGEN           1/71
D  FX       (0.555)  (0.020)          FAISSNER  69 ASPK   REGEN IN CU      10/69
D            0.542    0.006           CULLEN    70 CNTR                     1/71
D   R       (0.542)  (0.006)          ARONSON   70 ASPK   GAP METHOD        1/71
D   X       (0.481)  (0.052)  (0.075)BALATS     71 OSPK                     9/71
D   R       (0.534)  (0.007)          CARNEGIE  71 ASPK   GAP METHOD        8/71
D  TH  119 (+0.67)   (0.14)           HILL      71 DBC                     10/71
D   S 1757  (0.557)  (0.038)          FACKLER   73 OSPK                    11/73
D            0.5340   0.0030          GEWENIG3  74 SPEC   GAP METHOD       11/75*
D            0.5334   0.0040          GJESDAL1  74 SPEC   CHG ASYMMETRY    11/75*
D          . . . . . . . . .
D   AVG      0.5349   0.0022  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D   STUDENT  0.5348   0.0025  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                 COMMENTS
D   X   NO ATTEMPT HAS BEEN MADE TO CORRECT OLDER EXPERIMENTS WITH LARGE   11/75*
D   X   ERRORS FOR THE SUBSEQUENT CHANGES IN THE KOS MEAN LIFE OR IN ETA+-. 2/76*
D  T    A KOS MEAN LIFE OF 0.862 10**-10 SEC WAS USED IN CONVERTING THE    1/71
D  T    MASS DIFFERENCE FROM UNITS OF INVERSE KOS MEAN LIVES TO ABSOLUTE   1/71
D  T    UNITS. VALUES NOT BEARING THIS FOOTNOTE EITHER WERE GIVEN IN       1/71
D  T    ABSOLUTE UNITS OR WERE CONVERTED USING THE AUTHORS' VALUE OF THE   1/71
D  T    KOS MEAN LIFE.                                                     1/71
D    C  CAMERINI 62 VALUE CHANGED FROM 1.7 (SEE TABLE 1 OF CAMERINI 66)    8/67
D    A  CHRISTENSON 65 CORRECTED FOR INTERFERENCE BY FITCH 65 FOOTNOTE.    1/71
D   V   VISHNEVSKY 65 NOT CORRECTED FOR INTERFERENCE EFFECTS.              3/68
D   N   CANTER 66 ERROR IGNORES UNCERTAINTY OF PHASE SHIFTS.  THESE EVENTS 10/71
D   N   ARE USED IN HILL 71.                                              10/71
D  B    BOTT-BODENHAUSEN 69 IS A REEVALUATION OF BOTT-BODENHAUSEN 66.      1/71
D  F    FAISSNER 69 HAS ADDNL. SYSTEMATIC ERROR LESS THAN TWO PERCENT.     1/71
D   R   ARONSON 70 AND CARNEGIE 71 USE KOS MEAN LIFE=.862+-.006 E-10 SEC. 11/75*
D   R   WE HAVE NOT ATTEMPTED TO ADJUST THESE VALUES FOR THE SUBSEQUENT    2/76*
D   R   CHANGE IN THE KOS MEAN LIFE OR IN ETA+-.                           2/76*
D   H   HILL 71 PRIMARY RESULT IS THAT DM IS POSITIVE.                    10/71
D   H   THE MAGNITUDE MAY HAVE AN ADDITIONAL SYSTEMATIC ERROR OF ABOUT 0.12 10/71
D   S   NOT AVERAGED BECAUSE ERROR IS LARGE AND SYSTEMATICS NOT DISCUSSED.  2/76*

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                13  KOL MEAN LIFE (UNITS 10**-8 SEC)

T       KOL MEAN LIFE
T      34     8.1       3.2      2.4   BARDON     58 CNTR
T     ASSUMED DS=DQ AND DELTA I=1/2 CRAWFORD   59 HBC
T      15     5.1       2.4      1.3   DARMON     62 FBC
T             5.3       0.6            FUJII      64 OSPK
T    1700     6.1       1.5      1.2   ASTBURY3   65 CNTR
T             5.15      0.14           DEVLIN     67 CNTR
T   L        (5.0)     (0.5)           LOWYS      67 HLBC
T      .4M    5.154     0.044          VOSBURGH   72 CNTR                   2/71
T   L   SUM OF PARTIAL DECAY RATES.
T          . . . . . . . . .
T   AVG       5.158     0.042    0.042  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T   STUDENT   5.158     0.046    0.045  AVG. USING STUDENT10(H/1.11) -- SEE TEXT
T   FIT       5.181     0.040  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                13  KOL PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      KOL INTO 3PIO                       TAU 0 PRIME    134+ 134+ 134
P2      KOL INTO PI+ PI- PIO                TAU 0          139+ 139+ 134
P3      KOL INTO PI MU NEUTRINO             KL MU3         139+ 105+  .0
P4      KOL INTO PI E NEUTRINO              KL E3          139+  .5+   0
P5      KOL INTO PI+ PI-                    KL PI+ PI-     139+ 139
P6      KOL INTO MU+ MU-                    KL 2MU         105+ 105
P7      KOL INTO E+ E-                      KL 2E           .5+  .5
P8      KOL INTO E MU                       KL EMU          .5+ 105
P9      KOL INTO TWO GAMMAS                 KL 2GAMMA        0+   0
P10     KOL INTO PI+ PI- GAMMA              KL PI+-G       139+ 139+   0
P11     KOL INTO PIO PIO                    KL 2PIO        134+ 134
P12     KOL INTO PI E NEU GAMMA             KL E3GAM       139+  .5+   0+   0
P13     KOL INTO PIO TWO GAMMAS             KL PI2GAMMA    134+   0+   0
P14     KOL INTO E+ E- GAMMA                KL 2EGAM        .5+  .5+   0
P15     KOL INTO MU+ MU- GAMMA              KL 2MUGAM      105+ 105+   0
P16     KOL INTO MU+ MU- PIO                KL 2MUPIO      105+ 105+ 134
P17     KOL INTO PI+ PI- E+ E-              KL 2PI2E       139+ 139+  .5+  .5
P18     KOL INTO PIO PI+- E-+ NEU           KL 2PIENEU     134+ 139+  .5+   0

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                NEUTRAL K CONSTRAINED FIT
          OVERALL FIT OF MEAN LIFE, WIDTHS AND BRANCHING
          RATIOS USES 62 DATA POINTS TO DETERMINE SIX                      2/76*
          QUANTITIES.  OVERALL FIT HAS CHI-SQUARED=67.7                    2/76*

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

	P 1	P 2	P 3	P 4	P 5	P11
P 1	.2140+-.0067					
P 2	-.4051	.1225+-.0019				
P 3	-.5365	.0677	.2710+-.0047			
P 4	-.6408	.0893	-.2416	.3896+-.0053		
P 5	-.2195	.5350	.0342	.0453	.0020+-.0001	
P11	.1476	-.0732	-.0938	-.1119	-.0396	.0009+-.0002

FITTED PARTIAL DECAY MODE RATES

The matrix below is the branching fraction matrix above, transformed into rate space; i.e., $G_i \equiv \Gamma_i = \Gamma_{total} P_i$, in appropriate units. In analogy to the matrix above, the diagonal elements are $G_i \pm \delta G_i$, where $\delta G_i = \sqrt{\langle \delta G_i \delta G_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta G_i \delta G_j \rangle / (\delta G_i \cdot \delta G_j)$. Note that, because of the error in Γ_{total}, the errors and correlations here are not directly derivable from those above.

	G 1	G 2	G 3	G 4	G 5	G11
G 1	.0413+-.0014					
G 2	-.2195	.0236+-.0004				
G 3	-.3386	.1977	.0523+-.0010			
G 4	-.3854	.2367	-.0345	.0752+-.0011		
G 5	-.1255	.5630	.1098	.1315	.0004+-.0000	
G11	.1569	-.0445	-.0644	-.0733	-.0254	.0002+-.0000

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                13  KOL DECAY RATES

W1      KOL INTO PIO PIO PIO (UNITS 10**6 SEC-1)          (G1)
W1       54    5.22     1.03     0.84  BEHR      66 HLBC   ASSUMES CP      8/66
W1           . . . . . . . . .
W1   FIT       4.13     0.14   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

W2      KOL INTO PI+ PI- PO (UNITS 10**6 SEC-1)            (G2)
W2       18    3.26     0.77           ANDERSON  65 HBC                    8/66
W2       14    1.4      0.4            FRANZINI  65 HBC                    6/66
W2      136    2.62     0.28     0.27  BEHR      66 HLBC   ASSUMES CP      8/66
W2       53    2.20     0.35           WEBBER    70 HBC    ASSUMES CP     10/71
W2       99    2.71     0.28           CHO       71 DBC    ASSUMES CP    . 4/71
W2   J   98   (2.5)    (0.3)           JAMES     71 HBC    ASSUMES CP      6/71
W2       50    2.12     0.33           MEISNER   71 HBC    ASSUMES CP     10/71
W2 J    180    2.35     0.20           JAMES     72 HBC    ASSUMES CP      1/73
W2      192    2.32     0.13     0.15  BALDOCEOL 75 HLBC   ASSUMES CP      1/76*
W2       IN THE OVERALL FIT THIS RATE IS WELL DETERMINED BY THE MEAN LIFE AN
W2       THE BRANCHING RATIO R2. FOR THIS REASON THE DISCREPANCY BETWEEN THE
W2       W2 MEASUREMENTS DOES NOT AFFECT THE SCALE FACTOR OF THE OVERALL FIT
W2 J     JAMES 72 IS A FINAL MEASUREMENT AND INCLUDES JAMES 71.           11/73
W2           . . . . . . . . .
W2   AVG       2.34     0.11     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
W2   STUDENT   2.35     0.10     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
W2   FIT       2.364    0.039  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                        (SEE IDECGRAM BELOW )
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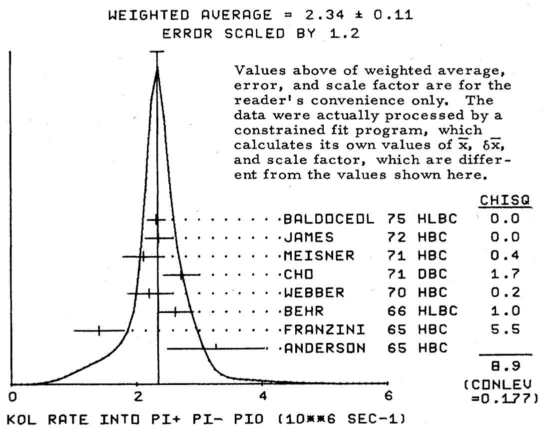
Data Card Listings

For notation, see key at front of Listings.

Stable Particles

K^0_L

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W3     KOL INTO PI E NEUTRINO (UNITS 10**6 SEC-1)          (G4)
W3            7.52     0.85     0.72  AUBERT     65 HLBC    DS=DQ,CP ASSUMED  8/67
W3     620    7.81     0.56           CHAN       71 HBC                      2/72
W3           . . . . . . . . .
W3  AVG       7.71     0.46     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W3  STUDENT   7.71     0.49     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
W3  FIT       7.52     0.11   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

W4     KOL INTO CHARGED (3-BODY) (UNITS 10**6 SEC-1)    (G2+G3+G4)
W4      98   15.1      1.9            AUERBACH  66 OSPK                      8/67
W4           . . . . . . . . .
W4  FIT      15.11     0.16   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

W5     KOL INTO LEPTONIC (KMU3+KE3) (UNITS 10**6 SEC-1) (G3+G4)
W5   D 109    9.85     1.15     1.05  FRANZINI   65 HBC                      2/72
W5  C  335  (10.3)    (0.8)           HILL       67 DBC     K+N TO KO P      8/67
W5   D 393   11.6      0.9            CHO        70 DBC     K+N TO KOP      10/70
W5   D 252   13.1      1.3            WEBBER     71 HBC     K- P TO KOBAR N  2/72
W5   D 410   12.4      0.7            BURGUN     72 HBC     K+P TO KOPPI+    1/73
W5   D 126    8.47     1.69           MANN       72 HBC     K- P TO KOBAR N  9/72
W5  C  CHO 70 INCLUDES EVENTS OF HILL 67
W5   D  ASSUMES DS=DQ RULE
W5           . . . . . . . . .
W5  AVG      11.60     0.65     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
W5  STUDENT  11.66     0.54     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
W5  FIT      12.75     0.15   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                       (SEE IDEOGRAM BELOW )
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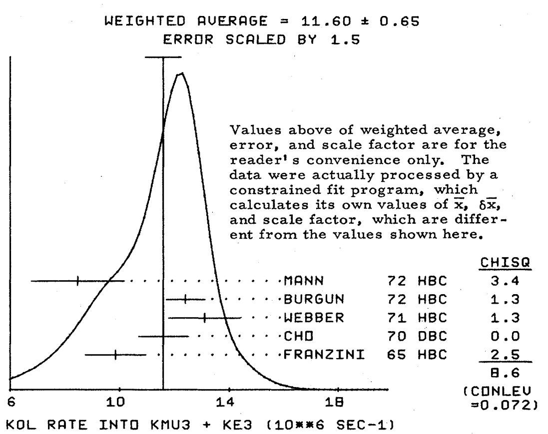


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W6     KOL INTO PI MU NEUTRINO UNITS 10**6 SEC-1)          (G3)
W6      19    4.54     1.24     1.08  LOWYS      67 HLBC                     8/67
W6           . . . . . . . . .
W6  FIT       5.230    0.099  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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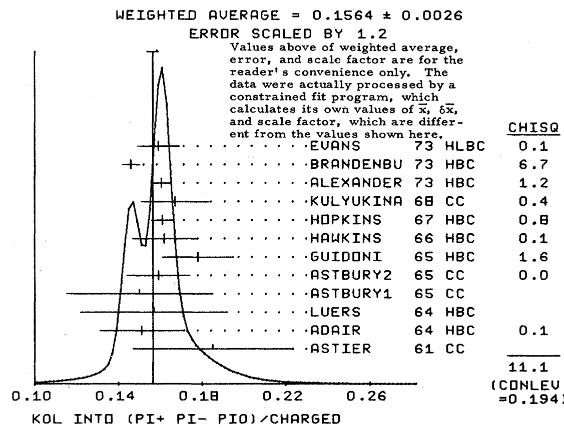
13 KOL BRANCHING RATIOS

```
R1     KOL INTO (PIO PIO PIO)/CHARGED                      (P1)/(P2+P3+P4)
R1      24    0.24     0.08           ANIKINA    64 CC                       6/66
R1     549    0.251    0.014          BUDAGOV    68 HLBC    ORSAY MEASUR.   10/68
R1     444    0.277    0.021          BUDAGOV    68 HLBC    EC. POLYTEC.MEAS 10/68
R1      29    0.31     0.07     0.06  KULYUKINA  68 CC                       2/71
R1           . . . . . . . . .
R1  AVG       0.260    0.011    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  STUDENT   0.2'0    0.013    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1  FIT       0.273    0.011  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)
```

```
R2     KOL INTO (PI+ PI- PIO)/CHARGED                      (P2)/(P2+P3+P4)
R2      59    0.185    0.038          ASTIER     61 CC                       8/66
R2      79    0.151    0.020          ADAIR      64 HBC                      8/66
R2      75    0.157    0.03     0.04  LUERS      64 HBC                      8/66
R2      66    0.15     0.03     0.04  ASTBURY1   65 CC                       8/66
R2     326    0.159    0.015          ASTBURY2   65 CC                       6/66
R2     566    0.178    0.017          GUIDONI    65 HBC                      6/66
R2    1729   (0.144)  (0.004)         HOPKINS    65 HBC     SEE HOPKINS 67   6/66
R2     126    0.162    0.015          HAWKINS    66 HBC                      6/66
R2            0.161    0.005          HOPKINS    67 HBC                      8/67
R2    1402    0.167    0.016          KULYUKINA  68 CC                       2/71
R2    1590    0.1605   0.0038         ALEXANDER  73 HBC                      1/74
R2    3200    0.146    0.004          BRANDENBU  73 HBC                      1/74
R2     558    0.159    0.010          EVANS      73 HLBC                     1/73
R2           . . . . . . . . .
R2  AVG       0.1564   0.0026   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R2  STUDENT   0.1578   0.0029   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2  FIT       0.1564   0.0022 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                       (SEE IDEOGRAM BELOW )
```

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R3     KOL INTO (PI MU NEUTRINO)/CHARGED                   (P3)/(P2+P3+P4)
R3  C  251  (0.356)  (0.07)           LUERS      64 HBC
R3  C  172  (0.39)   (0.08)   (0.10)  ASTBURY1   65 CC                       7/66
R3  C  330  (0.335)  (0.055)          KULYUKINA  68 CC                       2/71
R3  C THIS MODE NOT MEASUREC INDEPENDENTLY FROM R2 AND R4
R3           . . . . . . . . .
R3  FIT       0.3461   0.0051 FROM FIT

R4     KOL INTO (PI E NEUTRINO)/CHARGED                    (P4)/(P2+P3+P4)
R4      24    0.46     0.11           NEAGU      61 CC                       2/76*
R4     153    0.487    0.05           LUERS      64 HBC
R4     202    0.46     0.08     0.10  ASTBURY1   65 CC                       7/66
R4     500    0.498    0.052          KULYUKINA  68 CC                       2/71
R4           . . . . . . . . .
R4  AVG       0.485    0.032    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R4  STUDENT   0.485    0.034    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R4  FIT       0.4975   0.0052 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5     KOL INTO (PI E NEU)/((PI E NEU)+(PI MU NEU))        (P4)/(P3+P4)
R5     320    0.415    0.120          ASTIER     61 CC
R5           . . . . . . . . .
R5  FIT       0.5898   0.0059 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6     KOL INTO (PI+ PI- PIO)/TOTAL                        (P2)
R6
R6           . . . . . . . . .
R6  FIT       0.1225   0.0019 FROM FIT

R7     KOL INTO (LEPTON PI NEUTRINO)/TOTAL                 (P3+P4)
R7
R7           . . . . . . . . .
R7  FIT       0.6606   0.0062 FROM FIT

R8     KOL INTO (2 GAMMA)/TOTAL (UN. 10**-4)               (P9)
R8  C        (1.3)    (0.6)           CRIEGEE    66 OSPK                     8/66
R8      32    6.7      2.2            TODOROFF   67 OSPK    REPL.  CRIEGEE66 11/68
R8  K   33   (7.4)    (1.6)           CRONIN 1   67 OSPK                    11/67
R8      90    5.5      1.1            KUNZ       68 OSPK    NORM.TO 3PI(C+N) 2/71
R8      23    4.5      1.0            ENSTROM    71 OSPK    KOL 1.5-9 GEV/C  2/72
R8 R          5.0     (1.0)           REPELLIN   71 OSPK                    11/71
R8 B          4.54     0.84           BANNER2    72 OSPK                     8/72
R8 B   THIS VALUE USES (E00/E+-)**2=1.05+-0.14. IN GENERAL, S13R8 =          8/72
R8 B   (4.32+-0.55)*(10**-4)*((E00/E+-)**2).                                 8/72
R8 R   ASSUMES REGEN AMPL IN COPPER AT 2GEV IS 22  MB. TO EVALUATE          11/71
R8 R   FOR A GIVEN REGEN AMPL AND ERROR, MULTIPLY BY (REGEN AMPL/22MB)**2   11/71
R8  C     CRIEGEE 66 REPLACED BY TODOROFF 67                                11/68
R8  K     CRONIN1 67 REPLACED BY KUNZ 68.                                    2/71
R8           . . . . . . . . .
R8  AVG       4.89     0.54     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R8  STUDENT   4.88     0.59     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R9     KOL INTO (PI+ PI-)/CHARGED (UNIT 10**-3)            (P5)/(P2+P3+P4)
R9  O   45   (2.0)    (0.4)           CHRISTENS 64 OSPK ETA +- = 1.95+-0.20  2/76*
R9  O   54   (2.08)   (0.35)          GALBRAITH 65 OSPK ETA +- = 1.99+-0.16  2/76*
R9  O        (1.93)   (0.26)          BASILE    66 OSPK ETA +- = 1.92+-0.13. 2/76*
R9  O        (1.993)  (0.080)         BOTT-BODE 66 OSPK ETA +- = 1.95+-0.04  2/76*
R9  M 4200   (2.60)   (0.07)          MESSNER   73 ASPK ETA +- = 2.23+-0.05  6/73
R9  O   OLD EXPERIMENTS EXCLUDED FROM FIT.  SEE SUBSECTION E+- BELOW FOR     2/76*
R9  O   AVERAGE ETA+- OF THESE EXPERIMENTS AND FOR NOTE ON DISCREPANCY.      2/76*
R9  M   FROM SAME DATA AS R27 MESSNER 73,BUT WITH DIFFERENT NORMALIZATION.   6/73
R9           . . . . . . . . .
R9  FIT       2.565    0.J73  FROM FIT
```

Stable Particles

Data Card Listings

For notation, see key at front of Listings.

K^0_L

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R10     KOL INTO (PI MU NEU)/(PI E NEU)                          (P3)/(P4)
R10            0.81      0.19              ADAIR     64 HBC                          6/66
R10            0.82      0.10              DEBOUARD  67 OSPK                        11/67
R10     273    0.7       0.2               HAWKINS   67 HBC                          8/67
R10            0.81      0.08              HOPKINS   67 HBC                          8/67
R10     770    0.71      0.05              BUDAGOV   68 HLBC                        10/68
R10 K         (0.67)    (0.13)             KULYUKINA 68 CC                        . 3/74
R10 B  569    (0.71)    (0.04)             BEILLIERE 69 HLBC                      10/69
R10    1309   (0.648)   (0.030)            EVANS     69 HLBC REPL. BY EVANS 73    1/73
R10    3548    0.68      0.08              BASILE    70 OSPK                        10/70
R10    6700    0.741     0.044             BRANDENBU 73 HBC                          1/74
R10    1309    0.662     0.030             EVANS     73 HLBC                         1/73
R10     10K    0.662     0.037             WILLIAMS  74 ASPK                        10/74*
R10 K   KULYUKINA 68 R10 IS NOT MEASURED INDEPENDENTLY FROM R2 AND R4.               1/74
R10 B  BEILLIERE 69 IS A SCANNING EXPT USING SAME EXPOSURE AS BUDAGOV 68
R10           . . . . . . . . .
R10 AVG        0.695     0.019   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R10 STUDENT    0.695     0.021   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R10 FIT        0.696     0.017  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R11     KOL INTO (MU+MU-)/CHARGED (UNITS 10**-6)                 (P6)/(P2+P3+P4)
R11          100.0    OR LESS              ANIKINA   65 CC                           6/66
R11          250.0    OR LESS  CL=.90      ALFF-STEI 66 OSPK                         9/66
R11            2.0    OR LESS  CL=.90      BOTT-BODE 67 OSPK                         8/67
R11           35.0    OR LESS  CL=.90      FITCH     67 OSPK                         3/68

R12     KOL INTO (PI+ PI- GAMMA)/TOTAL (UNITS 10**-3)    (P10)
R12           15.0    OR LESS              ANIKINA   65 CC                           6/66
R12       0    5.0    OR LESS              BELLOTTI  66 HLBC   GAM KE 40-130 MV   8/67
R12       1    3.0    OR LESS              NEFKENS   66 OSPK   GAM KE 120 MEV      6/66
R12            0.4    OR LESS  CL=.90      THATCHER  68 OSPK   GAM KE 20-170 MV   2/71
R12            3.2    OR LESS  CL=.90      BOBISUT   74 HLBC   GAM KE GT 40 MEV  12/75*
R12  D  24     0.062     0.021             DONALDS1  74 SPEC                        10/74*
R12            0.46   OR LESS  CL=.90      WOO       74 SPEC                        12/75*
R12  D  USES KOL TO PI+PI-PIO/ALL KOL DECAYS = 0.126                                10/74*

R13     KOL INTO (E+ E-)/CHARGED (UNITS 10**-6)                  (P7)/(P2+P3+P4)
R13         1000.0    OR LESS              ANIKINA   65 CC                           6/66
R13          200.0    OR LESS  CL=.90      ALFF-STEI 66 OSPK                         6/66
R13           23.0    OR LESS  CL=.90      BOTT-BODE 67 OSPK                         8/67

R14     KOL INTO (E MU)/CHARGED (UNITS 10**-4)                   (P8)/(P2+P3+P4)
R14           10.0    OR LESS              ANIKINA   65 CC                           6/66
R14            1.0    OR LESS  CL=.90      CARPENTER 66 OSPK                         8/66
R14            0.1    OR LESS  CL=.90     'BOTT-BODE 67 OSPK                         8/67
R14            0.08   OR LESS  CL=.90      FITCH     67 OSPK                         3/68

R15     KOL INTO (E+ PI- NEU)/(E- PI+ NEU)
R15 O   97    (0.90)    (0.18)             NEAGU     61 CC
R15 O         (1.01)    (0.16)             LUERS     64 HBC                          8/66
R15 O  894    (0.99)    (0.023)            KULYUKINA 66 CC                           9/66
R15 O 1539    (1.06)    (0.05)             VERHEY    66 OSPK                         8/67
R15 O   LOW PRECISION EXPTS NOT AVERAGED.  FOR MORE PRECISE VALUE,
R15 O   SEE S13A2 (BENNETT 70, MARX 70)

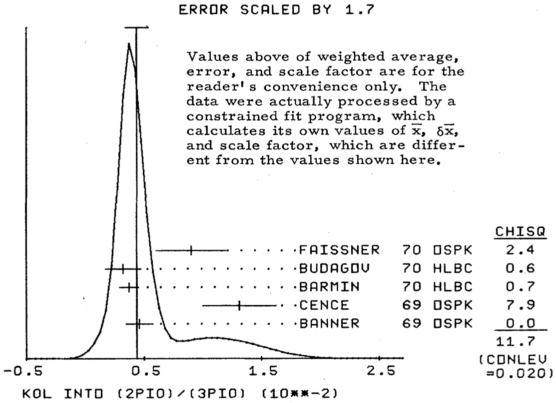
R16     KOL INTO (MU+ PI- NEU)/(MU- PI+ NEU)
R16      1M    1.0081    0.0027            DORFAN    67 OSPK                        11/67
R16       SEE ALSO S13A2 AND S13AL IN THE CP VIOLATION SECTION                       2/71

R17     KOL INTO (PIO PIO)/TOTAL (UNITS 10**-3)                  (P11)
R17 C    7    (1.2)     (1.5)      (1.2)   CRIEGEE   66 OSPK                         7/66
R17 C   CRIEGEE EXPT NOT DESIGNED TO MEASURE 2 PIO DECAY MODE
R17 G  189    (2.5)     (0.8)              GAILLARD  69 OSPK   E00=3.6+-0.6        5/69
R17 G   LATEST RESULT OF THIS EXPERIMENT GIVEN BY FAISSNER 70 R19                    1/71
R17           . . . . . . . . .
R17 FIT        0.94      0.19   FROM FIT

R18     KOL INTO (3PIO)/(PI+PI-PIO)                              (P1)/(P2)
R18     188    2.0       0.6               ALEKSANYA 64 FBC                          9/66
R18    1010    1.80      0.13              BUDAGOV   68 HLBC                        10/68
R18     883   (1.65)    (0.07)             BARMIN2   72 HLBC   ERROR STAT. ONLY   3/74
R18           . . . . . . . . .
R18 AVG        1.81      0.13    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R18 STUDENT    1.81      0.14    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R18 FIT        1.747     0.070  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R19     KOL INTO (2PIO)/(3PIO) (UNITS 10**-2)                    (P11)/(P1)
R19 C  109    (1.89)    (0.31)             CRONIN 1  67 OSPK   ETA00=4.9+-0.5      8/67
R19 C         (1.36)    (0.18)             CRONIN 2  67 OSPK   ETA00=3.92+-0.3    11/67
R19 C     CRONIN2 IS FURTHER ANALYSIS OF CRONIN1 ,NOW BOTH WITHDRAWN                11/68
R19      NO EVENTS SEEN                    BARTLETT  68 OSPK   SEE E00 BELOW      11/68
R19      57    0.46      0.11              BANNER    69 OSPK   ETA00=2.2+-0.3      2/72
R19     133    1.31      0.31              CENCE     69 OSPK   ETA00=3.7+-0.5     10/69
R19      29    0.37      0.08              BARMIN    70 HLBC   ETA00=2.02+-0.23  12/70
R19      30    0.32      0.15              BUDAGOV   70 HLBC   ETA00=1.9+-0.5     10/70
R19  F 172     0.90      0.30              FAISSNER  70 OSPK   ETA00=3.2+-0.5     12/70
R19  F FAISSNER 70 CONTAINS SAME 2PIO EVENTS AS GAILLARD 69 R17
R19           . . . . . . . . .
R19 AVG        0.439     0.098   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
R19 STUDENT    0.425     0.065   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R19 FIT        0.439     0.088  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)
                                (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.439 ± 0.098
ERROR SCALED BY 1.7

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R20     KOL INTO (PI+ PI-)/(KE3 + KMU3) (UNITS 10**-3)   (P5)/(P3+P4)
R20 O  309    (2.51)    (0.23)             DEBOUARD  67 OSPK   ETA+-=2.00+-0.09  2/76*
R20 O  525    (2.35)    (0.19)             FITCH     67 OSPK   ETA+-=1.94+-0.08  2/76*
R20 O   OLD EXPERIMENTS EXCLUDED FROM FIT.  SEE SUBSECTION E+- BELOW FOR         2/76*
R20 O   AVERAGE ETA+- OF THESE EXPERIMENTS AND FOR NOTE ON DISCREPANCY.          2/76*
R20           . . . . . . . . .
R20 FIT        3.041     0.090  FROM FIT

R21     KOL INTO (2GAMMA)/(3 PIO) (UNITS 10**-3)             (P9)/(P1)
R21      16    2.5       0.7               ARNOLD    68 HLBC   VACUUM DECAY       11/68
R21 $   BANNER 69 IS NEW EXPT. NOT TO BE CONF WITH R8 OF CRONIN1 67                  2/72
R21     115    2.24      0.28              BANNER    69 OSPK                        11/68
R21      28    2.13      0.43              BARMIN    71 HLBC                         8/71
R21           . . . . . . . . .
R21 AVG        2.24      0.22    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R21 STUDENT    2.24      0.24    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
```

Note on the $K^0_L \to \mu^+\mu^-$ Controversy

The $K^0_L \to \mu^+\mu^-$ branching ratio upper limit of CLARK 71 does not agree with the results of subsequent experiments.

A total of twelve examples of this decay have been observed in three experiments: CARITHERS1 73 (Columbia-CERN-NYU), CARITHERS2 73 (Columbia-BNL-CERN), and FUKUSHIMA 76 (Princeton-Univ. of Mass.-Amherst). Background from all sources (primarily from $K^0_L \to \pi\mu\nu$ with the pion either penetrating the muon counter or decaying to $\mu\nu$ in flight) has been estimated to be negligible for these experiments. The rates from these three experiments and the upper limits of FOETH 69 and DARRIULAT 70 are all quite consistent (see subsection R22 below). The combined result of these five experiments is

$$R = \frac{\Gamma(K^0_L \to \mu^+\mu^-)}{\Gamma(K^0_L \to \pi^+\pi^-)} = (5.0^{+1.6}_{-1.4}) \times 10^{-6} \ ,$$

where we have divided the observed number $(12^{+3.8}_{-3.3})$ by the sum of the effective denominators (which include the $\pi\pi/\mu\mu$ relative acceptances) given in the data card comments field.

CLARK 71 found no events and obtained the limit $R < 1.53 \times 10^{-6}$ at 90% confidence level. This result is from the FIELD 74 reanalysis of the experiment. The reanalysis uncovered no major flaws, but did find a few problems which increased the upper limit from 1.2×10^{-6} to the above. The combined result of the other five experiments leads us to expect 7.5 events for the sensitivity of the CLARK 71 experiment (9.5 events before reanalysis).

The theoretical lower limit for $\Gamma(K^0_L \to \mu^+\mu^-)/\Gamma(K^0_L \to \pi^+\pi^-)$ based on unitarity considerations is 3×10^{-6},[1] in agreement with the combined result, but above the CLARK 71 upper limit.

Data Card Listings
For notation, see key at front of Listings.

Stable Particles
K_L^0

In the Stable Particle Table we quote the above combined value, but warn in a footnote that the value does not include CLARK 71.

Reference

1. C. Quigg and J. D. Jackson, UCRL-18487 (1968).

```
R22     KOL INTO (MU+MU-)/(PI+PI-) (UNITS 10**-6)           (P6)/(P5)
R22       0  140.    OR LESS  CL=.90    FOETH      69 SPEC  EFF.DENOM.=  16000    5/70
R22       0  18.     OR LESS  CL=.90    DARRIULAT 70 SPEC  EFF.DENOM.= 125000   11/70
R22 A     0  (1.53) OR LESS  CL=.90    CLARK      71 SPEC  EFF.DENOM.(1500000)   2/76*
R22  C    6   6.7      6.1       3.1    CARITHE1   73 SPEC  EFF.DENOM.= 893000    2/76*
R22  C    3   4.5      6.        3.     CARITHE2   73 SPEC  EFF.DENOM.= 667000    2/76*
R22 C     9   (5.8)    (4.)      (2.)   CARITHE2   73 SPEC  EFF.DENOM.(1560000)   2/76*
R22  F    3   4.2      5.1       2.6    FUKUSHIMA 76 SPEC  EFF.DENOM.= 714000    2/76*
R22 A   CLARK 71 LIMIT RAISED FROM 1.2 E-06 BY FIELD 74 REANALYSIS.                 2/76*
R22 A   NOT IN AGREEMENT WITH THREE SUBSEQUENT EXPTS. SO NOT AVERAGED.              2/76*
R22  C  CARITHERS ERRORS ARE AT CL=90 PERCENT.  SECOND CARITHERS2 VALUE IS          2/76*
R22  C  AVERAGE OF CARITHERS1 73 VALUE AND FIRST CARITHERS2 73 VALUE.               2/76*
R22  F  FUKUSHIMA 76 ERRORS ARE AT CL=90 PERCENT.                                   2/76*
R22          . . . . . . . . .
R22      12   5.0      1.6       1.4    COMBINED (CL=.68) EFF.DENOM.=2415000      2/76*

R23     KOL INTO (E+ E- )/(PI+PI-) (UNITS 10**-5)           (P7)/(P5)
R23       0   10.0   OR LESS  CL=.90    FOETH      69 ASPK                          5/70
R23           0.10   OR LESS  CL=.90    CLARK      71 ASPK                          6/71

R24     KOL INTO (E MU)/(PI+PI-) (UNITS 10**-5)             (P8)/(P5)
R24           0.10   OR LESS  CL=.90    CLARK      71 ASPK                          6/71

R25     KOL INTO (PI E NEU GAM)/(KL E3) (UNITS 10**-2)      (P12)/(P3)
R25      10   3.3      2.0              PEACH      71 HLBC GAM KE GT 15 MEV        6/71

R26     KOL INTO (PIO TWO GAMMAS)/(3PIO) (UNITS 10**-3)     (P13)/(P1)
R26       0   1.1    OR LESS  CL=.90    BANNER     69 OSPK                          2/72

R27     KOL INTO (PI+ PI-)/TAU (UNITS 10**-2)               (P5)/(P2)               6/73
R27    4200   1.64     0.04             MESSNER    73 ASPK     ETA +- = 2.23       6/73
R27          . . . . . . . . .
R27 FIT       1.640    0.040  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R28     KOL INTO (E+ E- GAMMA)/(3PIO) (UNITS 10**-4)        (P14)/(P1)
R28       0   1.3    OR LESS  CL=.90    BARMIN1    72 HLBC                          3/74

R29     KOL INTO (MU+ MU- GAMMA)/TOTAL (UNITS 10**-6)       (P15)                  12/75*
R29           7.81   OR LESS  CL=.90    DONALDS3   74 SPEC                         12/75*

R30     KOL INTO (MU+ MU- PIO)/TOTAL     (UNITS 10**-5)     (P16)                  12/75*
R30           5.66   OR LESS  CL=.90    DONALDS3   74 SPEC                         12/75*

R31     KOL INTO (PI+PI-E+E-) /TOTAL     (UNITS 10**-6)     (P17)                  12/75*
R31           7.2    OR LESS  CL=.90    DONALDS3   74 SPEC                         12/75*

R32     KOL INTO (PIO PI+- E-+ NEU)/TOTAL (UNITS 10**-3) (P18)                     12/75*
R32           2.2    OR LESS  CL=.90    DONALDS3   74 SPEC                         12/75*
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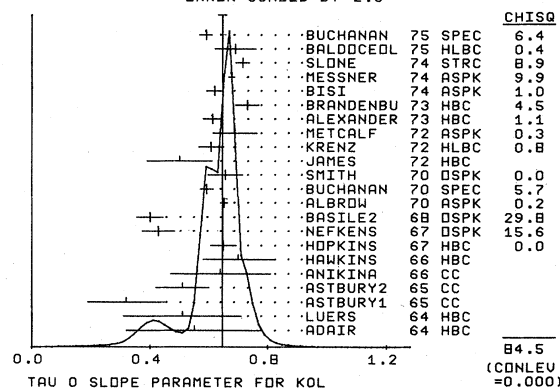
13 KOL ENERGY DEPENDENCE OF DALITZ PLOT

RELATED TEXT SECTION VI B.1, APPENDIX I, AND MINI-REVIEW ON SLOPE PARAMETERS IN THE CHARGED K SECTION OF THE DATA CARD LISTINGS ABOVE

MATRIX ELEMENT SQUARED = 1 + G (S3-S0)/(MPI+**2)

```
GTO  LINEAR ENERGY DEPENDENCE (G) FOR TAU DECAYS  KLONG INTO PI+ PI- PIO
GTO      79     0.55      0.23            ADAIR     64 HBC  AV=-7.6 +- 1.7       . 3/71
GTO      77     0.51      0.20            LUERS     64 HBC  AV=-7.3 +- 1.6         3/71
GTO      66     0.32      0.13            ASTBURY1  65 CC   AV=-5.5 +- 1.5         3/71
GTO     310     0.51      0.09            ASTBURY2  65 CC   AV=-(7.3 +.6 -.8)      3/71
GTO     280     0.64      0.17            ANIKINA   66 CC   AV=-(8.2 +.9 -1.3)     3/71
GTO     126     0.70      0.12            HAWKINS   66 HBC  AV=-8.6 +- 0.7         3/71
GTO    1350     0.649     0.044           HOPKINS   67 HBC  AT=-0.294 +- .018     10/69
GTO    1198     0.428     0.055           NEFKENS   67 OSPK AU=-0.204 +- .025      3/71
GTO    2446     0.400     0.045           BASILE2   68 OSPK AT=-0.188 +- .020      3/71
GTO   29000     0.651     0.012           ALBROW    70 ASPK AY=-0.862 +- .015      1/71
GTO   B 36K     0.593     0.022           BUCHANAN  70 SPEC AU=-0.278 +- .010      2/76*
GTO    4400     0.656     0.058           SMITH     70 OSPK AT=-0.297 +- .024      3/71
GTO     180     0.50      0.11            JAMES     72 HBC                         1/73
GTO    1486     0.608     0.043           KRENZ     72 HLBC AT=-0.277 +- .018     11/72
GTO     384     0.688     0.074           METCALF   72 ASPK AT=-0.31  +- .03      11/72
GTO             0.612     0.032           ALEXANDER 73 HBC                         2/76*
GTO    3200     0.73      0.04            BRANDENBU 73 HBC                         1/74
GTO   C 20K     0.619     0.027           BISI      74 ASPK AT=-0.282 +- .011     10/74*
GTO   M509K     0.677     0.010           MESSNER   74 ASPK AY=-0.917+-.013        7/75*
GTO   S         0.714     0.023           SLONE     74 STRC                       12/75*
GTO     192     0.69      0.07            BALDOCEOL 75 HLBC                       12/75*
GTO     56K     0.590     0.022           BUCHANAN  75 SPEC AU=-0.277 +- .010      7/75*
GTO  B  BUCHANAN 70 RESULT REVISED BY BUCHANAN 75 TO INCLUDE RADIATIVE COR.  2/76*
GTO  B  AND TO USE MORE RELIABLE KL MOM.SPECT. OF 2ND EXPT.(HAD SAME BEAM).  2/76*
GTO  C  BISI 74 VALUE COMES FROM QUADRATIC FIT WITH QUAD. TERM CONSISTENT   11/75*
GTO  C  WITH ZERO.  GTO ERROR IS THUS LARGER THAN IF LINEAR FIT WERE USED.  11/75*
GTO  M  MESSNER 74 FINDS NONLINEAR TERMS H=.079+-.007, J=0, K=.0097+-.0018.  1/76*
GTO  S  SLONE 74 VALUE IS FROM A FIT TO A LINEAR MATRIX ELEMENT, NOT TO A   12/75*
GTO  S  LINEAR SPECTRUM.  HIS FIT TO A LINEAR SPECTRUM GIVES                12/75*
GTO  S  GTO=0.630+-0.017 WITH A POOR CHI-SQUARED.                           12/75*
GTO          . . . . . . . . .
GTO AVG         0.646     0.014   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.5)
GTO STUDENT     0.6462    0.0095  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                                  (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.646 ± 0.014
ERROR SCALED BY 2.5



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13 KOL FORM FACTORS

RELATED TEXT SECTION VI B.2 AND MINI-REVIEW ON FORM FACTORS IN THE CHARGED K SECTION OF THE DATA CARD LISTINGS ABOVE.

IN THE FORM FACTOR COMMENTS, THE FOLLOWING ABBREVIATIONS ARE USED.
F+ AND F- ARE FORM FACTORS FOR THE VECTOR MATRIX ELEMENT.
FS AND FT REFER TO THE SCALAR AND TENSOR TERM.
FO = (F+) + (F-)*T/(MK**2-MPI**2)
L+, L- AND LO ARE THE LINEAR EXPANSION COEFFS. OF F+, F- AND FO.
L+ REFERS TO THE KMU3 VALUE EXCEPT IN THE KE3 SECTIONS.
DXI/DL IS THE CORRELATION BETWEEN XI(0) AND L+ IN KMU3.
DLO/DL+ IS THE CORRELATION BETWEEN LO AND L+ IN KMU3.
T = MOMENTUM TRANSFER TO THE PI IN UNITS OF MPI**2.
DP = DALITZ PLOT ANALYSIS
PI = PI SPECTRUM ANALYSIS
MU = MU SPECTRUM ANALYSIS
POL= MU POLARIZATION ANALYSIS
BR = KMU3/KE3 BRANCHING RATIO ANALYSIS
E = POSITRON OR ELECTRON SPECTRUM ANALYSIS
RC = RADIATIVE CORRECTIONS

```
XIA    XIA = F-/F+ (DETERMINED FROM SPECTRA)   ---------------------------
XIA  L1341    +1.2     (0.8)              CARPENTER 66 OSPK    DP, DXI/DL=-18     1/74
XIA B 3140   (-3.9)    (0.4)              BASILE    70 OSPK    DP, INDEP OF L+    1/74
XIA C  16K  (-0.68)    (0.12)    (0.20)  CHIEN     70 ASPK    DP, DXI/DL=-26     1/74
XIA  A9086    -1.5      0.7               ALBROW    72 ASPK    DP, DXI/DL=-28     1/74
XIA C  16K  (+0.50)    (0.61)             DALLY     72 ASPK    DP, DXI/DL UNKN.   1/74
XIA  P1385    -1.00    (0.45)             PEACH     73 HLBC    DP, DXI/DL=-20     1/74
XIA  D 82K    -0.26     0.21              ALBRECHT  74 WIRE    DP, DXI/DL=-24    11/75*
XIA D  82K   (-2.41)   (0.17)             ALBRECHT  74 WIRE    DP, DXI/DL=-9.4   11/75*
XIA  E1.6M    -0.11     0.07              DONALDS2  74 SPEC    DP, DXI/DL=-17    11/75*
XIA  F 32K    -0.25     0.22              BUCHANAN  75 SPEC    DP, DXI/DL=-5.9    2/76*
XIA  L  CARPENTER 66 XI(O) IS FOR L+=0.  DXI/DL IS FROM FIG. 9.               1/74
XIA B   BASILE 70 IS INCOMPATIBLE WITH ALL OTHER RESULTS.  AUTHORS SUGGEST     1/74
XIA B   THAT EFFICIENCY ESTIMATES MIGHT BE RESPONSIBLE.                        1/74
XIA  A  ALBROW 72 FIT HAS L- FREE, GETS L-=-.030+-.060 OR LAM=+.15+.17-.11.   1/74
XIA C   CHIEN 70 ERRORS ARE STATISTICAL ONLY.  DXI/DL FROM FIG.4.              1/74
XIA  C  DALLY 72 IS A REANALYSIS OF CHIEN 70.  THE DALLY 72 RESULT IS          1/74
XIA  C  NOT COMPATIBLE WITH ASSUMPTION L-=0 SO NOT INCLUDED IN OUR FIT.        2/76*
XIA  C  THE NON-ZERO L- VALUE AND THE RELATIVELY LARGE L+ VALUE FOUND BY       1/74
XIA  C  DALLY 72 COME MAINLY FROM A SINGLE LOW T BIN (FIGS.1,2).               1/74
XIA  C  THE (F+,XI) CORRELATION WAS IGNORED.                                   1/74
XIA  C  WE ESTIMATE FROM FIG. 2 THAT FIXING L-=0 WOULD GIVE XI(0)=-1.4+-0.3    1/74
XIA  C  AND WOULD ADD 10 TO CHI SQUARED.  DXI/DL IS NOT GIVEN.                 1/74
XIA  D  ALBRECHT 74 IS CALCULATED BY US FROM LO, L+ AND DLO/DL+.  THEY FIND  11/75*
XIA  D  TWO SOLUTIONS.  THE FIRST HAS L+=.046+-.008 IN AGREEMENT WITH KE3.     3/74
XIA  P  PEACH 73 GIVES XIO=-.95+-.45 FOR L+=L-=.025 .  THE ABOVE VALUE IS      1/74
XIA  P  FOR L-=0.  K.PEACH, PRIVATE COMMUNICATION(1974).                       1/74
XIA  E  DONALDSON2 74 GIVES XI=-.11+-.02 NOT INCLUDING SYSTEMATICS.  ABOVE   11/75*
XIA  E  ERROR AND DXI/DL WERE CALCULATED BY US FROM LO AND L+ ERRORS (WHICH  11/75*
XIA  E  INCLUDE SYSTEMATICS) AND DLO/DL+.                                    11/75*
XIA  F  BUCHANAN 75 IS CALCULATED BY US FROM LO, L+ AND DLO/DL+ BECAUSE       2/76*
XIA  F  THEIR APPENDIX A VALUE -.20+-22 ASSUMES XI(T) CONSTANT, I.E. L-=L+.   2/76*
XIA          . . . . . . . . .
XIA FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS IN K+- SECTION OF DATA CARDS.

XIB    XIB = F-/F+ (DETERMINED FROM KMU3/KE3)   ---------------------------
XIB     THE KMU3/KE3 BRANCHING RATIO FIXES A RELATIONSHIP BETWEEN XI(0)        1/74
XIB     AND L+.  WE QUOTE THE AUTHORS XI(0) AND ASSOCIATED L+ BUT DO NOT       1/74
XIB     AVERAGE BECAUSE THE L+ VALUES DIFFER.  THE FIT RESULT AND SCALE        1/74
XIB     FACTOR GIVEN IN THE NOTE ON KL3 FORM FACTORS IN THE K+- SECTION OF     2/76*
XIB     THE DATA CARDS ARE NOT OBTAINED FROM THESE XIB VALUES.  INSTEAD        2/76*
XIB     THEY ARE OBTAINED DIRECTLY FROM THE FITTED KMU3/KE3 RATIO (R10).       2/76*
XIB    389    +1.1      1.1               ADAIR     .64 HBC    BR, L+=0           1/74
XIB           +0.66     0.9      1.3      LUERS      64 HBC    BR, L+=0           1/74
XIB           +0.2      0.8      1.2      KULYUKINA  68 CC     BR, L+=0         . 1/74
XIB    569    +0.45     0.28              BEILLIERE  69 HLBC   BR, L+=0           1/74
XIB E 1309   (-0.22)   (0.30)             EVANS      69 HLBC   BR, L+=.02+-.015   1/74
XIB   3548    -0.5      0.5               BASILE     70 OSPK   BR, L+=.02         1/74
XIB   6700     0.5      0.4               BRANDENBU  73 HBC    BR,L+=.019+-.013   1/74
XIB  E1309    -0.08     0.25              EVANS      73 HLBC   BR, L+=.02         1/74
XIB  E  EVANS 73 REPLACES EVANS 69.                                            1/74
XIB          . . . . . . . . .
XIB FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS IN K+- SECTION OF DATA CARDS.
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Stable Particles

K^0_L

Data Card Listings
For notation, see key at front of Listings.

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XIC     XIC = F-/F+ (DETERMINED FROM MU POLARIZATION IN KMU3)   ------------
XIC     THE MU POLARIZATION IS A MEASURE OF XI(T). NO ASSUMPTIONS ON L+-
XIC     NECESSARY, T (WEIGHTED BY SENSITIVITY TO XIO) SHOULD BE SPECIFIED.
XIC     IN L+,XI(0) PARAMETERIZATION THIS IS XI(0) FOR L+=0.  DXI/DL=XI*T.
XIC      FOR RAD. CORR. TO MUON POLARIZATION IN KMU3, SEE GINSBERG 73.      2/72
XIC T 2608  (-1.2)    (0.5)              AUERBACH  66 OSPK    POLARIZATION       8/67
XIC T  638  (-1.6)    (0.5)              ABRAMS    68 OSPK    POLARIZATION       5/69
XIC  L       -1.81     0.50      0.26    LONGO     69 CNTR    POL. T=3.3         1/74
XIC  S2.2M  -0.385     0.105             SANDWEISS 73 CNTR    POL,DXI/DL=-6      1/74
XIC  H350K  +0.178     0.105             SHEN      75 SPEC    POL,DXI/DL=+.68    1/76*
XIC T   T VALUE NOT GIVEN.                                                       1/74
XIC  L  LONGO 69 T=3.3 CALC. FROM DXI/DL=-6.0 (TABLE 1) DIVIDED BY XI=-1.81      1/74
XIC  S  SANDWEISS 73 IS FOR L+=0 AND T=0.                                        1/74
XIC  H  SHEN 75 T=+3.80, DXI/DL=XT*T=.178*3.80=+.68 .                            1/76*
XIC          . . . . . . . . .
XIC FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS IN K+- SECTION OF DATA CARDS.

IXI        IMAGINARY PART OF XI  (TEST OF T REVERSAL)  -------------------
IXI          -0.2       0.6                ABRAMS    68 OSPK    POLARIZATION      10/69
IXI          -0.02      0.08               LONGO     69 CNTR    POL. T=3.3        11/69
IXI    2.2M  -0.060     0.045              SANDWEISS 73 CNTR    POL, T=0           1/74
IXI          . . . . . . . . .
IXI AVG      -0.051     0.039   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
IXI STUDENT  -0.051     0.042   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

L+M     LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KMU3 DECAY)   ---------
L+M      SEE ALSO THE CORRESPONDING ENTRIES AND NOTES IN SECTION XIA AND LO.
L+M      FOR RAD.COR. OF KMU3 DP SEE GINSBURG 70 AND BECHERRAWY 70.              3/74
L+M C  16K   (0.07)    (0.02)            CHIEN     70 ASPK    DP                 1/74
L+M  A9086    0.085     0.015            ALBROW    72 ASPK    DP                 1/74
L+M C  16K   (0.11)    (0.04)            DALLY     72 ASPK    DP                 1/74
L+M  D 82K    0.046     0.008            ALBRECHT  74 WIRE    DP                11/75*
L+M D  82K   (0.076)   (0.004)           ALBRECHT  74 WIRE    DP                11/75*
L+M   1.6M    0.030     0.003            DONALDS2  74 SPEC    DP                10/74*
L+M    32K    0.046     0.030            BUCHANAN  75 SPEC    DP                 9/75*
L+M C   CHIEN 70 VALUE AND ERROR HAVE BEEN CHANGED FROM 0.08 +- 0.01 TO          3/71
L+M C   INCLUDE SYSTEMATIC EFFECTS. DALLY 72 IS A REANALYSIS OF CHIEN 70.        3/71
L+M C   SEE NOTE IN SECTION XIA.                                                 1/74
L+M  D  ALBRECHT 74 FINDS TWO SOLUTIONS.  THE FIRST AGREES WITH KE3.            11/75*
L+M          . . . . . . . . .
L+M FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS IN K+- SECTION OF DATA CARDS.

LO      LAMBDA O (LINEAR ENERGY DEPENDENCE OF FO IN KMU3 DECAY)   ----------
LO       WHEREVER POSSIBLE, WE HAVE CONVERTED THE ABOVE VALUES OF XI(0) INTO
LO       VALUES OF LO USING THE ASSOCIATED L+M AND DXI/DL.
LO L  1371   +0.10     (0.07)            CARPENTER 66 OSPK   DP,DLO/DL+=-0.54  1/74
LO L         -0.155    (0.043)  (0.022)LONGO      69 CNTR   POL,DLO/DL+=+.49  1/74
LO  B 3140  (-0.333)   (0.034)           BASILE    70 OSPK   DP,DLO/DL+=+1.    1/74
LO A  9086   -0.043     0.052            ALBROW    72 ASPK   DP,DLO/DL+=-1.39  1/74
LO  C  16K  (-0.067)   (0.227)           DALLY     72 ASPK   DP,DLO/DL+ UNKN.  1/74
LO  R 6700  (+0.06)    (0.03)            BRANDENBU 73 HBC    BR,L+=.019+-.013  1/74
LO P  1385   -0.060    (0.038)           PEACH     73 HLBC   DP,DLO/DL+=-0.71  1/74
LO L  2.2M   -0.033    (0.009)           SANDWEISS 73 CNTR   POL,DLO/DL+=+.49  1/74
LO   D 82K   +0.024     0.011            ALBRECHT  74 WIRE   DP,DLO/DL+=-1.06 11/75*
LO  D  82K  (-0.130)   (0.014)           ALBRECHT  74 WIRE   DP,DLO/DL+=+0.20 11/75*
LO E 1.6M     0.019     0.004            DONALDS2  74 SPEC   DP,DLO/DL+=-0.47 10/74*
LO   F 32K   +0.025     0.019            BUCHANAN  75 SPEC   DP,DLO/DL+=+0.5   2/76*
LO L  350K   +0.015    (0.009)           SHEN      75 SPEC   POL,DLO/DL+=1.06  1/76*
LO L    LO VALUE IS FOR L+=0.  CALCULATED BY US FROM XIO AND DXI/DL.            1/74
LO  B   BASILE 70 LO IS FOR L+=0.  CALCULATED BY US FROM XIA WITH DXI/DL=0.     1/74
LO  B   BASILE 70 IS INCOMPATIBLE WITH ALL OTHER RESULTS.  AUTHORS SUGGEST      1/74
LO  B   THAT EFFICIENCY ESTIMATES MIGHT BE RESPONSIBLE.                         1/74
LO A    ALBROW 72 LO IS CALCULATED BY US FROM XIA,L+ AND DXI/DL.  THEY GIVE     1/74
LO A    LO=-.043+-.039 FOR L-=0.  WE USE OUR LARGER CALCULATED ERROR.           1/74
LO  C   DALLY 72 GIVES FO=1.20+-.35, LO=-.080+-.272, LOPRIME=-.006+-.045,       1/74
LO  C   BUT WITH A DIFFERENT DEFINITION OF LO.  OUR QUOTED LO IS HIS LO/FO.     1/74
LO  C   WE CANNOT CALCULATE TRUE LO ERROR WITHOUT HIS (LO,FO) CORRELATIONS.     1/74
LO  C   SEE ALSO NOTE C IN SECTION XIA.                                         1/74
LO P    PEACH 73 ASSUMES L+=0.025.  CALCULATED BY US FROM XIO AND DXIO/DL+.     1/74
LO  R   FIT FOR LO DOES NOT INCLUDE THIS VALUE BUT INSTEAD INCLUDES THE         2/76*
LO  R   KMU3/KE3 RESULT FROM THIS EXPERIMENT.                                   2/76*
LO   D  ALBRECHT 74 FINDS TWO SOLUTIONS.  THE FIRST HAS L+=.046+-.008 IN       11/75*
LO   D  AGREEMENT WITH KE3.  DLO/DL+ OBTAINED FROM FIG.2C.
LO E    DONALDSON2 74 DLO/DL+ OBTAINED FROM FIG. 18.                           11/75*
LO   F  BUCHANAN 75 VALUE IS FROM THEIR APPENDIX A AND USES ONLY KMU3 DATA.    2/76*
LO   F  DLO/DL+ WAS OBTAINED BY PRIVATE COMMUNICATION, C.BUCHANAN, 1976.       2/76*
LO           . . . . . . . . .
LO  FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS IN K+- SECTION OF DATA CARDS.

L+E      LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KO E3 DECAY)   ------
L+E      FOR RAD.COR. OF KE3 DP SEE GINSBURG 67 AND BECHERRAWY 70.               3/74
L+E    153   +0.07      .06               LUERS     64 HBC    DP, NO RC
L+E    577   +0.15      .08               FISHER    65 OSPK   DP, NO RC          8/67
L+E    762   -0.01      .02               FIRESTONE 67 HBC    DP, NO RC          8/67
L+E    531   +0.01      .015              KADYK     67 HBC    E,PI, NO RC        8/67
L+E    240   +0.08      .10       .08     LOWYS     67 FBC    PI, USES RC        8/67
L+E   1000    0.02     0.013              ARONSON   68 OSPK   PI                 5/69
L+E   4800   +0.023    0.012              BASILE    68 OSPK   DP, NO RC          3/68
L+E    42K    0.023    0.005              BISI      71 ASPK   DP, USES RC       12/71
L+E    16K    0.05     0.01               CHIEN     71 ASPK   DP, NO RC          6/71
L+E   1910    0.022    0.014              NEUHOFER  72 ASPK   PI, USES RC        1/73
L+E   5600    0.045    0.014              ALBROW    73 ASPK   DP, USES RC        9/73
L+E   1871    0.019    0.013              BRANDENBU 73 HBC    PI TRANSV., RC     1/74
L+E Z 500K   (0.031)  (0.0025)            GJESDAL   73        DP                 3/74
L+E   2171    0.040    0.012              WANG      74 OSPK   DP, USES RC        7/74*
L+E    25K    0.0270   0.0028             BLUMENTHA 75 SPEC   DP                 7/75*
L+E    24K    0.044    0.006              BUCHANAN  75 SPEC   DP, USES RC        7/75*
L+E Z   PRELIMINARY.                                                             3/74
L+E          . . . . . . . . .
L+E AVG       0.0288   0.0028  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
L+E STUDENT   0.0280   0.0024  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                               (SEE IDEOGRAM BELOW )

FS      FS/F+  RATIO OF SCALAR TO F+ COUPLINGS FOR KE3 DECAY(ABS. VALUE)----
FS             0.15  OR LESS  CL=.68   KULYUKINA 67 CC                          10/69
FS     5600    0.19  OR LESS  CL=.95   ALBROW    73 ASPK                         9/73
FS      25K    0.04  OR LESS  CL=.68   BLUMENTHA 75 SPEC                         7/75*

FT      FT/F+  RATIO OF TENSOR TO F+ COUPLINGS FOR KE3 DECAY(ABS. VALUE)----
FT             1.0   OR LESS  CL=.68   KULYUKINA 67 CC                          10/69
FT     5600    1.0   OR LESS  CL=.95   ALBROW    73 ASPK                         9/73
FT      25K    0.23  OR LESS  CL=.68   BLUMENTHA 75 SPEC                         7/75*

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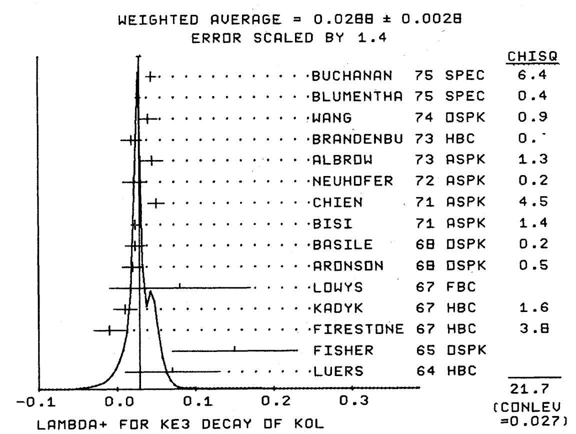


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                  13   CP VIOLATION PARAMETERS IN KOL DECAYS

      RELATED TEXT SECTION VI B.3 AND MINI-REVIEW BELOW

--------------------13 CHARGE ASYMMETRY IN TAU DECAYS---------------------
TEXT SECTION VI B.3 B

     SEE SCRIBANO 70 FOR DEFINITION (HIS SIGMA+-). A=1 FOR MAX ASYMMETRY
     (M)**2 = 1+ SIG+- (2/SQRT(3) *((T+)-(T-))/ TMAX)  AS SCRIBANO 70

A      DECAY ASYMMETRY PARAMETER FOR PI+ PI- PIO   (UNITS 10**-2)
A       .3M    0.2       0.95            BLANPIED  68 CNTR                 . 4/70
A        3M    0.27      0.2             SCRIBANO  70 CNTR                 .12/70
A      4400    0.000     0.050           SMITH     70 OSPK                 .10/70
A              . . . . . . . . .
A     AVG      0.016     0.063   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
A     STUDENT  0.015     0.053   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                                 (SEE IDEOGRAM BELOW )
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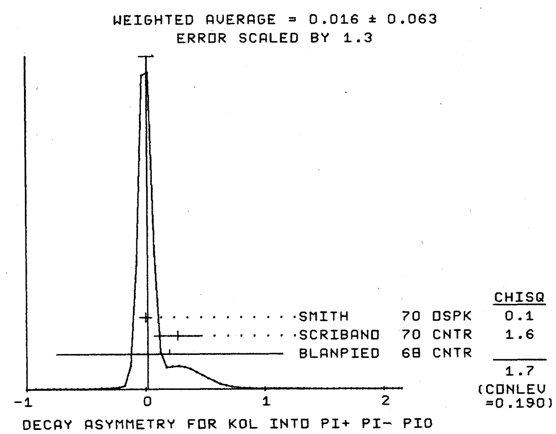


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--------------------13  CHARGE ASYMMETRY IN LEPTONIC DECAYS (PERCENT)------
TEXT SECTION VI B.3 C

      SUCH ASYMMETRY VIOLATES CP . IT IS RELATED TO REAL(EPSILON).

A1     KOL INTO (MU+PI-NU)-(MU-PI+NU)/(MU+PI-NU)+(MU-PI+NU)     (PERCENT)
A1  D   1M    (0.403)  (0.134)         DORFAN    67 OSPK   DERIVED FROM R16 11/67
A1 D    1M     0.57     0.17           PACIOTTI  69 OSPK                     1/73
A1     7.7M    0.278    0.051          PICCIONI  72 ASPK                     1/73
A1     4.1M    0.60     0.14           MCCARTHY  73 CNTR                     6/73
A1      15M    0.313    0.029          GEWENIG1  74 ASPK                     7/74*
A1 D     PACIOTTI 69 IS A REANALYSIS OF DORFAN 67 AND IS CORRECTED FOR       1/73
A1 D     MU+ MU- RANGE DIFFERENCE IN MC CARTHY 72.                           1/73
A1            . . . . . . . . .
A1  AVG        0.319    0.038   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
A1  STUDENT    0.316    0.027   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

A2     KOL INTO (E+PI-NU)-(E-PI+NU)/(E+PI-NU)+(E-PI+NU)         (PERCENT)
A2  B  10M    (0.224)  (0.036)         BENNETT   67 CNTR                    11/67
A2 B   10M     0.246    0.059          SAAL      69 CNTR                    10/70
A2     10M     0.346    0.033          MARX      70 CNTR                    10/70
A2    600K     0.36     0.18           ASHFORD   72 ASPK                     2/72
A2     40M     0.318    0.038          FITCH     73 ASPK                    12/73
A2     34M     0.341    0.018          GEWENIG1  74 ASPK                     7/74*
A2  B SAAL 69 IS A REANALYSIS OF BENNETT 67
A2            . . . . . . . . .
A2  AVG.       0.333    0.014   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A2  STUDENT    0.334    0.016   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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Data Card Listings

Stable Particles

For notation, see key at front of Listings. K_L^0

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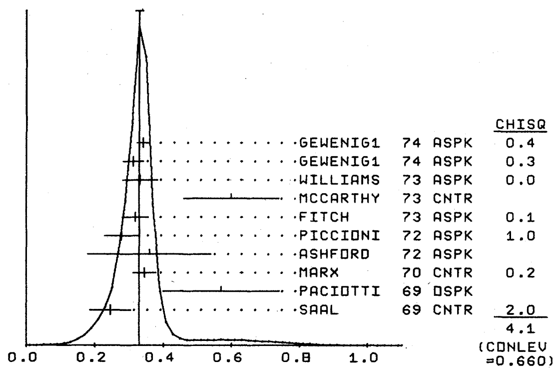
AL       KOL  INTO ((L+)-(L-))/((L+)+(L-))  (COMBINED A1 AND A2) (PERCENT)
AL B    10M     0.246     0.059           SAAL      69 CNTR    KE3              2/71
AL D     1M     0.57      0.17            PACIOTTI  69 OSPK    KMU3             1/73
AL      10M     0.346     0.033           MARX      70 CNTR    KE3              2/71
AL     600K     0.36      0.18            ASHFORD   72 ASPK    KE3              2/72
AL     7.7M     0.278     0.051           PICCIONI  72 ASPK    KMU3             1/73
AL      40M     0.318     0.038           FITCH     73 ASPK    KE3             12/73
AL     4.1M     0.60      0.14            MCCARTHY  73 CNTR    KMU3             6/73
AL      33M     0.333     0.050           WILLIAMS  73 ASPK    KMU3+KE3        12/73
AL      15M     0.313     0.029           GEWENIG1  74 ASPK    KMU3             7/74*
AL      34M     0.341     0.018           GEWENIG1  74 ASPK    KE3              7/74*
AL        SEE FOOTNOTES IN SECTIONS A1 AND A2 ABOVE.                            1/73
AL              . . . . . . . . .
AL  AVG         0.330     0.012    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
AL  STUDENT     0.330     0.013    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                          (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.330 ± 0.012
ERROR SCALED BY 1.0



CHARGE ASYMMETRY FOR KOL INTO LEPTONS

```
--------------------13  PARAMETERS FOR KOL INTO 2PI DECAY------------------
TEXT SECTION VI B.3 D

     ETA+- = A(KL TO PI+PI-)/A(KS TO PI+PI-)
     ETA00 = A(KL TO PIOPIO)/A(KS TO PIOPIO)
```

Note on $|\eta_{+-}|$

There is a very large discrepancy between old and new results for $|\eta_{+-}|$, the ratio of amplitudes $A(K_L^0 \to \pi^+\pi^-)/A(K_S^0 \to \pi^+\pi^-)$. The average of the older $|\eta_{+-}|$ results of CHRISTENSON 64, GALBRAITH 65, BASILE 66, BOTT-BODENHAUSEN 66, DE BOUARD 67, and FITCH 67 (see subsections R9, R20, and E+- of the K_L^0 Data Card Listings) is

$$|\eta_{+-}| = (1.95 \pm 0.03) \times 10^{-3}$$

with very good consistency.

In 1973 a CERN-Heidelberg K_L^0,K_S^0 interference experiment and a Colorado-SLAC-Santa Cruz branching ratio measurement gave the following results:

$$|\eta_{+-}| = (2.30 \pm 0.035) \times 10^{-3} \quad \text{GEWENIGER2 74,}$$

$$|\eta_{+-}| = (2.23 \pm 0.05\ ) \times 10^{-3} \quad \text{MESSNER 73,}$$

which are around 11 standard deviations above the previous average but are in good agreement with each other. GEWENIGER2 74 also made a check measurement in order to confirm their interference result by measuring the branching ratio $K_L^0 \to \pi^+\pi^-/K_L^0 \to \pi e\nu$. They obtained the result $|\eta_{+-}| = (2.30 \pm 0.06)\times 10^{-3}$, which, although systematically less reliable than the interference result, is in good agreement with it. A Columbia experiment[1] and two Chicago experiments (Cronin group[2] and Telegdi group[3]) have also yielded unpublished measurements which corroborate the higher values of $|\eta_{+-}|$.

The origin of the discrepancy between old and new results is not known. The effect of the change in the K_S^0 mean life value (see note in K_S^0 section of the Stable Particle Data Card Listings) is insufficient to explain it, raising $|\eta_{+-}|$ by only about 2%. The MESSNER 73 result above was evaluated for the old K_S^0 mean life and branching fractions for $K_S^0 \to \pi^+\pi^-$ and $K_L^0 \to \pi^+\pi^-\pi^0$. The new K_S^0 mean life and the current branching fractions increase the MESSNER 73 $|\eta_{+-}|$ value slightly to $(2.246 \pm 0.032) \times 10^{-3}$.

We are troubled by this large unexplained discrepancy. We feel that our normal procedure of averaging and increasing the error by a scale factor S to account for the discrepancy is not adequate for this case. The two new results, when combined with the average of the earlier results by that procedure, give 2.15 ± 0.11 $(S = 6.0)$. While this value-and-error makes some sense in that it nearly spans both incompatible sets of data, we choose not to quote it. Instead, since the newer experiments are in principle superior (higher statistics, better acceptance, easier trigger conditions), we have chosen to average them separately from the earlier experiments as is seen in the E+- subsection of the Data Card Listings below.

The entry referenced as GKL/GKS 71 is the average of all seven experiments before 1971. This average is determined from the branching ratios quoted for these experiments in subsections R9 and R20 above. It was quoted by us as the $|\eta_{+-}|$ value in our 1971 edition. The average and fit values at the end of the E+- subsection below do not include

Stable Particles

K_L^0

Data Card Listings

For notation, see key at front of Listings.

the pre-1971 $|\eta_{+-}|$ results. The reader may thus utilize the pre-1971 and post-1971 results as desired.

The fitted values in the EOS, E+-, and ER subsections below are the result of a fit to the unparenthesized values of $|\eta_{00}|$, $|\eta_{+-}|$, and $|\eta_{00}/\eta_{+-}|$ in these subsections. We quote the fitted values of $|\eta_{+-}|$ and $|\eta_{00}|$ in the Addendum to the Stable Particle Table but warn in a footnote that they exclude pre-1971 $|\eta_{+-}|$ results.

See also D. Nygren's "Review of K^0 Decays"[4] for additional discussion of this and other K^0 controversies.

References

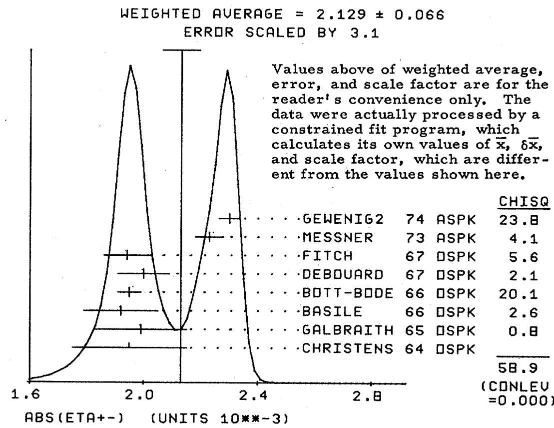
1. D. R. Nygren, private communication.
2. R. DeVoe, private communication.
3. S. Aronson, private communication to D. Nygren reported in reference 4.
4. D. R. Nygren, Review of K^0 Decays, presented at the Berkeley A.P.S. Meeting of the Division of Particles and Fields, Berkeley, California, August 13-17, 1973; LBL-2407.


```
THE FITTED VALUES OF ETA+- AND ETA00 GIVEN BELOW ARE THE RESULTS
OF A FIT TO ETA+-, ETA00 AND ETA00/ETA+- RESULTS.  THE VALUES LISTED
BELOW WHICH ARE NOT PARENTHESIZED ENTER THE FIT AS SHOWN.  THE
VALUES WHICH ARE PARENTHESIZED AND BEAR THE FOOTNOTE X DO NOT ENTER
THE FIT AS SHOWN.  THESE EXPERIMENTS GIVE BRANCHING RATIOS AND ENTER
THE FIT VIA THE QUANTITY ACTUALLY MEASURED -- BRANCHING RATIOS
R9, R20 AND R27 (ETA+-) AND R17 AND R19 (ETA00).  THESE BRANCHING
RATIOS ARE COMBINED WITH CURRENT NORMALIZATIONS AND CURRENT KL AND KS
MEAN LIVES TO OBTAIN PI PI RATES.  THE ETA+- AND ETA00 VALUES OBTAINED
FROM THESE RATES ARE ENTERED BELOW WITH THE NAME 'GKL/GKS'.

EOS      (ETA00)**2 = (A(KL TO 2PI0)/A(KS TO 2PI0))**2  (UNITS 10**-6)   ---
EOS X     0  (-2.)      (7.0)           BARTLETT  68 OSPK                        10/69
EOS X    57   (4.9)     (1.2)           BANNER    69 OSPK                         2/72
EOS X   133  (14.1)     (3.4)           CENCE     69 OSPK                        10/69
EOS XF  180  (13.)      (4.)            GAILLARD  69 OSPK                        10/69
EOS X    29   (4.08)    (0.9)           BARMIN    70 HLBC                        12/70
EOS X    30   (3.61)    (1.9)           BUDAGOV   70 HLBC                        10/70
EOS  C         8.7       3.7            CHOLLET   70 OSPK    CU REG.,4 GAMMAS  2/72
EOS XF  172   (9.9)     (3.4)           FAISSNER  70 OSPK                        12/70
EOS  C   56    7.4       2.0            WOLFF     71 OSPK    CU REG.,4GAMMAS   12/71
EOS  X         5.2       1.1            GKL/GKS   76 RVUE BR SCALE FACTOR=1.5  2/76*
EOS X   SEE NOTE ABOVE REGARDING FITTED VALUES OF ETA+- AND ETA00.
EOS  C  CHOLLET 70 GIVES ETA00=(1.23+-0.24)*(REGEN AMPL,2GEV/C CU)/10000MB   2/72
EOS  C  WOLFF 71   GIVES ETA00=(1.13+-0.12)*(REGEN AMPL,2GEV/C CU)/10000MB   2/72
EOS  C  WE COMPUTE BOTH ETA00**2 VALUES FOR (REGEN AMPL,2GEV/C CU)=24+-2MB.  2/72
EOS  C  THIS REGEN AMPL RESULTS FROM AVERAGING OVER FAISSNER 69,             2/72
EOS  C  EXTRAPOLATED USING OPTICAL MODEL CALCULTIONS OF BOHM ET AL.          2/72
EOS  C  PL 27B 594 (1968) AND THE DATA OF BALATS 71. (FROM H. FAISSNER,      2/72
EOS  C  PRIVATE COMMUNICATION)                                               2/72
EOS  F  FAISSNER 70 CONTAINS SAME 2PI0 EVENTS AS GAILLARD 69
EOS          . . . . . . . . .
EOS AVG        5.90      0.93    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
EOS STUDENT    5.9       1.1     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
EOS FIT        5.41      0.22   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  2/76*
E00 THIS FIT VALUE CORRESPONDS TO ETA00=2.325+-0.093                           2/76*

E+-     ETA+-  = A(KL TO PI+PI-)/A(KS TO PI+PI-) UNITS 10**-3  -------------
E+- X    45    (1.95)    (0.20)         CHRISTENS 64 OSPK                      2/76*
E+- X    54    (1.99)    (0.16)         GALBRAITH 65 OSPK                      2/76*
E+- X          (1.92)    (0.13)         BASILE    66 OSPK                      2/76*
E+- X          (1.95)    (0.04)         BOTT-BODE 66 OSPK                      2/76*
E+- X          (2.00)    (0.09)         DEBOUARD  67 OSPK                      2/76*
E+- X          (1.94)    (0.08)         FITCH     67 OSPK                      2/76*
E+- AX         (1.95)    (0.03)         GKL/GKS   71 RVUE   EXPTS. BEFORE 71   2/76*
E+- A   AVERAGE OF ABOVE EXPTS.  EXCLUDED FROM FIT.  SEE TYPED NOTE ABOVE.     2/76*
E+- X 4200     (2.23)    (0.05)         MESSNER   73 ASPK                     11/75*
E+-             2.30      0.035         GEWENIG2  74 ASPK                      3/74
E+-B X          2.246     0.032         GKL/GKS   76 RVUE   BR EXP. AFTER 71   2/76*
E+-B    CURRENTLY INCLUDES ONLY MESSNER 73 + NEW KL TAU AND KS PI+PI- RATES   2/76*
E+- X   SEE NOTE ABOVE REGARDING FITTED VALUES OF ETA+- AND ETA00.
E+-          . . . . . . . . .
E+- AVG         2.271     0.027   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
E+- STUDENT     2.270     0.027   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
E+- FIT         2.272     0.023  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0) 2/76*
                          (SEE IDEOGRAM BELOW )

ER      RATIO OF ETA00 OVER ETA+-
ER      124     1.03      0.07          BANNER1   72 OSPK                      8/72
ER      167     1.00      0.06          HOLDER    72 ASPK                      8/72
ER           . . . . . . . . .
ER  AVG         1.013     0.046   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
ER  STUDENT     1.013     0.049   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
ER  FIT         1.023     0.040  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1) 2/76*
```



Note on $K_L^0 \to 2\pi$ and K_S Regeneration

Some experiments obtain ϕ_{+-} (the phase of η_{+-}) using K_S, $K_L \to \pi^+\pi^-$ interference behind a regenerator. In these interference experiments the measured quantity is the difference of ϕ_{+-} and the regeneration phase ϕ_R, as shown in the expression below. After the regenerator, the intensity of the $\pi^+\pi^-$ decays in the forward direction is

$$I(t,p) = S(p)\Big[|R(p)|^2 e^{-\Gamma_S t} + |\eta_{+-}|^2 e^{-\Gamma_L t} + 2|R(p)||\eta_{+-}| \times e^{-(\Gamma_S+\Gamma_L)t/2} \times \cos(\Delta m t + \phi_R(p) - \phi_{+-})\Big] , \qquad (1)$$

where:

t is the decay time in the K^0 rest frame,

$\Delta m = m_L - m_S$, and $m_L, \Gamma_L, m_S, \Gamma_S$ are the masses and decay rates of the long- and short-lived K^0,

$\eta_{+-} = |\eta_{+-}| e^{i\phi_{+-}}$ is the ratio of decay amplitudes $A(K_L \to \pi^+\pi^-)/A(K_S \to \pi^+\pi^-)$,

$S(p)$ is proportional to the K_L momentum spectrum, and

$R(p) = |R(p)| e^{i\phi_R(p)}$ is the transmission-regenerated K_S amplitude (relative to the K_L):

$$R(p) = \pi N \Lambda i \, \frac{[f_0(p) - \bar{f}_0(p)]}{p} \left\{ \frac{1 - e^{-\frac{1}{2}\Gamma_S \ell(p)[1 - 2i\Delta m/\Gamma_S]}}{\frac{1}{2}\Gamma_S[1 - 2i\Delta m/\Gamma_S]} \right\}, \qquad (2)$$

where

Data Card Listings

For notation, see key at front of Listings.

Stable Particles

K_L^0

$\ell(p)$ is the thickness of regenerator measured in units of the mean decay length of K_S,

N is the number of nuclei per cubic centimeter,

Λ is the K_S mean decay length, and

$f_0(p)$, $\bar{f}_0(p)$ are the forward scattering amplitude of K^0 and $\bar{K}^0$.

From (1) above it is clear that the value of ϕ_{+-} is highly correlated with the value of Δm and ϕ_R. In addition, a less obvious but significant correlation exists between ϕ_{+-} and Γ_S. Usually Δm is a parameter of the fit and ϕ_R is determined by some other means (optical model calculations, time dependence of the charge asymmetry in K_{e3} decay, etc.).

We list ϕ_{+-} and give in comment cards both the value of ϕ_R used by the authors and the Δm dependence of ϕ_{+-}.

```
F+-     PHASE OF ETA +-         (DEGREES)      -------------------------------
F+-      THE DEPENDENCE OF THE PHASE ON THE KOL-KOS MASS DIFFERENCE
F+-      IS GIVEN FOR EACH EXPERIMENT IN THE COMMENTS BELOW, WHERE DM IS
F+-      (MASS DIFF./HBAR) IN UNITS 10**10 SEC-1.  WE HAVE EVALUATED THESE
F+-      MASS DEPENDENCES USING OUR APRIL 1976 VALUE, DM=0.5349+-0.0022
F+-      TO OBTAIN THE VALUES AND AVERAGE QUOTED BELOW.
F+- O       (45.0)    (50.0)             FITCH     65 OSPK    BE REGEN       11/67
F+- O       (30.0)    (45.0)             FIRESTONE 66 HBC                    11/67
F+- O       (70.0)    (21.0)             BOTT-BODE 67 OSPK    C REGEN        11/67
F+- O       (25.0)    (35.0)             MISCHKE   67 OSPK    CU REGEN        7/68
F+- O    OLD EXPERIMENTS WITH LARGE ERRORS NOT INCLUDED IN AVERAGE.           2/76*
F+- N       (51.0)    (11.0)             BENNETT2  68 CNTR    CU REG. USES    8/68
F+-  C       34.2      10.0              BENNETT   69 CNTR    CU REGEN        2/71
F+-  B       45.3      12.0              BOHM      69 OSPK    VACUUM REGEN    2/71
F+-  F       45.2       7.4              FAISSNER  69 ASPK    CU REGEN        2/71
F+-  J       40.6       4.2              JENSEN    70 ASPK    VACUUM REGEN    2/71
F+-  D       37.2      12.0              BALATS    71 OSPK    CU REGEN        9/71
F+-  P       36.2       6.1              CARNEGIE  72 ASPK    CU REGEN        1/73
F+-  G       46.5       1.6              GEWENIG2  74 ASPK    VACUUM REGEN    3/74
F+-  H       45.5       2.8              CARITHERS 75 SPEC    C REGEN         7/75*
F+-         . . . . . . . . .
F+- AVG      45.0       1.3      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
F+- STUDENT  45.1       1.4      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
F+- FIT      45.0       1.2     FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*
                          COMMENTS
F+-  N  BENNETT 69 IS A REEVALUATION OF BENNETT2 68.                          11/69
F+-  C  BENNETT 69 USES MEASUREMENT OF (F+-)-(PHIF) OF ALFF-STEINBERGER 66.    2/71
F+-  C  BENNETT 69   F+-=(34.9+-10.0)+ 69*(DM-.545) DEG.  FR=-49.9+-5.4 DEG.   2/71
F+-  B  BOHM 69      F+-=(41.0+-12.0)+479*(DM-.526) DEG.                       2/71
F+-  F  FAISSNER 69 ERROR ENLARGED TO INCLUDE ERROR IN REGENERATOR PHASE.     11/69
F+-  F  FAISSNER 69 F+-=(49.3+-7.4)+205*(DM-.555) DEG.   FR=-42.7+-5.0 DEG.    2/71
F+-  J  JENSEN 70    F+-=(42.4+-4.0)+576*(DM-.538) DEG.                        2/71
F+-  D  BALATS 71    F+-=(39.0+-12.0)+198*(DM-.544) DEG.  FR=-43.0+-4.0 DEG.   9/71
F+-  P  CARNEGIE 72 F+- IS INSENSITIVE TO DM.             FR=-56.2+-5.2 DEG.   1/73
F+-  G  GEWENIG2 74 F+-=(49.4+-1.0)+565*(DM-.540) DEG.                         3/74
F+-  H  CARITHER 75 F+-=(45.5+-2.8)+224*(DM-.5348) DEG.  FR=-40.9+-2.6 DEG. 11/75*

FOO     PHASE OF ETA 00     (DEGREES)      ---------------------------------
FOO          FIRST QUADRANT PREFERRED    GOBBI      69 OSPK                   11/69
FOO  C          51.0       30.0          CHOLLET    70 OSPK   CU REG.,4 GAMMAS 10/70
FOO  W  56      38.0       25.0          WOLFF      71 OSPK   CU REG.,4 GAMMAS 12/71
FOO  C  CHOLLET 70 USES REGENERATOR PHASE FR=-46.5+-4.4 DEG.                   1/73
FOO  W  WOLFF 71    USES REGENERATOR PHASE FR=-48.2+-3.5 DEG.                  1/73
FOO           . . . . . . . . .
FOO AVG         43.3       19.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
FOO STUDENT     43.3       20.7     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
FOO FIT         48.3       13.2    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*

DF      PHASE DIFFERENCE FOO - F+-       (DEGREES)----------------------------
DF B             7.6       18.0          BARBIELLI 73 ASPK                     7/73
DF B    INDEPENDENT OF REGENERATOR MECHANISM,DM,AND LIFETIMES.                 7/73
DF            . . . . . . . . .
DF  FIT          3.3       13.1     FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*
```

<u>Superweak Model Predictions for $\phi_{\eta_{+-}}$ and Reε</u>

The superweak model of Wolfenstein, Phys. Letters 13, 562 (1964) predicts that

$$\phi_{+-} = \phi_{00} = \tan^{-1}\left(\frac{2\Delta m\tau_S}{\hbar}\right)$$

and

$$\mathrm{Re}\varepsilon = |\eta_{+-}|\left[1 + \left(\frac{2\Delta m\tau_S}{\hbar}\right)^2\right]^{-1/2} .$$

These expressions and the values of the $K_L^0 - K_S^0$ mass difference $\Delta M = (0.5349\pm0.0022)\times10^{10}\,\hbar\ \mathrm{sec}^{-1}$, the K_S^0 mean life $\tau_S = (0.8930\pm0.0023)\times10^{-10}$ sec, and the magnitude of the $K_L^0 \to \pi^+\pi^-/K_S^0 \to \pi^+\pi^-$ amplitude ratio $|\eta_{+-}| = (2.272\pm0.023)\times10^{-3}$, all from the current edition, result in the preditions that

$$\phi_{+-} = \phi_{00} = (43.69\pm0.13)^\circ$$

and

$$\mathrm{Re}\varepsilon = (1.643\pm0.017)\times10^{-3} .$$

These can be compared with the experimental values

$$\phi_{+-} = (45.0\pm1.2)^\circ$$

$$\phi_{00} = (48.3\pm13.2)^\circ$$

$$\mathrm{Re}\varepsilon = (1.624\pm0.088)\times10^{-3} ,$$

where Reε has been computed using the relation

$$\mathrm{Re}\varepsilon = \frac{\delta}{2}\left(\frac{|1 - x|^2}{1 - |x|^2}\right) ,$$

and our current values of the charge asymmetry parameter for leptonic K_L^0 decay $\delta = (0.330\pm0.012)\%$ and the $\Delta S = -\Delta Q$ amplitude (Rex, Imx) = $(0.008\pm0.020, -0.003\pm0.027)$.

The superweak predictions are in good agreement with the data.

The values of τ_S and $|\eta_{+-}|$ have undergone major revision in the past few years (see notes on these parameters in the K_S^0 and K_L^0 sections of the Data Card Listings). We have utilized only the post-1971 experimental values of these parameters and have made necessary changes in the related parameters ΔM and ϕ_{+-} (see footnotes in the related data card subsections D and F+- above).

Stable Particles

K^0_L

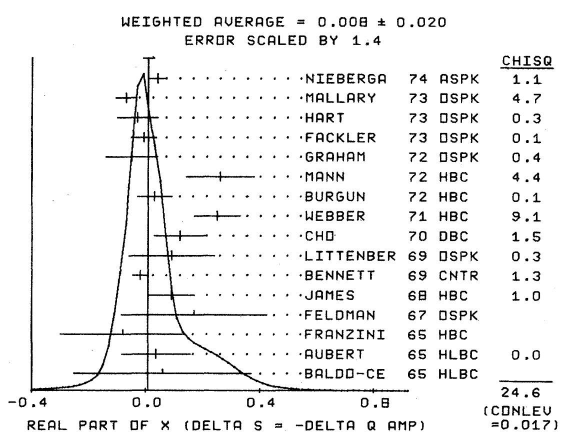
Data Card Listings

For notation, see key at front of Listings.

```
                    13  X = (DS=-DQ AMPLITUDE)/(DS=+DQ AMPLITUDE)

        RELATED TEXT SECTION VI B.4

REX         REAL PART OF X
REX   C 152    0.06      0.18      0.44  BALDO-CE  65 HLBC    K+ CHARGE EXCHNG 11/67
REX     196    0.035     0.11      0.13  AUBERT    65 HLBC    K+ CHARGE EXCHNG 11/67
REX   F 109   -0.08      0.16      0.28  FRANZINI  65 HBC     PBAR P           11/67
REX     116    0.17      0.16      0.35  FELDMAN   67 OSPK    PI-P TO KO LMBDA 11/67
REX N   335   (0.17)    (0.10)           HILL      67 DBC     K+D YIELDS KOPP  11/67
REX B         (0.03)    (0.03)           BENNETT1  68 CNTR                      7/68
REX     121    0.09      0.07      0.09  JAMES     68 HBC     PBAR P            5/69
REX   B       -0.020     0.025           BENNETT   69 CNTR    CHAR ASYM+ CU RE 10/69
REX     686    0.09      0.14      0.16  LITTENBER 69 OSPK    K+N TO KOP        4/69
REX   N 215    0.12      0.09            CHO       70 DBC     K+D TO KOPP      10/70
REX U   222   (0.04)    (0.07)    (0.08) BURGUN    71 HBC     K+P TO KOPPI+     2/72
REX     252    0.25       .07       .09  WEBBER    71 HBC     K-P TO KBAR N    10/69
REX   U 410    0.03      0.06      0.06  BURGUN    72 HBC     K+P TO KOPPI+     1/73
REX     126    0.26      0.10      0.14  MANN      72 HBC     K-P TO KOBAR N    9/72
REX G   342  (-0.13)    (0.11)           MANTSCH   72 OSPK    KE3  FROM KO LMB  2/72
REX G   100   (0.04)    (0.10)    (0.13) GRAHAM    72 OSPK    KMU3 FROM KO LMB  2/72
REX   G 442   -0.05      0.09            GRAHAM    72 OSPK    PI-P TO KO LMBDA  2/72
REX    1757   -0.008     0.044           FACKLER   73 OSPK    KE3 FROM KO       9/73
REX    1367   -0.03      0.07            HART      73 OSPK    KE3 FROM KO LMB   2/74
REX    1079   -0.070     0.036           MALLARY   73 OSPK    KE3 FROM KO LM +  6/73
REX    4724    0.04      0.03            NIEBERGA  74 ASPK    K+P TO KOPPI+     7/74*
REX   C  BALDO-CE 65 GIVES X AND THETA.CONVERTED BY US TO REX AND IMX.         11/67
REX   F  FRANZINI 65 GIVES X AND THETA.FOR REX AND IMX SEE SCHMIDT 67.         11/67
REX N    CHO 70 IS ANALYSIS OF UNAMBIGUOUS EVENTS IN NEW DATA AND HILL 67.
REX   U  BURGUN 72 IS A FINAL RESULT WHICH INCLUDES BURGUN 71.                 11/73
REX   B  BENNETT 69 IS A REANALYSIS OF BENNETT1 68
REX G    SECOND GRAHAM 72 VALUE IS FIRST GRAHAM 72 VALUE COMBINED WITH          2/72
REX G    MANTSCH 72.                                                            2/72
REX         . . . . . . . . . .
REX AVG        0.008     0.020    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
REX STUDENT    0.007     0.017    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                         (SEE IDEOGRAM BELOW )
```




```
IMX     IMAGINARY PART OF X (ASSUMES M(KL)-M(KS) POSITIVE -- SEE S13D)
IMX   C 152   -0.44      0.32      0.19  BALDO-CE  65 HLBC    K+ CHARGE EXCHNG  3/68
IMX     196   -0.21      0.11      0.15  AUBERT    65 HLBC    K+ CHARGE EXCHNG  3/68
IMX   F 109   +0.24      0.40      0.30  FRANZINI  65 HBC     PBAR P            3/68
IMX     116    0.0       0.25            FELDMAN   67 OSPK    PI-P TO KO LMBDA 11/67
IMX N   335  (-0.20)    (0.10)           HILL      67 DBC     K+D YIELDS KOPP  11/67
IMX     121   +0.22      0.37      0.29  JAMES     68 HBC     PBAR P            5/69
IMX     686   -0.11      0.10      0.11  LITTENBER 69 OSPK    K+N TO KOP        4/69
IMX   N 215   -0.08      0.07            CHO       70 DBC     K+D TO KOPP      10/70
IMX U   222   (0.12)    (0.08)    (0.09) BURGUN    71 HBC     K+P TO KOPPI+     2/72
IMX     252    0.0        .08            WEBBER    71 HBC     K-P TO KBAR N    10/69
IMX   U 410    0.07      0.06      0.07  BURGUN    72 HBC     K+P TO KOPPI+     1/73
IMX     126    0.21      0.15      0.12  MANN      72 HBC     K-P TO KOBAR N    9/72
IMX G   342  (-0.04)    (0.16)           MANTSCH   72 OSPK    KE3  FROM KO LMB  2/72
IMX G   100   (0.12)    (0.17)    (0.16) GRAHAM    72 OSPK    KMU3 FROM KO LMB  2/72
IMX   G 442    0.05      0.13            GRAHAM    72 OSPK    PI-P TO KO LMBDA  2/72
IMX    1757   -0.017     0.060           FACKLER   73 OSPK    KE3 FROM KO       9/73
IMX    1367    0.09      0.07            HART      73 OSPK    KE3 FROM KO LMB   2/74
IMX    1079    0.107     0.092     0.074 MALLARY   73 OSPK    KE3 FROM KO LM +  6/73
IMX    4724   -0.06      0.05            NIEBERGA  74 ASPK    K+P TO KOPPI+     7/74*
IMX   C  BALDO-CE 65 GIVES X AND THETA.CONVERTED BY US TO REX AND IMX.         11/67
IMX   F  FRANZINI 65 GIVES X AND THETA.FOR REX AND IMX SEE SCHMIDT 67.         11/67
IMX N    FTNOTE 10 OF HILL 67 SHOULD READ +0.58, NOT -0.58 (PRIV.COMM.).        3/68
IMX N    CHO 70 IS ANALYSIS OF UNAMBIGUOUS EVENTS IN NEW DATA AND HILL 67.
IMX   U  BURGUN 72 IS A FINAL RESULT WHICH INCLUDES BURGUN 71.                 11/73
IMX G    SECOND GRAHAM 72 VALUE IS FIRST GRAHAM 72 VALUE COMBINED WITH          2/72
IMX G    MANTSCH 72.                                                            2/72
IMX         . . . . . . . . . .
IMX AVG       -0.003     0.027    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
IMX STUDENT   -0.003     0.027    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                         (SEE IDEOGRAM BELOW )
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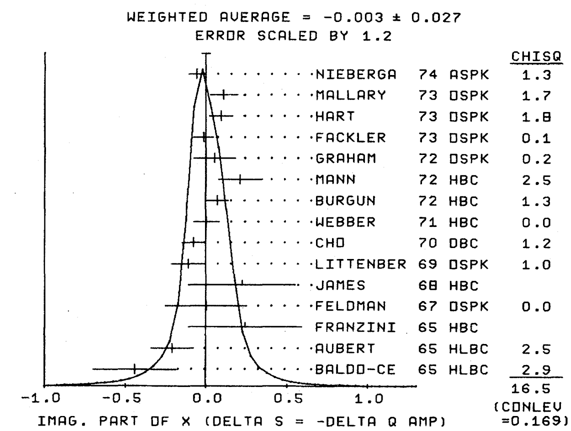

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REFERENCES FOR KOL


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BARDON   58 ANP 5 156            M BARDON,K LANDE,L LEDERMAN  (COLUMBIA+BNL)
CRAWFORD 59 PRL 2 361            CRAWFORD,CRESTI,DOUGLASS,GOOD +         (LRL)
ASTIER   61 AIX CONF 1 227       ASTIER,BLASKOVIC,RIVET,SIAUD +         (EPOL)
FITCH    61 NC  22 1160          V FITCH,P PIROUE,R PERKINS        (PRINCETON)
GOOD     61 PR 124 1223          GOOD,MATSEN,MULLER,PICCIONI,POWELL +    (LRL)
NEAGU    61 PRL  6  552          NEAGU,OKONOV,PETROV,ROSANOVA,RUSAKOV (JINR)
    ALSO 61 JETP 13 1138         NYAGU,OKONOV,PETROV,ROZANOVA,RUSAKOV (JINR)

CAMERINI 62 PR 128 362           CAMERINI,FRY,GAIDOS,BIRGE,ELY +  (WISC+LRL)
DARMON   62 PL 3 57              J DARMON,A ROUSSET,J SIX               (EPOL)

ADAIR    64 PL 12 67             R K ADAIR,L B LEIPUNER             (YALE+BNL)
ALEKSANY 64 DUBNA 2 102          ALEKSANYAN,ALIKHANYAN,VARTAZARYAN+ (EREVAN)
    ALSO 64 JETP 19 1019         ALEKSANYAN+   (LEBEDEV+MOS ENG PHYS+EREVAN)
ANIKINA  64 JETP  19 42          ANIKINA,ZHURAVLEVA+ (GEORG ACAD SCI+ DUBNA)
CHRISTEN 64 PRL 13 138           CHRISTENSON,CRONIN,FITCH,TURLAY (PRINCETON)
FUJII    64 DUBNA 2 146          FUJII,JOVANOVICH,TURKOT+ (BNL,MARYLAND,MIT)
LUERS    64 PR 133 B 1276        LUERS,MITTRA,WILLIS,YAMAMOTO            (BNL)

ANIKINA  65 JINR P 2488          ANIKINA,VARDENGA,ZHURAVLEVA,KOTLYA+ (DUBNA)
ANDERSON 65 PRL 14 475           ANDERSON,CRAWFORD,GOLDEN,STERN + (LRL+WISC)
ASTBURY1 65 PL 16 80             ASTBURY,FINOCCHIARO,BEUSCH +  (CERN+ZURICH)
    ALSO 65 HELV.PH.AC.39 523 M PEPIN
ASTBURY2 65 PL  18 175           ASTBURY,MICHELINI,BEUSCH +    (CERN+ZURICH)
ASTBURY3 65 PL  18 178           ASTBURY,MICHELINI,BEUSCH +    (CERN+ZURICH)
AUBERT   65 PL  17 59            AUBERT,BEHR,CANAVAN,CHOUNET+    (EPOL+ORSAY)
    ALSO 67 LOWYS
BALDO-CE 65 NC 38 684            BALDO-CEOLIN,CALIMANI,CIAMPOLILLO +  (PADO)

CHRISTEN 65 PR 140 B 74          CHRISTENSON,CRONIN,FITCH,TURLAY (PRINCETON)
FISHER   65 ANL 7130 83          FISHER,ABASHIAN,ABRAMS,CARPENTER+      (ILL)
FITCH    65 PRL 15 73            FITCH,ROTH,RUSS,VERNON            (PRINCETON)
FRANZINI 65 PR 140 B 127         FRANZINI,KIRSCH,PLANO +  (COLUMBIA+RUTGERS)
GALBRAIT 65 PRL 14 383           GALBRAITH,MANNING,JONES +  (AERE+BRIS+RHEL)
GUIDONI  65 ARGONNE CONF 49      +BARNES,FOELSCHE,FERBEL,FIRESTO+ (BNL+YALE)
HOPKINS  65 ARGONNE CONF 67      H W K HOPKINS,BACON,EISLER  (VAND+RUTGERS)
VISHNEVS 65 PL  18   339         VISHNEVSKY,GALANINA,SEMENOV +          (ITEP)

ALFF-STE 66 PL 21 595            ALFF-STEINBERGER,HEUER,RUBBIA +        (CERN)
ANIKINA  66 SJNP 2 339           ANIKINA, VARDENGA, ZHURAVLEVA+         (JINR)
AUERBACH 66 PRL   17  980        AUERBACH,MANN,MCFARLANE,SCIULLI        (PENN)
AUERBACH 66 PR   149 1052        AUERBACH,DOBBS,LANDE,MANN,SCIULLI+     (PENN)
    ALSO 65 PRL   14  192        +LANDE,MANN,SCIULLI,UTO,WHITE,YOUNG    (PENN)
BALDO-CE 66 NC   45A  733        BALDO-CEOLIN,CALIMANI,CIAMPOLILLO+    (PADUA)
BASILE   66   BALATON CONF       BASILE,CRONIN,THEVENET +             (SACLAY)

BEHR     66 PL   22 540          +BRISSON,BALDO-CEOLIN,AUBERT+   (PADO,EPOL)
BELLOTTI 66 NC   45A  737        BELLOTTI,PULLIA,BALDO-CEOLIN+ (MILAN,PADUA)
BOTT-BOD 66 PL   23  277         BOTT-BODENHAUSEN,DE BOUARD,CASSEL+     (CERN)
CAMERINI 66 PR   150 1148        CAMERINI,CLINE,ENGLISH,FISCHBEIN+WISCONSIN
CANTER   66 PRL 17 942           +CHO,ENGLER,FISK,HILL +       (CARNEGIE+BNL)
CARPENTE 66 PR   142  871        CARPENTER,ABASHAN,ABRAMS,FISHER  (ILLINOIS)
CHANG    66 PL   23  702         CHANG,BASSANO,KIKUCHI,DODD+  (SYRACUSE,BNL)

CRIEGEE  66 PRL 17 150           +FOX,FRAUENFELDER,HANSON,MOSCAT+ (ILLINOIS)
FIRESTON 66 PRL 16 556           FIRESTONE,KIM,LACH,SANDWEISS+    (YALE,BNL)
FIRESTON 66 PRL 17 116           FIRESTONE,KIM,LACH,SANDWEISS+    (YALE,BNL)
FUJII    66 PRL 13 253           FUJII,JOVANOVICH,TURKOT,ZORN (BNL+MARYLAND)
    FUJII 66 IS THE CORRECTED VALUE GIVEN BY JOVANOVICH+ 66
HAWKINS  66 PL 21 238            C J B HAWKINS                          (YALE)
    ALSO 67 PR  156  1444        C J B HAWKINS                          (YALE)

JOVANOVI 66 PRL 17 1075          JOVANOVICH,FUJII,TURKOT,ZORN +(BNL+UMD+MIT)
KULYUKIN 66  BERKELEY 2B         KULYUKINA,MESTVIRISHVILI,NEAGU,PETR+ (JINR)
MEISNER1 66 PRL 16 278           G W MEISNER,B B CRAWFORD,F CRAWFORD   (LRL)
MEISNER2 66 PRL  17  492         G MEISNER,B CRAWFORD,F CRAWFORD        (LRL)
NEFKENS  66 PL 19 706            NEFKENS,ABASHIAN,ABRAMS,CARPENTER+     (ILL)
VERHEY   66 PRL 17 669           VERHEY,NEFKENS,ABASHIAN+               (ILL)

BENNETT  67 PRL  19  993         BENNETT,NYGREN,SAAL,STEINBERGER +(COLUMBIA)
BOTT-BOD 67 PL  24B  194         BOTT-BODENHAUSEN,DEBOUARD,CASSEL +     (CERN)
BOTT-BOD 67 PL  24B  438         BOTT-BODENHAUSEN,DEBOUARD,DEKKERS+     (CERN)
    ALSO 66 PL  20   212         BOTT-BODENHAUSEN,DEBOUARD,CASSEL+      (CERN)
    ALSO 66 PL  23   277         BOTT-BODENHAUSEN,DEBOUARD,CASSEL+      (CERN)
CANTER   67 THESIS               J.M. CANTER                        (CARNEGIE)
CRONIN 1 67 PRL 18 25            +KUNZ,RISK,WHEELER                (PRINCETON)
CRONIN 2 67 PRINC CONF(11/67) +KUNZ,RISK,WHEELER                   (PRINCETON)
DEBOUARD 67 NC  52A  662         DEBOUARD,DEKKERS,JORDAN,MERMOD +       (CERN)
    ALSO 65 PL  15  58           DE BOUARD,DEKKERS,SCHARFF+ (CERN+ORSA+MPIM)

DEVLIN   67 PRL 18 54            DEVLIN,SOLOMON,SHEPARD,BEALL+      (PRIN+UMD)
    ALSO 68 PR 169 1045          SAYER,BEALL,DEVLIN,SHEPHARD+ (UMD+PPA+PRIN)
DORFAN   67 PRL  19  987         DORFAN,ENSTROM,RAYMOND,SCHWARTZ +(SLAC+LRL)
FELDMAN  67 PR  155  1611        FELDMAN,FRANKEL,HIGHLAND,SLOAN         (PENN)
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

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FIRESTON 67 PRL 18 176 FIRESTONE,KIM,LACH,SANDWEISS,+ (YALE,BNL)
FITCH 67 PR 164 1711 FITCH,ROTH,RUSS,VERNON (PRINCETON)
HAWKINS 67 PR 156 1444 C J B HAWKINS (YALE)
HILL 67 PRL 19 668 HILL,LUERS,ROBINSON,CANTER+ (BNL,CARNEGIE)

HOPKINS 67 PRL 19 185 HOPKINS,BACON,EISLER (BNL)
KADYK 67 PRL 19 597 KADYK,CHAN,DRIJARD,OREN,SHELDON (LRL)
KULYUKIN 67 PREPRINT KULYUKINA+MESTVIRISHVILI+NEAGU + (JINR)
LOWYS 67 PL 24B 75 LOWYS,AUBERT,CHOUNET,PASCAUD+ (EPOL,ORSA)
MISCHKE 67 PRL 18 138 MISCHKE,ABASHIAN,ABRAMS+ (ILLINOIS)
NEFKENS 67 PR 157 1233 +ABASHIAN,ABRAMS,CARPENTER,FISHER+ (ILL)
TODOROFF 67 THESIS JOHN A TODOROFF (ILLINOIS)

ABRAMS 68 PR 176 1603 +ABASHIAN,MISCHKE,NEFKENS,SMITH+ (ILLINOIS)
ARNOLD 68 PL 28B 56 ARNOLD,BUDAGOV,CUNDY,AUBERT+ (CERN+ORSAY)
ARONSON 68 PRL 20 287 S.H.ARONSON, K.W.CHEN (PRINCETON)
ALSO 69 PR 175 1708 S H ARONSON, K W CHEN (PRINCETON)
BALATZ 68 PL 26B 320 BALATZ,BEREZIN,VISHNEVSKY,GALANINA+ (ITEP)
BARTLETT 68 PRL 21 558 BARTLETT,CARNEGIE,FITCH+ (PRINCETON)

BASILE 68 PL 26B 542 BASILE,CRONIN,THEVENET,TURLAY+ (SACLAY)
BASILE2 68 PL 28B 58 +CRONIN,THEVENET,TURLAY,ZYLBERAJCH+(SACLAY)
BENNETT1 68 PL 27B 244 BENNETT,NYGREN,STEINBERGER+ (COLUMBIA+CERN)
BENNETT2 68 PL 27B 248 BENNETT,NYGREN,STEINBERGER+ (COLUMBIA+CERN)
BLANPIED 68 PRL 21 1650 BLANPIED,LEVIT,ENGELS+ (CASE+HARV+MCGI)
BUDAGOV 68 NC 57A 182 BUDAGOV,BURMEISTER,CUNDY+ (CERN,ORSA,IPNP)
ALSO 68 PL 28B 215 +CUNDY,MYATT,NEZRICK+ (CERN,ORSA,EPOL)

CARNEGIE 68 PRINC TR44 THESIS R.K.CARNEGIE (PRINCETON)
JAMES 68 NP B8 365 F JAMES, H BRIAND (IPNP,CERN)
ALSO 68 PRL 21 257 HELLAND,LONGO,YOUNG (UCLA,MICH)
KULYUKIN 68 JETP 26 20 KULYUKINA,MESTVIRISHVILI,NEAGU+ (JINR)
KUNZ 68 THESIS (PU 46) P F KUNZ (PRINCETON)
MELHOP 68 PR 172 1613 MELHOP MURTY BOWLES,BURNETT+ (LA JOLLA)
THATCHER 68 PR 174 1674 THATCHER,ABASHIAN,ABRAMS,CARPENTER + (ILL)

BANNER 69 PR 188 2033 +CRONIN,LIU,PILCHER (PRINCETON)
ALSO 68 PRL 21 1103 BANNER,CRONIN,LIU,PILCHER (PRINCETON)
ALSO 68 PRL 21 1107 BANNER CRONIN,LIU,PILCHER (PRINCETON)
BEILLIER 69 PL 30B 202 BEILLIERE,BOUTANG,LIMON (EPOL)
BENNETT 69 PL 29B 317 +NYGREN,SAAL,STEINBERGER+ (COLU,BNL)
BOHM 69 NP B9 605 +DARRIULAT,GROSSO,KAFTANOV+ (CERN)
ALSO 68 PL 27B 321 BOHM,DARRIULAT,GROSSO,KAFTANOV (CERN)

BOTT-BOD 69 CERN 69-7 329 BOTT-BODENHAUSEN,DE BOUARD,CASSEL+ (CERN)
CENCE 69 PRL 22 1210 CENCE,JONES,PETERSON,STENGER+ (HAWAII,LPL)
EVANS 69 PRL 23 427 EVANS,GOLDEN,MUIR,PEACH+ (EDINBURGH,CERN)
FAISSNER 69 PL 30B 204 +FOETH,STAUDE,TITTEL+ (AACH,CERN,TORI)
FOETH 69 PL 30B 282 +HOLDER,RADERMACHER + (AACHEN,CERN,TORINO)

GAILLARD 69 NC 59A 453 +GALBRAITH,HUSSRI,JANE+ (CERN,RHEL,AACHEN)
ALSO 67 PRL 18 20 +KRIENEN,GALBRAITH,HUSSRI+ (CERN+RHEL+AACH)
GOBBI 69 PRL 22 685 +GREEN,HAKEL,MOFFETT,ROSEN,GOZ+ (ROCH+RUTG)
LITTENBE 69 PRL 22 654 LITTENBERG,FIELD,PICCIONI,MEHLHOP+ (UCSD)
LONGO 69 PR 181 1808 M J LONGO,K K YOUNG,J A HELLAND (MICH,UCLA)
PACIOTTI 69 THESIS,UCRL 19446 M A PACIOTTI (LRL)
SAAL 69 THESIS H J SAAL (COLUMBIA)

ALBROW 70 PL 33B 516 +ASTON,BARBER,BIRD,ELLISON + (MCHS+DARE)
ARONSON 70 PRL 25 1057 +EHRLICH,HOFER,JENSEN+ (EFI,ILLC,SLAC)
BARMIN 70 PL 33B 377 +BARYLON,BORISOV,BYSHEVA+ (ITEP,JINR)
BASILE 70 PR D2 78 +CRONIN,THEVENT,TURLAY,ZYLBERAJCH + (SACL)
BUCHANAN 70 PL 33B 623 +DRICKEY,RUDNICK,SHEPARD+ (SLAC,JHU,UCLA)
ALSO PRIVATE COMMUNICATION, B. COX, FEB. 71
BUDAGOV 70 PR D2 815 +CUNDY,MYATT,NEZRICK+ (CERN, ORSA,EPOL)
ALSO 68 PL 28B 215 +CUNDY,MYATT,NEZRICK+ (CERN,ORSA,EPOL)

CHIEN 70 PL 33B 627 C-Y.CHIEN,COX,ETTLINGER + (JHU+SLAC+UCLA)
ALSO PRIVATE COMMUNICATION, B. COX, FEB. 71.
CHO 70 PR D1 3031 +DRALLE,CANTER,ENGLER,FISK+ (CARN,BNL,CASE)
ALSO 67 PRL 19 668 HILL,LUERS,ROBINSON,SAKITT + (BNL,CARN)
CHOLLET 70 PL 31B 658 +GAILLARD,JANE,RATCLIFFE,REPELLIN + (CERN)
CULLEN 70 PL 32B 523 +DARRIULAT,DEUTSCH,FOETH + (AACH,CERN,TORI)

DARRIULA 70 PL 33B 249 +FERRERO,GROSSO,HOLDER + (AACH,CERN,TORI)
FAISSNER 70 NC 70A 57 +REITHLER,THOME,GAILLARD+ (AACH,CERN,RHEL)
JENSEN 70 THESIS D.A. JENSEN (EFI)
ALSO 69 PRL 23 615 JENSEN,ARONSON,EHRLICH,FRYBERGER+ (EFI,ILL)
MARX 70 PL 32B 219 +NYGREN,PEOPLES,STEINBERGE+(COLU,HARV,CERN)
ALSO 70 THESIS,NEVIS 179 JAY MARX (COLUMBIA)

SCRIBANO 70 PL 32B 224 +MANNELLI,PIERAZZINI,MARX+ (PISA,COLU,HARV)
SMITH 70 PL 32B 133 +WANG,WHATLEY,ZORN,HORNBOSTEL (UMD,BNL)
WEBBER 70 PR D1 1967 +SOLMITZ,CRAWFORD,ALSTON-GARNJOST (LRL)
ALSO 69 UCRL 19226 THESIS B R WEBBER (LRL)

BALATS 71 SJNP 13 53 +BEREZIN,VISHNEVSKII,GALANINA+ (ITEP)
BARMIN 71 PL 35B 604 +BARYLOV,VESELOVSKY,DAVIDENKO+ (ITEP)
BISI 71 PL 36B 533 +DARRIULAT,FERRERO,RUBBIA+ (AACH,CERN,TORI)
BURGUN 71 LNC 2 1169 +LESQUOY,MULLER,PAULI+ (SACL+CERN+OSLO)
CARNEGIE 71 PR D4 1 +CESTER,FITCH,STROVINK,SULAK (PRIN)
CHAN 71 LBL-350 THESIS J.HIONG-SING CHAN (LBL)
CHIEN 71 PL 35B 261 +COX,ETTLINGER,RESVANIS+ (JHU,SLAC,UCLA)
ALSO 72 DALLY

CHO 71 PR D3 1557 +DRALLE,CANTER,ENGLER,FISK+ (CARN,BNL,CASE)
CLARK 71 PRL 26 1667 +ELIOFF,FIELD,FRISCH,JOHNSON,KERTH+ (LRL)
ALSO 70 UCRL 19709-THESIS ROLLAND JOHNSON (LRL)
ALSO 71 UCRL 20264-THESIS HENRY FRISCH (LRL)
ALSO 74 SLAC-PUB-1498 R.C.FIELD (SLAC)
ENSTROM 71 PR D4 2629 +AKAVIA,COOMBES,DORFAN+ (SLAC,STAN)
ALSO 70 THESIS (SLAC 125) J E ENSTROM (STANFORD)

HILL 71 PR D4 7 +SAKITT,SKJEGGESTAD,CANTER+ (BNL,CARN,CASE)
JAMES 71 PL 35B 265 +MONTANET,PAUL,PAULI+ (CERN+SACL+OSLO)
MEISNER 71 PR D3 59 +MANN,HERTZBACH,KOFLER + (MASA+BNL+YALE)
PEACH 71 PL 35B 351 +EVANS,MUIR,BUDAGOV,HOPKINS+ (EDIN,CERN)

REPELLIN 71 PL 36B 603 +WOLFF,CHOLLET,GAILLARD,JANE+ (ORSA,CERN)
WEBBER 71 PR D3 64 +SOLMITZ,CRAWFORD,ALSTON-GARNJOST (LRL)
ALSO 68 PRL 21 498 WEBBER,SOLMITZ,CRAWFORD,ALSTONGARNJOST(LRL)
ALSO 69 UCRL 19266-THESIS B R WEBBER (LRL)
WOLFF 71 PL 36B 517 +CHOLLET,REPELLIN,GAILLARD+ (ORSA,CERN)

ALBROW 72 NP B44 1 +ASTON,BARBER,BIRD,ELLISON+ (MCHS+DARE)
ASHFORD 72 PL 38B 47 +BROWN,MASEK,MAUNG,MILLER,RUDERMAN+ (UCSD)
BANNER1 72 PRL 28 1597 +CRONIN,HOFFMAN,KNAPP,SHOCHET (PRINCETON)
BANNER2 72 PRL 29 237 +CRONIN,HOFFMAN,KNAPP,SHOCHET (PRINCETON)
BARMIN1 72 SJNP 15 636 +DAVIDENKO,DEMIDOV,DOLGOLENKO+ (ITEP)
BARMIN2 72 SJNP 15 638 +BARYLOV,DAVIDENKO,DEMIDOV+ (ITEP)
BURGUN 72 NP B50 194 +LESQUOY,MULLER,PAULI,+ (SACL+CERN+OSLO)
CARNEGIE 72 PR D6 2335 +CESTER,FITCH,STROVINK,SULAK (PRINCETON)

DALLY 72 PL 41B 647 +INNOCENTI,SEPPI,CHIEN,COX+ (SLAC+JHU+UCLA)
ALSO 70 CHIEN
ALSO 71 CHIEN
GRAHAM 72 NC 9A 166 +ABASHIAN,JONES,MANTSCH,ORR+ (ILL+NEAS)
HOLDER 72 PL 40B 141 +RADERMACHER,STAUDE+ (AACH+CERN+TORI)
JAMES 72 NP B49 1 +MONTANET,PAUL,SAETRE+ (CERN+SACL+OSLO)
KRENZ 72 LNC 4 213 +HOPKINS,EVANS,MUIR,PEACH (AACH+CERN+EDIN)

MANN 72 PR D6 137 +KOFLER,MEISNER,HERTZBACH+ (MASA+BNL+YALE)
MANTSCH 72 NC 9A 160 +ABASHIAN,GRAHAM,JONES,ORR+ (ILL+NEAS)
METCALF 72 PL 40B 703 +NEUHOFER,NIEBERGALL+ (CERN+IPN+WIEN)
NEUHOFER 72 PL 41B 642 +NIEBERGALL,REGLER,STIER+ (CERN+ORSA+VIEN)
PICCIONI 72 PRL 29 1412 +COOMBES,DONALDSON,DORFAN,FRYBERGER+ (SLAC)
ALSO 74 PR D9 2939 PICCIONI,DONALDSON + (SLAC+UCSC+COLO)
VOSBURGH 72 PR D6 1834 +DEVLIN,ESTERLING,GOZ,BRYMAN + (RUTG,MASA)
ALSO 71 PRL 26 866 VOSBURGH,DEVLIN,ESTERLING,GOZ + (RUTG,MASA)

ALBROW 73 NP B58 22 +ASTON,BARBER,BIRD,ELLISON+ (MCHS+DARE)
ALEXANDE 73 NP B65 301 ALEXANDER,BENARY,BOROWITZ,LANDE+(TELA+HEID)
BARBIELL 73 PL 43B 529 BARBIELLINI,DARRIULAT,FAINBERG+ (CERN)
BRANDENB 73 PR D8 1978 BRANDENBURG,JOHNSON,LEITH,LOOS+ (SLAC)
CARITHE1 73 PRL 30 1336 +MODIS,NYGREN,PUN,SCHWARTZ+ (COLU+CERN+NYU)
CARITHE2 73 PRL 31 1025 CARITHERS,NYGREN,GORDON+ (COLU+BNL+CERN)
EVANS 73 PR D7 36 +MUIR,PEACH,BUDAGOV+ (EDINBURGH+CERN)
ALSO 69 PRL 23 427 EVANS,GOLDEN,MUIR,PEACH+ (EDINBURGH+CERN)

FACKLER 73 PRL 31 847 +FRISCH,MARTIN,SMOOT,SOMPAYRAC (MIT)
FITCH 73 PRL 31 1524 +HEPP,JENSEN,STROVINK,WEBB (PRINCETON)
ALSO 72 COO-3072-13 R.C.WEBB (THESIS) (PRINCETON)
GJESDAL 73 2ND AIX CONF +KAMAE,PRESSER,STEFFEN,STEINBER+(CERN+HEID)
HART 73 NP B66 317 +HUTTON,FIELD,SHARP,BLACKMORE+ (CAVE+RHEL)
MALLARY 73 PR D7 1953 +BINNIE,GALLIVAN,GOMEZ,PECK,SCIULLI + (CIT)
ALSO 70 PRL 25 1214 SCIULLI,GALLIVAN,BINNIE,GOMEZ + (CIT)

MCCARTHY 73 PR D7 687 +BREWER,BUDNITZ,ENTIS,GRAVEN,MILLER+ (LBL)
ALSO 72 PL 42B 291 MCCARTHY,BREWER,BUDNITZ,ENTIS,GRAVEN+ (LBL)
ALSO 71 THESIS LBL-550 R.L.MCCARTHY (LBL)
MESSNER 73 PRL 30 876 +MORSE,NAUENBERG,HITLIN + (COLO+SLAC+UCSC)
PEACH 73 PL 43B 441 +EVANS,MUIR,HOPKINS,KRENZ (EDIN+CERN+AACH)
SANDWEIS 73 PRL 30 1002 +SUNDERLAND,TURNER,WILLIS,KELLER (YALE+ANL)
WILLIAMS 73 PRL 31 1521 +LARSEN,LEIPUNER,SAPP,SESSOMS+ (BNL+YALE)

ALBRECHT 74 PL 48B 393 DUBNA+BERLIN+BUDAPEST+PRAGUE+SERPUKH+SOFIA
BISI 74 PL 50B 504 BISI,FERRERO (TORI)
BOBISUT 74 LNC 11 646 +HUZITA,MATTIOLI,PUGLIERIN (PADO)
DONALDS1 74 PRL 33 554 DONALDSON,HITLIN,KENNELLY,KIRKBY + (SLAC)
ALSO 74 DONALDSON 3
DONALDS2 74 PR D9 2960 DONALDSON,FRYBERGER,HITLIN,LIU+ (SLAC+UCSC)
ALSO 73 PRL 31 337 DONALDSON,FRYBERGER,HITLIN,LIU+ (SLAC+UCSC)
DONALDS3 74 SLAC 184-THESIS GREGORY J. DONALDSON (SLAC)

GEWENIG1 74 PL 48B 483 GEWENIGER,GJESDAL,KAMAE,PRESSER+(CERN+HEID)
ALSO 74 CERN INT. REPT. VERA LUTH (THESIS-INT. REPT. 74-4) (HEID)
GEWENIG2 74 PL 48B 487 GEWENIGER,GJESDAL,PRESSER + (CERN+HEID)
ALSO 74 PL 52B 119 GJESDAL,PRESSER,STEFFEN + (CERN+HEID)
GEWENIG3 74 PL 52B 108 GEWENIGER,GJESDAL,PRESSER + (CERN+HEID)
GJESDAL1 74 PL 52B 113 +PRESSER,KAMAE,STEFFEN+ (CERN+HEID)

MESSNER 74 PRL 33 1458 +FRANKLIN,MORSE,NAUENBERG+ (COLO+SLAC+UCSC)
NIEBERGA 74 PL 49B 103 NIEBERGALL,REGLER,STIER + (CERN+ORSA+VIEN)
SLONE 74 SLAC 181-THESIS DAVID NEIL SLONE (SLAC)
WANG 74 PR D9 540 +SMITH,WHATLEY,ZORN,HORNBOSTEL (UMD+BNL)
WILLIAMS 74 PRL 33 240 +LARSEN,LEIPUNER,SAPP,SESSOMS + (BNL+YALE)
WOO 74 LNC 10 38 +BUCHANAN,PEPPER (UCLA)

BALDOCEO 75 NC 25A 688 BALDO-CEOLIN,BOBISUT,CALIMANI+ (PADO+WISC)
BLUMENTH 75 PRL 34 164 BLUMENTHAL,FRANKEL,NAGY + (PENN+CHIC+TEMP)
BUCHANAN 75 PR D11 457 +DRICKEY,PEPPER,RUDNICK + (UCLA+SLAC+JHU)
CARITHER 75 PRL 34 1244 CARITHERS,MODIS,NYGREN,PUN + (COLU+NYU)
SHEN 75 LBL-4275 THESIS GILBERT SHEN (LBL)
FUKUSHIM 76 PRL 36 348 FUKUSHIMA,JENSEN,SURKO,THALER+ (PRIN+MASA)

PAPERS NOT REFERRED TO IN DATA CARDS

ALEXANDE 62 PRL 9 69 G ALEXANDER,S ALMEIDA,F CRAWFORD (LRL)
JOVANOVI 63 BNL CONF 42 JOVANOVIC,FISCHER,BURRIS + (BNL+MARYLAND)
STERN 64 PRL 12 459 STERN,BINFORD,LIND,ANDERSON + (WISC+LRL)
BEHR 65 ARGONNE CONF 59 BEHR,BRISSON,BELLOTTI+ (EPOL,MILA,PADO)
MESTVIRI 65 JINR P 2449 MESTVIRISHVILI,NYAGU,PETROV,RUSAKOV+ (JINR)
TRILLING 65 UCRL 16473 GEORGE H TRILLING (LRL)
UPDATED FROM 1965 ARGONNE CONF., PAGE 115.
GINSBERG 67 PR 162 1570 EDWARD S GINSBERG (U. MASS BOSTON)

RUBBIA 67 PL 24B 531 C.RUBBIA,J.STEINBERGER (CERN+COLU)
ALSO 1 66 PL 20 207 ALFF-STEINBERGER,HEUER,KLEINKNECHT+ (CERN)
ALSO 2 66 PL 21 595 ALFF-STEINBERGER,HEUER,KLEINKNECHT+ (CERN)
ALSO 3 66 PL 23 167 C.RUBBIA,J.STEINBERGER (CERN+COLU)
SCHMIDT 67 NEVIS 160(THESIS) P. SCHMIDT (COLUMBIA)
CRONIN 68 VIENNA CONF P.281 CRONIN,RAPPORTEURS TALK (PRINCETON)
BECHERRA 70 PR D1 1452 T BECHERRAWY (ROCH)
GINSBERG 70 PR D1 229 E S GINSBERG (IIT HAIFA)
HEUSSE 70 LNC 3 449 +AUBERT,PASCAUD,VIALLE (ORSAY)
GINSBERG 73 PR D8 3887 E S GINSBERG, J SMITH (MIT+STON)

****** ********* ********* ********* ********* ********* ********* ********
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14 ETA(549,JPG=0-+) I=0

FOR C. BALTAY'S REVIEW OF THE ETA MESON, SEE PROC. UNIV. OF PENN. CONF. ON MESON SPECTROSCOPY (W.A.BENJAMIN, N.Y., 1968)

------ --------- --------- --------- --------- --------- --------- --------

14 ETA MASS (MEV)

M	53	549.0	1.2	BASTIEN	62	HBC	
M	35	546.0	4.0	PICKUP	62	HBC	
M	91	548.0	1.0	ALFF	62	HBC	
M		549.3	2.9	DELCOURT	63	CNTR	
M	148	549.0	0.7	FOELSCHE	64	HBC	
M	325	552.0	3.0	KRAEMER	64	DBC	
M		548.2	0.65	FOSTER3	65	HBC	7/66
M	250	555.0	2.0	JAMES	66	HBC	6/66
M		. . . . .	. . . .				
M	AVG	548.82	0.56	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)			
M	STUDENT	548.72	0.44	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT			
			(SEE IDEOGRAM BELOW)				

Stable Particles

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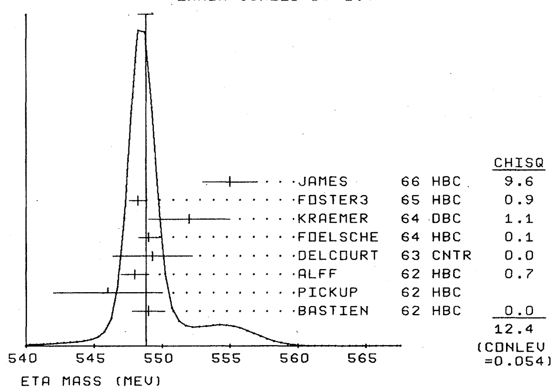
Data Card Listings

For notation, see key at front of Listings.

WEIGHTED AVERAGE = 548.82 ± 0.56
ERROR SCALED BY 1.4



14 ETA WIDTH

```
W        ETA WIDTH DETERMINED FROM MASS SPECTRUM (UNITS MEV)
W         91  (10.0)  OR LESS                ALFF       62 HBC
W        148  (10.0)  OR LESS                FOELSCHE   64 HBC
W         31  (12.0)  OR LESS                JAMES      66 HBC                      6/66
W              (4.0)  OR LESS                BALTAY     66 DBC                      7/66
W               (.9)  OR LESS   CL=.95       JONES      66 CNTR                     8/67

W        ETA WIDTH DETERMINED FROM DECAY RATE (UNITS KEV)
W         THIS IS THE PARTIAL DECAY RATE (W1) FOR THE MODE (ETA INTO 2GAMMA)
W         DIVIDED BY THE FITTED BRANCHING FRACTION (P1) FOR THAT MODE.
W             . . . . . . . . .
W    FIT        0.85      0.12    FROM FIT
```

14 ETA PARTIAL DECAY MODES

```
                                                               DECAY MASSES
P1       ETA INTO 2GAMMA                                        0+    0
P2       ETA INTO 3PIO                                        134+ 134+ 134
P3       ETA INTO PI+ PI- PIO                                 139+ 139+ 134
P4       ETA INTO PI+ PI- GAMMA                               139+ 139+   0
P5       ETA INTO E+ E- PIO (VIOLATES C IN E.M.I.)            134+  .5+  .5
P6       ETA INTO E+ E- PI+ PI-                               139+ 139+  .5+  .5
P7       ETA INTO PIO 2GAMMA                                  134+   0+   0
P8       ETA INTO E+ E- GAMMA                                  .5+  .5+   0
P9       ETA INTO 2PIO GAMMA (VIOLATES C)                     134+ 134+   0
P10      ETA INTO PI+ PI- PIO GAMMA                           139+ 139+ 134+   0
P11      ETA INTO PI+ PI- 2GAMMA                              139+ 139+   0+   0
P12      ETA INTO MU+ MU-                                     105+ 105
P13      ETA INTO MU+ MU- GAMMA                               105+ 105+   0
P14      ETA INTO MU+ MU- PIO                                 105+ 105+ 134
P15      ETA INTO PI+ PI-                                     139+ 139
```

FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
          P 1        P 2        P 3        P 4        P 7        P 8
P 1  .3799+-.0098
P 2    -.2691    .2990+-.0106
P 3    -.3224      -.2353   .2358+-.0056
P 4    -.2866      -.2095      .8201   .0489+-.0013
P 7    -.4271      -.5781     -.0939     -.0801   .0314+-.0109
P 8    -.0434      -.0326     -.0494     -.0501     -.0036   .0050+-.0012
```

FITTED PARTIAL DECAY MODE RATES

The matrix below is the branching fraction matrix above, transformed into rate space; i.e., $G_i \equiv \Gamma_i = \Gamma_{total} P_i$, in appropriate units. In analogy to the matrix above, the diagonal elements are $G_i \pm \delta G_i$, where $\delta G_i = \sqrt{\langle \delta G_i \delta G_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta G_i \delta G_j \rangle / (\delta G_i \cdot \delta G_j)$. Note that, because of the error in Γ_{total}, the errors and correlations here are not directly derivable from those above.

```
          G 1        G 2        G 3        G 4        G 7        G 8
G 1  .3240+-.0460
G 2     .9386    .2550+-.0385
G 3     .9689       .9513   .2011+-.0294
G 4     .9646       .9471     1.0097   .0417+-.0061
G 7     .3661       .3028      .4240      .4226   .0268+-.0104
G 8     .5178       .5082      .5233      .5199      .2318   .0043+-.0012
```

14 ETA DECAY RATES

Note on Conflicting Results for $\eta \to \gamma\gamma$ Decay Rate

The BROWMAN 74 result for $\Gamma_{\gamma\gamma}$ is three standard deviations below the earlier BEMPORAD 67 result. This is because the BEMPORAD 67 analysis finds a negligible strong-production amplitude and attributes all of their observed η photoproduction cross section to Coulomb production. BROWMAN 74, on the other hand, find that the strong-production contribution to the cross section is significant, especially at lower energies, and that the Coulomb contribution is smaller, resulting in a smaller value of $\Gamma_{\gamma\gamma}$.

The η photoproduction data of BROWMAN 74 were taken at incident γ-ray energies of 5.8, 9.0, and 11.45 GeV on beryllium, aluminum, copper, silver, and uranium targets, while the BEMPORAD 67 data were taken at 4.0 and 5.5 GeV on lead, silver, and zinc. The higher energies, higher statistics, better angular resolution, and larger range of atomic weights of the BROWMAN 74 experiment result in a more reliable separation of the Coulomb amplitude from the strong-production amplitude. In addition, the bad approximation mentioned in BROWMAN 74 footnote 4 was present in the theoretical work utilized by BEMPORAD 67 and this may account for some of the discrepancy.

Browman et al. state that the BROWMAN 74 result is compatible with the BEMPORAD 67 data, although the agreement is not as good as that given by the BEMPORAD 67 fit to these data. On the other hand, the BEMPORAD 67 result appears to be incompatible with the 9 GeV data (especially uranium) shown in Fig. 2 of BROWMAN 74.

We quote the BROWMAN 74 result.

```
W1       ETA INTO 2GAMMA (UNITS KEV)                            (G1)
W1   B         (1.00)    (0.22)          BEMPORAD  67 CNTR    PRIMAKOFF EFFECT 11/75*
W1              0.324     0.046          BROWMAN   74 CNTR    PRIMAKOFF EFFECT  7/74*
W1   B    BEMPORAD 67 GIVES W1=1.21+-.26 KEV ASSUMING THAT W1/TOTAL=0.314.      11/75*
W1   B    BEMPORAD PRIVATE COMMUNICATION GIVES MORE GENERAL RESULT AS           11/75*
W1   B    W1*W1/TOTAL=.380+-.083.  WE EVALUATE THIS USING W1/TOTAL=.38+-.01.    11/75*
W1   B    NOT INCLUDED IN AVERAGE BECAUSE THE UNCERTIANTY RESULTING FROM THE     2/76*
W1   B    SEPARATION OF THE COULOMB AND NUCLEAR AMPLITUDES HAS APPARENTLY        2/76*
W1   B    BEEN UNDERESTIMATED.  SEE NOTE ON DISCREPANCY ABOVE.                   2/76*
W1            . . . . . . . . . .
W1   FIT        0.324     0.046   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
```

Data Card Listings

For notation, see key at front of Listings.

Stable Particles

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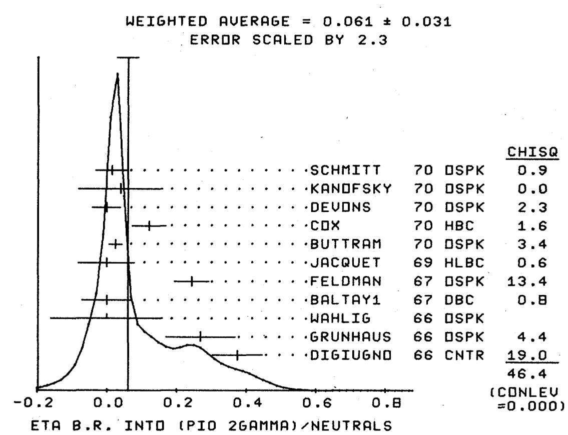
              14  ETA BRANCHING RATIOS

R1      ETA INTO NEUTRALS/CHARGED                         (P1+P2+P7)/(P3+P4+P8)
R1  N   10   (2.5)     (1.0)           PICKUP    62 HBC
R1  N   53   (3.20)    (1.26)          BASTIEN   62 HBC
R1  N        (2.7)     (0.8)           SHAFER    62 HBC
R1            2.6        .9            BUSCHBECK 63 HBC                     7/66
R1  N  280   (4.5)     (1.0)           JAMES     66 HBC                     6/66
R1  N    THESE EXPERIMENTS HAVE NOT BEEN USED IN COMPUTING THE AVERAGES
R1  N    AS THEY WERE UNABLE TO SEPARATE CLEARLY PARTIAL MODES (3) AND (4)
R1  N    FROM EACH OTHER.  THE REPORTED VALUES THUS PROBABLY CONTAIN
R1  N    SOME (UNKNOWN) FRACTION OF MODE (4).
R1            2.64      0.23           BALTAY2   67 DBC                    11/67
R1         . . . . . . . . .
R1  AVG       2.64      0.22    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  STUDENT   2.64      0.24    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1  FIT       2.452     0.081  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R2      ETA INTO 2GAMMA/CHARGED                         (P1)/(P3+P4+P8)
R2            0.99      0.48           CRAWFORD  63 HBC
R2         . . . . . . . . .
R2  FIT       1.311     0.053  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
```

<u>Note on $\eta \to \pi^0\gamma\gamma$</u>

The discrepancies between various measurements of branching ratios involving $\eta \to \pi^0\gamma\gamma$ are displayed in the ideogram below, in which all relevant experiments have been converted to a common ratio, $\pi^0\gamma\gamma$/neutrals. Our branching ratio fit does not include DIGIUGNO 66, FELDMAN 67, or the upper limit measurements. See page 43 of "Review of Particle Properties", Physics Letters 39B, No. 1 (1972) for more discussion.

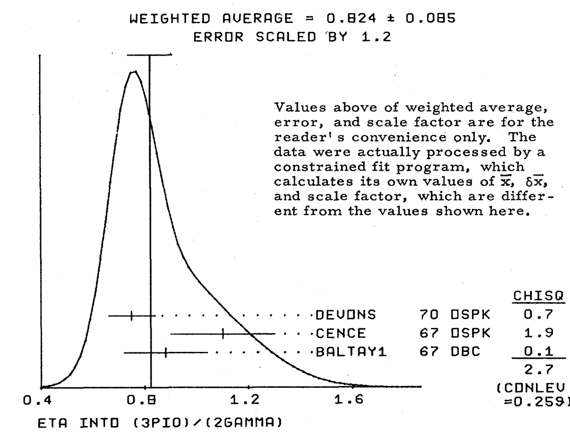



```
R3      ETA INTO (PIO 2GAMMA)/NEUTRALS                (P7)/(P1+P2+P7)
R3  S        (0.375)  (0.072)           DIGIUGNO  66 CNTR    ERROR DOUBLED    6/66
R3       THE ERRORS OF DIGIUGNO+ 66 HAVE BEEN INCREASED BY A FACTOR
R3       OF TWO, TO TAKE INTO ACCOUNT POSSIBLE SYSTEMATIC ERRORS, AS
R3       SUGGESTED BY THE AUTHORS.
R3             .27       .10            GRUNHAUS  66 OSPK                   8/67
R3  R        (.028)   (.044)            BUNIATOV  67 OSPK                  11/67
R3  S        (.244)   (.05)             FELDMAN   67 OSPK                   8/67
R3  S    SEE THE NOTE ON ETA DECAY INTO NEUTRALS ABOVE.
R3             .026      .019           BUTTRAM   70 OSPK                  12/70
R3             .122      .052      .044 COX       70 HBC                    6/70
R3           (.07) OR LESS  CL=.90      DEVONS    70 OSPK                  12/70
R3 R     16    .016      .047           SCHMITT   70 OSPK                  12/70
R3 R     SCHMITT 70 IS A REANALYSIS BUNIATOV 67
R3  E        (0.11)   (0.03)            STRUGALSK 71 HLBC                   5/71
R3  E    THIS MEASUREMENT HAS BEEN EXCLUDED BECAUSE THE ERROR APPEARS       2/71
R3  E    TO BE SERIOUSLY UNDERESTIMATED.                                    2/71
R3          . . . . . . . . .
R3  AVG        0.042     0.023   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R3  STUDENT    0.039     0.019   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R3  FIT        0.044     0.015  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R4      ETA INTO (PI+ PI- GAMMA)/(PI+ PI- PIO)          (P4)/(P3)
R4             0.14      0.08           FOELSCHE  64 HBC
R4  M    24  (0.73)   (0.25)            PAULI     64 DBC
R4  M    THIS EXPERIMENT HAS NOT BEEN INCLUDED IN THE AVERAGES SINCE IT IS
R4  M    NOT CLEAR THAT THEIR CLASS B EVENTS ARE ACTUALLY FROM ETAS.
R4             0.30      0.06           CRAWFORD  66 HBC                    6/66
R4              .10       .10           KRAEMER   64 CBC                    7/66
R4              .196      .041          FOSTER3   65 HBC                    7/66
R4              .25       .035          LITCHFIEL 67 DBC                    8/67
R4             0.28      0.04           BALTAY2   67 DBC                   11/67
R4     7250     .201      .006          GORMLEY   70 ASPK                   6/70
R4      18K    0.209     0.004          THALER    73 ASPK                   6/73
R4          . . . . . . . . .
R4  AVG        0.2074    0.0037  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R4  STUDENT    0.2074    0.0037  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R4  FIT        0.2075    0.0033 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
```

```
R5      ETA INTO (3PIO) + 2/3(PIO 2GAMMA)/ PI+PI-PIO     (P2+2/3P7)/P3
R5            0.83      0.32           CRAWFORD  63 HBC                     7/66
R5            2.0       1.0            FOELSCHE  64 HBC                     7/66
R5            0.90      0.24           FOSTER1   65 HBC                     7/66
R5         . . . . . . . . .
R5  AVG       0.91      0.19    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  STUDENT   0.91      0.20    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R5  FIT       1.357     0.057  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R6      ETA INTO 3PIO/2GAMMA                             (P2)/(P1)
R6           (.90) OR MORE             CHRETIEN  62 PBC
R6            0.88      0.16           BALTAY1   67 DBC                    11/67
R6            1.1       0.2            CENCE     67 OSPK                    1/68
R6            0.75      0.09           DEVONS    70 OSPK                   12/70
R6         . . . . . . . . .
R6  AVG       0.824     0.085   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R6  STUDENT   0.821     0.085   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R6  FIT       0.787     0.039  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                        (SEE IDEOGRAM BELOW )
```

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R7      ETA INTO 2GAMMA/(PI+ PI- PO)                     (P1)/(P3)
R7            1.61      0.39           FOSTER1   65 HBC
R7     401    1.72       .25           BAGLIN    69 HLBC                    7/69
R7         . . . . . . . . .
R7  AVG       1.69      0.21    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R7  STUDENT   1.69      0.23    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R7  FIT       1.611     0.065  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R8      ETA INTO NEUTRAL/(PI+ PI- PIO)                   (P1+P2+P7)/(P3)
R8      50    3.6       0.8            KRAEMER   64 DBC
R8            3.8       1.1            PAULI     64 DBC                     7/66
R8            2.89      0.56           ALFF-STEI 66 HBC                     9/66
R8     244    3.6       0.6            FLATTE2   67 HBC                     1/68
R8      29    3.4       1.1            AGUILAR-B 72 HBC                    11/72
R8 B    70    2.83      0.80           BLOODWORT 72 HBC                    11/72
R8      74    2.54      1.89           KENDALL   74 OSPK                   12/75*
R8 B    ERROR INCREASED FROM PUBLISHED VALUE 0.5 BY BLOODWORTH, PRIV. COMM.  1/73
R8         . . . . . . . . .
R8  AVG       3.26      0.30    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R8  STUDENT   3.26      0.33    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R8  FIT       3.01      0.10   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R9      ETA INTO (E+E-PIO)/(PI+PI-PIO) (UNITS 10**-4)    (P5)/(P3)
R9           110.     OR LESS          PRICE     65 HBC
R9       0    77.     OR LESS          FOSTER2   65 HBC
R9            42.     OR LESS  CL=.90  BAGLIN1   67 HLBC                    8/67
R9       0    16.     OR LESS  CL=.90  BILLING   67 HLBC                   11/67
R9            1.9     OR LESS  CL=.90  JANE1     75 OSPK                   12/75*

R10     ETA INTO (E+E-PI+PI-)/TOTAL (UNITS 10**-2)       (P6)
R10          (0.7)    OR LESS          RITTENBER 65 HBC                     6/66

R11     ETA INTO (E+E-PI+PI-)/(PI+PI-GAMMA)              (P6)/(P4)
R11      1    0.026     0.026          GROSSMAN  66 HBC                     6/66

R12     ETA INTO 2 GAMMA/NEUTRALS                        (P1)/(P1+P2+P7)
R12 S        (0.416)  (0.044)          DIGIUGNO  66 CNTR   ERROR DOUBLED    6/66
R12            .44       .07           GRUNHAUS  66 OSPK                    8/67
R12 S        (.579)   (.052)           FELDMAN   67 OSPK                    8/67
R12 S    SEE THE NOTE ON ETA DECAY INTO NEUTRALS ABOVE.
R12 T        (0.39)   (0.06)           JONES     66 CNTR                    8/67
R12 T    THIS RESULT FROM COMBINING CROSS SECTIONS FROM TWO DIFFERENT EXPTS.
R12            .59       .033          BUNIATOV  67 OSPK                   11/67
R12            .535      .018          BUTTRAM   70 OSPK                   12/70
R12            .486      .036          COX       70 HBC                     6/70
R12           0.57      0.09           STRUGALSK 71 HLBC                    5/71
R12     113   0.60      0.14           KENDALL   74 OSPK                   12/75*
R12        . . . . . . . . .
R12 AVG       0.535     0.018   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R12 STUDENT   0.535     0.016   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R12 FIT       0.535     0.013  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)
                        (SEE IDEOGRAM BELOW )

R13     ETA INTO 3PIO/NEUTRALS                           (P2)/(P1+P2+P7)
R13 S        (0.209)  (0.054)          DIGIUGNO  66 CNTR   ERROR DOUBLED    6/66
R13 R        (.29)    (.10)            GRUNHAUS  66 OSPK                    8/67
R13 S        (.177)   (.035)           FELDMAN   67 OSPK                    8/67
R13 S    SEE THE NOTE ON ETA DECAY INTO NEUTRALS ABOVE.
R13            .41       .033          BUNIATOV  67 OSPK                   11/67
R13 R    REDUNDANT INFORMATION FROM THIS EXPERIMENT.
R13 R        (.439)   (.024)           BUTTRAM   70 OSPK                   12/70
R13            .392      .042          COX       70 HBC                     6/70
R13           0.32      0.09           STRUGALSK 71 HLBC                    5/71
R13      75   0.40      0.14           KENDALL   74 OSPK                   12/75*
R13        . . . . . . . . .
R13 AVG       0.397     0.025   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R13 STUDENT   0.397     0.027   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R13 FIT       0.421     0.014  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
```

Stable Particles

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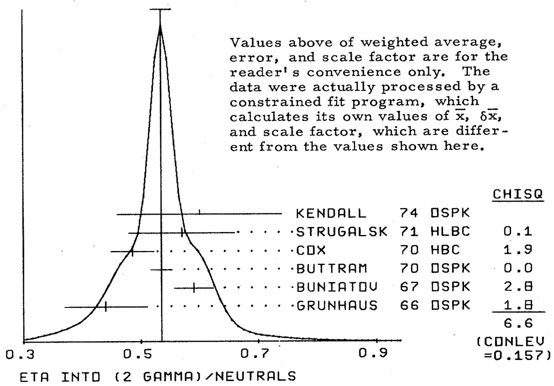
Data Card Listings

For notation, see key at front of Listings.

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R14     ETA INTO PIO (2 GAMMA)/2GAMMA                  (P7)/(P1)
R14          (.5) OR LESS  CL=.90   WAHLIG     66 SPRK                    7/66
R14          0.0       0.14         BALTAY1    67 DBC                    11/67
R14 P        (0.05)    (0.04)       BONAMY     67 SPRK  PRELIMINARY RESULT 11/67
R14          . . . . . . . . .
R14 FIT      0.083     0.030   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R15     ETA INTO (E+E-PIO)/TOTAL (UNITS 10**-2)        (P5)
R15          (0.7)  OR LESS          RITTENBER 65 HBC                     6/66
R15          (0.084)OR LESS  CL=.90  BAZIN     68 DBC                     6/68

R16     ETA INTO 2GAMMA/(3PIO + PIO 2GAMMA)            (P1)/(P2+P7)
R16          0.80       .25          BACCI      63 CNTR                   7/66
R16          . . . . . . . . .
R16 FIT      1.150     0.060   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R17     ETA INTO (PI+PI-PIO GAMMA)/(PI+PI-PIO) (UNITS 10**-2)
R17                                                    (P10)/(P3)
R17          (7.0)  OR LESS          FLATTE     67 HBC                    8/67
R17          (0.9)  OR LESS          PRICE      67 HBC                    8/67
R17          (1.6)  OR LESS  CL=.95  BALTAY2    67 DBC                   11/67
R17          (1.7)  OR LESS  CL=.90  ARNOLD     68 HLBC                   9/68
R17  T  O    0.24   OR LESS  CL=.90  THALER     73 ASPK                   6/73
R17  T  O    0.0       0.15          LIMIT ABOVE RESTATED FOR AVERAGING   6/73

R18     ETA INTO (PI+PI- 2GAMMA)/(PI+PI-PIO)            (P11)/(P3)
R18          (.009)OR LESS           PRICE      67 HBC                    8/67
R18          (.016)OR LESS  CL=.95   BALTAY2    67 DBC                   11/67

R19     ETA INTO 3PIO/(PI+ PI- PIO)                     (P2)/(P3)
R19          1.3        .4              BAGLIN2    67 HLBC                8/67
R19          1.47      0.20     0.17    BULLOCK    68 HLBC                9/68
R19     199  1.50       .15      .29    BAGLIN     69 HLBC                7/69
R19          . . . . . . . . .
R19 AVG      1.46      0.13     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R19 STUDENT  1.46      0.14     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R19 FIT      1.268     0.060   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R20     ETA INTO 2GAMMA/((3PIO)+2/3(PIO 2GAMMA))        (P1)/(P2+2/3P7)
R20          1.10       0.5          MULLER     63 DBC                    7/66
R20          . . . . . . . . .
R20 FIT      1.187     0.058   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R21     ETA INTO NEUTRALS/TOTAL                         (P1+P2+P7)
R21          .79        .08          BUNIATOV   67 OSPK                  11/67
R21     16K  .705       .008         BASILE     71 CNTR MM SPECTROMETER   8/71
R21          . . . . . . . . .
R21 AVG      0.7058    0.0080  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R21 STUDENT  0.7058    0.0086  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R21 FIT      0.7103    0.0068 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R22     ETA INTO (PIO 2GAMMA)/TOTAL                     (P7)
R22          .12  OR LESS  CL=.95    JACQUET    69 HLBC                   6/70
R22          . . . . . . . . .
R22 FIT      0.031     0.011   FROM FIT

R23     ETA INTO MU+MU-/TOTAL (UNITS 10**-5)            (P12)
R23       0  2.     OR LESS  CL=.95  WEHMANN    68 OSPK                   4/68

R24     ETA INTO MU+MU-PIO/TOTAL (UNITS 10**-4)         (P14)
R24          5.     OR LESS          WEHMANN    68 OSPK                   4/68

R25     ETA INTO MU+MU-/2GAMMA (UNITS 10**-5)           (P12)/(P1)
R25          5.9        2.2          HYAMS      69 OSPK                   7/69

R26     ETA INTO (PIO 2GAMMA)/(3PIO + PIO 2GAMMA)       (P7)/(P2+P7)
R26  N       0.1        0.3          KANOFSKY   70 OSPK                   2/71
R26  N  WE HAVE CHANGED THE ERROR ON THIS EXPERIMENT FROM +0.3,-0.1       2/71
R26  N  TO THE ABOVE +0.3,-0.3 SINCE IT IS CLEAR FROM FIGURE 7 IN THE     2/71
R26  N  ARTICLE THAT A CENTRAL VALUE OF 0.0 IS ABOUT AS PROBABLE AS THE   2/71
R26  N  QUOTED VALUE OF 0.1.                                              2/71
R26          . . . . . . . . .
R26 FIT      0.095     0.032   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R27     ETA INTO (PI+ PI-)/TOTAL (UNITS 10**-2)         (P15)             6/73
R27       0  (0.15) OR LESS          THALER     73 ASPK CON. LEV. NOT GIVEN 6/73

R28     ETA INTO (E+E-GAMMA)/(PI+PI-PIO) (UNITS 10**-2)  (P8)/(P3)
R28  J  80   2.1        0.5          JANE2      75 OSPK                  2/76*
R28  J  VALUE CHANGED BY ERRATUM.                                        2/76*
R28          . . . . . . . . .
R28 FIT      2.11      0.50    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
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                 14  ETA C-NONCONSERVING DECAY PARAMETERS

      RELATED TEXT SECTION VI C.1

A1      LEFT-RIGHT ASYMMETRY PARAMETER FOR PI+ PI- PIO  (UNITS 10**-2)
A1    1351     7.2       2.8            BALTAY     66 DBC                  8/66
A1    1300     5.8       3.4            CLPWY      66 HBC                  8/66
A1   10665    (0.3)     (1.0)           CNOPS      66 OSPK REPL BY MULLER 69  8/67
A1     705    -6.1       4.0            LARRIBE    66 HBC                  8/67
A1  G36800    (1.5)     (.5)            GORMLEY3   68 ASPK                 6/68
A1   10709      .3       1.1            MULLER     69 OSPK                 9/69
A1    1138    -1.4       3.             CARPENTR   70 HBC                  6/70
A1     349     3.2       5.4            DANBURG    70 DBC                  2/71
A1    220K    -0.05      0.22           LAYTER     72 ASPK                 8/72
A1    165K     0.28      0.26           JANE1      74 OSPK                 3/74
A1  G   GORMLEY3 68 ASYMMETRY PROBABLY DUE TO UNMEASURED (E X B) SPK. CH.  3/74
A1  G   EFFECTS.  NEW EXPTS. WITH (E X B) CONTROLS DONT OBSERVE ASYMMETRY. 3/74
A1         . . . . . . . . .
A1  AVG        0.12      0.17     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A1  STUDENT    0.11      0.19     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

A2      LEFT-RIGHT ASYMMETRY PARAMETER FOR PI+ PI- GAMMA (UNITS 10**-2)
A2      33    -2.        17.            CRAWFORD   66 HBC                 11/66
A2            -4.        8.             LITCHFIEL  67 DBC                  8/67
A2 N  1620     1.5       2.5            MULLER     69 OSPK                 9/69
A2    7257     1.22      1.56           GORMLEY    70 ASPK                 6/70
A2     36K     0.5       0.6            THALER     72 ASPK                 8/72
A2     35K     1.2       0.6            JANE2      74 OSPK                 3/74
A2 N  MULLER 69 IS SENSITIVE ONLY TO UPPER .4 OF GAMMA-RAY SPECTRUM.
A2         . . . . . . . . .
A2  AVG        0.88      0.40     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A2  STUDENT    0.88      0.45     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

AS      SEXTANT ASYMMETRY PARAMETER FOR PI+ PI- PIO  (UNITS 10**-2)
AS    1300     6.8       3.3            CLPWY      66 HBC                12/75*
AS     705    -2.4       4.0            LARRIBE    66 HBC                12/75*
AS     37K     0.5       0.5            GORMLEY3   68 WIRE               12/75*
AS    220K     0.10      0.22           LAYTER     72 ASPK               12/75*
AS    165K     0.20      0.25           JANE1      74 OSPK               12/75*
AS         . . . . . . . . .
AS  AVG        0.19      0.16     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
AS  STUDENT    0.19      0.17     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

AQ      QUADRANT ASYMMETRY PARAMETER FOR PI+ PI- PIO (UNITS 10**-2)
AQ    220K    -0.07      0.22           LAYTER     72 ASPK               12/75*
AQ    165K    -0.30      0.25           JANE1      74 OSPK               12/75*
AQ         . . . . . . . . .
AQ  AVG       -0.17      0.17     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
AQ  STUDENT   -0.17      0.18     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

BET     BETA FOR ETA TO PI+ PI- GAMMA. SENSITIVE TO D-WAVE CONTRIBUTION.
BET     DN/DCOS THETA = SIN**2 THETA * (1 + BETA * COS**2 THETA)         12/75*
BET   7250    -0.060     0.065          GORMLEY    70 WIRE               12/75*
BET L          0.12      0.06           THALER     72 ASPK               12/75*
BET    35K     0.11      0.11           JANE2      74 OSPK               12/75*
BET L   AUTHORS DONT BELIEVE THIS TO INDICATE D-WAVE BECAUSE DEPENDENCE OF 12/75*
BET L   BETA ON GAMMA ENERGY INCONSISTENT WITH THEOR. PREDICTION.        12/75*
BET L   COS**2 DEPENDENCE MAY ALSO COME FROM P AND F-WAVE INTERFERENCE.  12/75*
BET        . . . . . . . . .
BET AVG        0.047     0.062    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
BET STUDENT    0.053     0.053    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

                 14  ENERGY DEPENDENCE OF ETA DALITZ PLOT

DP      RELATED TEXT SECTION VI C.2
DP      THE FOLLOWING EXPTS FIT TO ONE OR MORE OF THE COEFFICIENTS
DP      A,B,C,D, OR E FOR ETA TO PI+ PI- PIO
DP      MATRIX ELEMENT**2=1 + A*Y + B*(Y**2) + C*X + D*(X**2) + E*X*Y
DP    1300 SEE TEXT SEC VI C.2          CLPWY      66 HBC                12/75*
DP     705 SEE TEXT SEC VI C.2          LARRIBE    66 HBC                12/75*
DP    7170 SEE TEXT SEC VI C.2          CNOPS      68 OSPK               12/75*
DP     37K SEE TEXT SEC VI C.2          GORMLEY3   68 WIRE               12/75*
DP     526 SEE TEXT SEC VI C.2          BAGLIN     69 HLBC               12/75*
DP    1138 SEE TEXT SEC VI C.2          CARPENTR   70 HBC                12/75*
DP     349 SEE TEXT SEC VI C.2          DANBURG    70 DBC                12/75*
DP    7250 SEE TEXT SEC VI C.2          GORMLEY    70 WIRE               12/75*
DP    220K SEE TEXT SEC VI C.2          LAYTER     72 ASPK               12/75*
DP     81K SEE TEXT SEC VI C.2          LAYTER     73 ASPK               12/75*

AO      ALPHA PARAMETER FOR ETA TO 3 PIO
AO      MATRIX ELEMENT **2 = 1 + 2*ALPHA*Z (SEE TEXT SEC VI C.3)         12/75*
AO     192    -0.32      0.37           BAGLIN     70 HLBC               12/75*

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REFERENCES FOR ETA


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PEVSNER   61 PRL 7 421           PEVSNER,KRAEMER,NUSSBAUM,RICHARDSON + (JHU)

ALFF      62 PRL 9 322           ALFF,BERLEY,COLLEY,BRUGGER + (COLU+RUTGERS)
BASTIEN   62 PRL 8 114           BASTIEN,BERGE,DAHL,FERRO-LUZZI +      (LRL)
CHRETIEN  62 PRL  9  127         CHRETIEN+   (BRAN+BROWN+HARVARD+MIT+PADOVA)
PICKUP    62 PRL 8 329           E PICKUP,ROBINSON,SALANT         (CNRC+BNL)
SHAFER    62 CERN CONF 307       J SHAFER,FERRO-LUZZI,MURRAY +      (UCB+LRL)

BACCI     63 PRL 11 37           BACCI,PENSO,SALVINI +           (ROMA+FRAS)
BUSCHBEC  63 SIENA CONF 1 166    BUSCHBECK-CZAPP,COOPER + (VIENNA,CERN,AMST)
CRAWFORD  63 PRL 10 546          F S CRAWFORD,LLOYD,FOWLER         (LRL+DUKE)
  ALSO    66 PRL 16 907          F S CRAWFORD,L LLOYD,E FOWLER     (LRL+DUKE)
DELCOURT  63 PL 7 215            DELCOURT,LEFRANCOIS,PEREZ Y JORBA+  (ORSAY)
MULLER    63 SIENA CONF 99       MULLER,PAULI +                  (SACL+ROMA)

FOELSCHE  64 PR 134 B 1138       H W FOELSCHE,H L KRAYBILL            (YALE)
KRAEMER   64 PR 136 B 496        KRAEMER,MADANSKY,FIELDS +    (JHU+NWES+WOOD)
PAULI     64 PL 13 351           E PAULI,A MULLER                    (SACLAY)

FOSTER1   65 PR 138 B 652        FOSTER,PETERS,MEER,LOEFFLER + (WISC+PURDUE)
FOSTER2   65 ATHENS              FOSTER,GOOD,MEER                 (WISCONSIN)
FOSTER3   65 THESIS              M.C.FOSTER                       (WISCONSIN)
PRICE     65 PRL  15  123        L.R.PRICE,F.S.CRAWFORD                (LRL)
RITTENBE  65 PRL 15 556          RITTENBERG,KALBFLEISCH            (LRL+BNL)

ALFF-STE  66 PR 145 1072         ALFF-STEINBERGER,BERLEY+ (COLUMBIA+RUTGERS)
BALTAY    66 PRL 16 1224         +FRANZINI,KIM,KIRSCH+(COLUMBIA+STONY BROOK)
CLPWY     66 PR 149  1044        COLUMBIA,LRL,PURDUE,WISCONSIN,YALE
CNOPS     66 PL 22 546           CNOPS,FINOCCHIARS,LASSALLE,(CERN,ETHZ,SACL)
CRAWFORD  66 PRL  16  333        F.S.CRAWFORD,L.R.PRICE                (LRL)
DIGIUGNO  66 PRL 16 767          DIGIUGNO,GIORGI,SILVESTRI+ (NAPL,TRST,FRAS)
GROSSMAN  66 PR 146  993         R GROSSMAN,L PRICE,F CRAWFORD         (LRL)
GRUNHAUS  66 THESIS              J.GRUNHAUS                       (COLUMBIA)
JAMES     66 PR 142   896        F E JAMES,H L KRAYBILL           (YALE+BNL)
JONES     66 PL 23  597          JONES,BINNIE,DUANE,HORSEY,MASON,(LOIC,RHEL)
LARRIBE   66 PL 23 600           LARRIBE,LEVEQUE,MULLER,PAULI,+  (SACL+RHEL)
WAHLIG    66 PRL  17  221        WAHLIG,SHIBATA,MANNELLI          (MIT+PISA)
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

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BAGLIN1 67 PL 24B 637 BAGLIN,BEZAGUET,DEGRANGE,+ (EPOL+UCB)
BAGLIN2 67 BAPS 12 567 BAGLIN,BEZAGUET,DEGRANGE,+ (EPOL+UCB)
BALTAY1 67 PRL 19 1495 BALTAY,FRANZINI,KIM,NEWMAN+ (COLU+BRAN)
BALTAY2 67 PRL 19 1498 BALTAY,FRANZINI,KIM,NEWMAN+ (COLU+STON)
BEMPORAD 67 PL 25B 380 BEMPORAD,BRACCINI,FOA,LUBELSMEY+(PISA,BONN)
ALSO PRIVATE COMMUNICATION
BILLING 67 PL 25B 435 BILLING,BULLOCK,ESTEN,GOVAN,+ (LOUC,OXF)
BONAMY 67 HEIDELBERG CONF. BONAMY,SONDEREGGER (SACLAY)
BOWEN 67 PL 24B 206 BOWEN,CNOPS ,FINOCCHIARO,+ (CERN+ETHZ+SACL)
BUNIATOV 67 PL 25B 560 BUNIATOV,ZAVATTINI,DEINET,+ (CERN+KARL)
CENCE 67 PRL 19 1393 CENCE,PETERSON,STENGER,CHIU+ (HAWAII+LRL)
FELDMAN 67 PRL 18 868 FELDMAN,FRATI,GLEESON,HALPERN,+ (PENN)
FLATTE 67 PRL 18 976 S.M.FLATTE (LRL)
FLATTE2 67 PR 163 1441 S.M.FLATTE AND C.G.WOHL (LRL)
LITCHFIE 67 PL 24B 486 LITCHFIELD,RANGAN,SEGAR,SMITH+(RHEL+SACLAY)
PRICE 67 PRL 18 1207 L.R.PRICE,F.S.CRAWFORD (LRL)

ARNOLD 68 PL 27B 466 +PATY,BAGLIN,BINGHAM+ (STRB+MADR+EPOL+UCB)
BAZIN 68 PRL 20 895 BAZIN,GOSHAW,ZACHER,+ (PRINCETON,QUEENS)
BULLOCK 68 PL 27B 402 +ESTEN,FLEMING,GOVAN,HENDERSON,OWEN+ (LOUC)
GORMLEY3 68 PRL 21 402 GORMLEY,HYMAN,LEE,NASH,PEOPLES+ (COLU+BNL)
WEHMANN 68 PRL 20 748 WEHMANN,ENGELS,+ (HARV+CASE+SLAC+CORN+MCGI)

BAGLIN 69 PL 29B 445 BAGLIN,BEZAGUET,+ (EPOL,UCB,MADR,STRB)
ALSO 70 NP B22 66 +BEZAGUET,DEGRANGE,MUSSET +(EPOL,MADR,STRB)
HYAMS 69 PL 29B 128 HYAMS,KOCH,POTTER,VON LINDERN,+ (CERN,MPIM)
JACQUET 69 NC 58 743 JACQUET,NGUYEN-KHAC,HAATUFT+ (EPOL,BERG)
MULLER 69 THESIS ARMAND MULLER (STRB)

BAGLIN 70 NP B22 66 +BEZAGUET,DEGRANGE,MUSSET+ (EPOL+MADR+STRB)
BUTTRAM 70 PRL 25 1358 +KREISLER,MISCHKE (PRIN)
CARPENTR 70 PR D1 1303 CARPENTER,BINKLEY,CHAPMAN,COX,DAGAN+ (DUKE)
COX 70 PRL 24 534 COX,FORTNEY,GOLSON (DUKE)
DANBURG 70 PR D2 2564 +ABOLINS,DAHL,DAVIES,HOCH,KIRZ,+ (LRL)
DEVONS 70 PR D1 1936 +GRUNHAUS,KOZLOWSKI,NEMETHY + (COLU,SYRA)
GORMLEY 70 PR D2 501 GORMLEY,HYMAN,LEE,NASH,PEOPLES+ (COLU+BNL)
ALSO 70 NEVIS 181(THESIS) MICHAEL GORMLEY (COLU)
KANOFSKY 70 NC 68 413 A. KANOFSKY (LEHI)
SCHMITT 70 PL 32B 638 +BUNIATOV,ZAVATTINI,DEINET+ (CERN,KARL)

BASILE 71 NC 3A 796 +BOLLINI,DALPIAZ,FRABETTI+ (CERN,BGNA,STRB)
STRUGALS 71 NP B27 429 +CHUVILO,GEMESY,IVANOVSKAYA+ (JINR)
AGUILAR- 72 PR D6 29 AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS (BNL)
BLOODWOR 72 NP B39 525 BLOODWORTH,JACKSON,PRENTICE,YOON (TORONTO)
LAYTER 72 PRL 29 316 +APPEL,KOTLEWSKI,LEE,STEIN,THALER (COLU)
THALER 72 PRL 29 313 +APPEL,KOTLEWSKI,LAYTER,LEE,STEIN (COLU)
THALER 73 PR D7 2569 +APPEL,KOTLEWSKI,LAYTER,LEE,STEIN (COLU)
BROWMAN 74 PRL 32 1067 +DEWIRE,GITTELMAN,HANSON,LOH + (CORN+BING)
JANE1 74 PL 48B 260 +JONES,LIPMAN,OWEN,PENNEY+ (RHEL+LOWC+SUSS)
JANE2 74 PL 48B 265 +JONES,LIPMAN,OWEN,PENNEY+ (RHEL+LOWC+SUSS)
KENDALL 74 NC 21A 387 +LANOU,MASSIMO,SHAPIRO + (BROW+BARI+MIT)
JANE1 75 PL 59B 99 +GRANNIS,JONES,LIPMAN,OWEN + (RHEL+LOWC)
JANE2 75 PL 59B 103 +GRANNIS,JONES,LIPMAN,OWEN + (RHEL+LOWC)
ALSO 76 PL (TO BE PUBL.) ERRATUM, M.R.JANE, PRIVATE COMMUNICATION.

QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

BASTIEN 62 PRL 8 114 BASTIEN,BERGE,DAHL,FERRO-LUZZI,MILLER+(LRL)
CARMONY 62 PRL 8 117 D CARMONY,A ROSENFELD,VAN DE WALLE (LRL)
ROSENFEL 62 PRL 8 293 A ROSENFELD,D CARMONY,VAN DE WALLE (LRL)

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16 PROTON(938,J=1/2) I=1/2

16 PROTON MASS (MEV)

M	(938.256) (0.005)	COHEN	65 RVUE		7/66
M	(938.2592) (0.0052)	TAYLOR	69 RVUE	USING NEW E/H	7/70
M	938.2796 0.0027	COHEN	73 RVUE		3/74

16 PROTON MEAN LIFE (UNITS 10**26 YR)

T	(.000001)OR MORE	GOLDHABE	54 TH 232 FISS.MODE INDEPEN	
T	(0.002)OR MORE	FLEROV	57 TH 232 FISS.MODE INDEPEN	
T B	(1.5) OR MORE	BACKENSTO	60 CNTR	
T B	(60.0) OR MORE	KROPP	65 CNTR	
T	(200.0) OR MORE	GURR	67 CNTR DEP. ON DECAY MODE	
T	(1300.0) OR MORE	BERGAMASC	74 CNTR	12/75*
T R	20000.0 OR MORE	REINES	74 CNTR	12/75*

T B KROPP AND BACKENSTOSS SENSITIVE TO PARTICULAR DECAY MODES OF PROTON
T R REINES 74 LOOKS AT DECAY CHAINS ENDING IN MUON DECAY. 12/75*

16 PROTON MAGNET. MOMENT(E/2MP)

MM	(2.79276) (.00002)	COHEN	65 RVUE		
MM	(2.792782)(.000017)	TAYLOR	69 RVUE	USING NEW E/H	7/70
MM	2.7928456 .0000011	COHEN	73 RVUE		3/74

16 ANTIPROTON MAGNETIC MOMENT (E/2MP)

MM1 O	(-1.8) (1.2)	BUTTON	62 CNTR	
MM1 R	(-2.83) (0.10)	FOX	72 CNTR	11/75*
MM1 R	-2.819 0.056	ROBERTS	74 CNTR	7/75*

MM1 O OLD EXPERIMENT WITH LARGE ERROR. NOT AVERAGED.
MM1 R ROBERTS 74 IS REANALYSIS OF FOX 72 DATA. REPLACES OLD FOX VALUE. 7/75*

16 PROTON ELECTRIC DIPOLE MOMENT (UNITS 10**-23 E CM)
NONZERO VALUE IMPLIES VIOLATION OF T AND P IN EM INTERACTION

EDM	1G 700.	900.	HARRISON	69 MBR	10/69

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REFERENCES FOR PROTON

GOLDHABE 54 PR 96 1157 FNOTE2 GOLDHABER,F REINES+ (LOS ALAMOS,BNL)
FLEROV 57 SOV PHYS DOK 3 79 FLEROV,KLOCHKOV,SKOBKIN,TERENTEV (USSR)
BACKENST 60 NC 16 749 BACKENSTOSS,FRAUENFELDER,HYAMS + (CERN)
BUTTON 62 PR 127 1297 J BUTTON,B MAGLIC (LBL)
COHEN 65 RMP 37 537 +DUMOND (N.AMER.AVIATION SCIENCE CENT.,CIT)
KROPP 65 PR 137 B 740 W R KROPP,F REINES (CASE INST TECHNOLOGY)
GURR 67 PR 158 1321 GURR,KROPP,REINES,MEYER (CASE,JOHANNESBURG)

HARRISON 69 PRL 22 1263 HARRISON,SANDARS,WRIGHT (CLARENDON OXFORD)
TAYLOR 69 RMP 41 375 +PARKER,LANGENBERG (PRIN+UCI+PENN)
FOX 72 PRL 29 193 +BARNES,EISENSTEIN+(BNL+CARN+VPI+WILL+WYOM)
COHEN 73 J.PHYS.CHEM.REF.DATA 2, P.663, E.R.COHEN,B.N.TAYLOR
BERGAMAS 74 LNC 11 636 BERGAMASCO,PICCHI (TORI+FRAS)
REINES 74 PRL 32 493 +CROUCH (UCI+CASE)
ROBERTS 74 PRL 33 1181 +COX,ECKHAUSE+ (WILL+VPI+CARN+WYOM+CIT+BNL)
ALSO 75 PR D12 1232 ROBERTS,COX + (WILL+VPI+CARN+WYOM+CIT+BNL)

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n

17 NEUTRON(939,J=1/2) I=1/2

17 NEUTRON MASS (MEV)

M T	(939.5527) (0.0052)	TAYLOR	69 RVUE	USING NEW E/H	7/70
M T	939.5731 0.0027	COHEN	73 RVUE		3/74

M T THESE DETERMINATIONS OF NEUTRON MASS NOT INDEPENDENT OF 7/70
M T NEUTRON-PROTON MASS DIFFERENCE MEASUREMENTS BELOW. 7/70

17 (NEUTRON) - (PROTON) MASS DIFFERENCE (MEV)

D M	(1.29344)(0.00007)	MATTAUCH	65 RVUE	3/71
D	1.29343 0.00004	COHEN	74 RVUE	3/74

D M WE HAVE CONVERTED MATTAUCH NEUTRON-HYDROGEN MASS DIFFERENCE TO 3/71
D M NEUTRON-PROTON MASS DIFFERENCE USING CURRENT VALUE OF ELECTRON MASS 3/71
D M AND A HYDROGEN BINDING ENERGY OF 13.6 EV. 3/71

17 NEUTRON MAGNETIC MOMENT (MAGNETONS,938.2 MEV)

MM	-1.913148 0.000066	COHEN	56 RVUE	7/66

17 NEUTRON ELECTRIC DIPOLE MOMENT (UNITS 10**-23 E CM)
TEST OF CP OR T VIOLATION IN THE EM INTERACTION

EDM	(5.) OR LESS	BAIRD	69 MBR	INCLUDED IN DRESS73	10/69
EDM	0.32 0.75	DRESS	73 MBR	.LT.10**-23 CL=.80	6/73

17 NEUTRON MEAN LIFE (UNITS 10**3 SEC)

THE MEASUREMENT OF THE NEUTRON MEAN LIFE BY SOSNOVSKII 59 HAS BEEN DISCARDED SINCE 1. IT DISAGREES WITH THE BETTER AND MORE RECENT RESULT OF CHRISTENSEN 67. 2. THE VALUE OF GA/GV DERIVED FROM THE NEW VALUE OF THE MEAN LIFE AGREES WELL WITH THE GA/GV VALUE OBTAINED FROM THE FREE NEUTRON DATA.

T	(1.012) (0.021)	SOSNOVSKI	59 PILE	SEE NOTE E	7/68
T.	(0.935) (0.014)	CHRISTENS	67 PILE	REPL BY CHRISTENS72	3/68
T	0.918 0.014	CHRISTENS	72 PILE		6/72

E ERROR CHANGED BECAUSE ERROR IN CROSS SECTION FOR NEUTRON ABSORPTION
E IN GOLD HAS BEEN REDUCED.

17 NEUTRON BETA DECAY COUPLING CONSTANTS

RELATED TEXT SECTION VI D.1

AV GA/GV (SEE TEXT FOR SIGN CONVENTION)

AV C	(-1.250) (0.044)	CONFORTO	67 RVUE	SEE NOTE C BELOW	
AV EP	(-1.23) (0.01)	CHRISTENS	67 CNTR	N DECAY FT VALUE	11/68
AV P	(-1.22) (0.08)	GRIGOREV	68 CNTR	E-NEU ANG CORREL	10/71
AV P	(-1.26) (0.02)	CHRISTENS	70 CNTR	PE,NEUT SPIN CORREL	10/71
AV EP	(-1.27) (0.025)	EROZOLIMS	71 CNTR	PE,NEUT SPIN CORREL	10/71
AV EP	(-1.239) (0.011)	CHRISTENS	72 CNTR	N DEC.+ FT VALUE	1/73
AV P	(-1.263) (0.016)	KROPF	73 RVUE	N DECAY ALONE	1/73
AV P	-1.250 0.009	KROPF	73 RVUE	N DEC.+ FT VALUE	1/73
AV E	-1.250 0.036	DOBROZEMS	75 CNTR	E-NEU ANG CORREL.	12/75*

AV C CONFORTO 67 COMBINES FREE NEUTRON DATA TO 1967. REPL. BY KROPF 73. 1/73
AV E THESE EXPERIMENTS MEASURE THE ABSOLUTE VALUE OF GA/GV ONLY 10/71
AV P KROPF 73 VALUE OBTAINED BY FITTING ALL DATA THROUGH 1972. 1/73
AV . . . .
AV AVG -1.2500 0.0087 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
AV STUDENT -1.2500 0.0094 AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

F PHASE ANGLE OF GA RELATIVE TO GV (DEGREES)

F C	(176.1) (6.4)	CONFORTO	67 RVUE		11/68
F P	(181.3) (1.3)	EROZOLIMS	70 CNTR	POLAR. NEUTRON	10/69
F P	181.1 1.3	KROPF	73 RVUE	N DECAY	1/73

F C CONFORTO 67 COMBINES FREE NEUTRON DATA TO 1967. REPL. BY KROPF 73. 1/73
F P KROPF 73 VALUE OBTAINED BY FITTING ALL DATA THROUGH 1972. 1/73

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REFERENCES FOR NEUTRON

COHEN 56 PR 104 283 V W COHEN, CORNGOLD, RAMSEY (BNL+HARVARD)
SOSNOVSK 59 JETP 9 717 SOSNOVSKII,SPIVAK,PROKOFEV + (IAE MOSCOW)

MATTAUCH 65 NP 67 1 +THIELE,WAPSTRA (MAX PLANCK INST.CHEM.)
CHRISTEN 67 PL 26B 11 CHRISTENSEN,NIELSON,BAHNSEN,BROWN+ (RISO)
CONFORTO 67 APAH 22 15 G. CONFORTO (CERN)
GRIGOREV 68 SJNP 6 239 +GRISHIN,VLADIMIRSKII,NIKOLAEVSKII + (ITEP)

BAIRD 69 PR 179 1285 +MILLER,DRESS,RAMSEY (ORNL,HARV)
TAYLOR 69 RMP 41 375 +PARKER,LANGENBERG (PRIN+UCI+PENN)
CHRISTEN 70 PR C1 1693 CHRISTENSEN,KROHN,RINGO (ANL)
EROZOLIM 70 SJNP 11 583 EROZOLIMSKII,BONDARENKO, + (KURC MOSCOW)
ALSO PL 27B 557 EROZOLIMSKY,BONDARENKO + (KURC IN MOSCOW)
EROZOLIM 71 JETPL 13 252 EROZOLIMSKII,BONDARENKO + (KURC MOSCOW)
CHRISTEN 72 PR D5 1628 CHRISTENSEN,NIELSON,BAHNSEN,BROWN+ (RISO)
COHEN 73 J.PHYS.CHEM.REF.DATA 2, P.663, E.R.COHEN,B.N.TAYLOR
DRESS 73 PR D7 3147 DRESS,MILLER,RAMSEY (ORNL+HARV)
KROPF 73 ZPHY TO BE PUBL. A KROPF,H PAUL (LINZ)
ALSO 70 NP A154 160 H PAUL (VIEN)
COHEN 74 PRIVATE COMM. E.R.COHEN (ROCKWELL INTERNATL. SCI. CENTER)
DOBROZEM 75 PR D11 510 DOBROZEMSKY,KERSCHBAUM,MORAW,PAUL + (SEIB)

PAPERS NOT REFERRED TO IN DATA CARDS

JACKSON 57 PR 106 517 JACKSON,TREIMAN,WYLD (PRINCETON)
COHEN 65 RMP 37 537 +DUMOND (N.AMER.AVIATION SCIENCE CENT.,CIT)
BHALLA 66 PL 19 691 C P BHALLA (ALABAMA)

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Stable Particles

Data Card Listings

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For notation, see key at front of Listings.

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                    18  LAMBDA(1115,JP=1/2+) I=0
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                    18  LAMBDA MASS (MEV)

M   N   SINCE OUR FINAL VALUES FOR THE SIGMA AND LAMBDA MASSES COME FROM
M   N   DOING AN OVERALL FIT TO ALL MEASURED MASSES AND MASS DIFFERENCES,
M   N   WE HAVE USED THE UNCORRELATED MEASUREMENTS FROM SCHMIDT 65 RATHER
M   N   THAN THE ONES COMING FROM THE OVERALL FIT REPORTED IN THAT PAPER.
M   N   SINCE THERE SEEMS TO BE NO CONVINCING ARGUMENT AS TO WHY ONE SHOULD
M   N   IGNORE DATA USING RANGE MEASUREMENTS, WE HAVE INCLUDED HERE VALUES
M   N   DEPENDING ON PROTON AND PION RANGES.  THE SCHMIDT 65 MASSES HAVE
M   N   BEEN REEVALUATED USING OUR APRIL 1973 PROTON AND CHARGED K AND PI
M   N   MASSES.  P. SCHMIDT, PRIVATE COMMUNICATION, (1974).

M        1115.44     0.12             BHOWMIK   63 RVUE +  SEE NOTE L BELOW
M   L   ABOVE LAMBDA MASS HAS BEEN RAISED 35 KEV TO ACCOUNT FOR 46 KEV
M   L   INCREASE IN PROTON MASS AND 11 KEV DECREASE IN CHARGED PION MASS.
M   S  635(1115.86)  (0.09)           BALTAY    65 HBC    ERROR IS STATIS.   6/66
M      488 1115.65    0.07            SCHMIDT   65 HBC  SEE NOTE N           3/74
M   S 1147(1115.74)  (0.04)           CHIEN     66 HBC       6.9 PBAR P      9/67
M   S  972(1115.69)  (0.05)           CHIEN     66 HBC       6.9 PBAR PANTIL 9/67
M        1115.6       0.4             LONDON    66 HBC                       6/66
M       (1116.0)     (0.2)            BADIER    67 HBC     2.4 PBAR P,LLBAR  8/67
M      195 1115.39    0.12            MAYEUR    67 EMUL                     11/67
M   B 1524(1115.52)  (0.03)           BOHM      70 EMUL                      3/72
M      935 1115.59    0.08            HYMAN     72 HEBC                     11/71
M   B   AVERAGE OF VERY INCONSISTENT DATA. ERROR STATISTICAL ONLY. AUTHORS   3/72
M   B   DETECT SYSTEMATIC EFFECT OF ABOUT .15 MEV, WHICH THEY ATTRIBUTE      3/72
M   B   TO ERROR IN RANGE-ENERGY RELATIONS, IN REGION BETA=0.6-0.7.          3/72
M   B   THIS EFFECT, IF CONFIRMED, WOULD AFFECT VERY LITTLE THE VALUES OF    3/72
M   B   BHOWMICK 63 AND MAYEUR 67.
M   S   ERROR PURELY STATISTICAL.
M          . . . . . . . . . . .
M   AVG     1115.566    0.056   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
M   STUDENT1115.568    0.053   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
M   FI      1115.600    0.048  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)  2/76*
                       (SEE IDEOGRAM BELOW )
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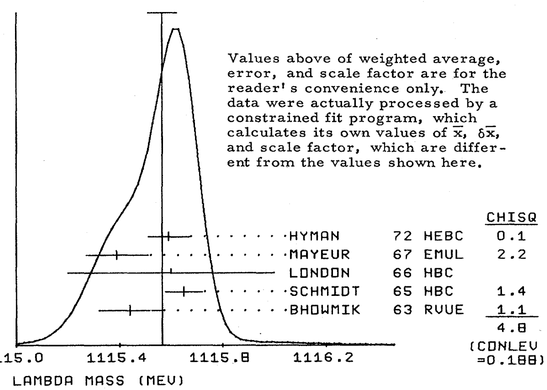
WEIGHTED AVERAGE = 1115.566 ± 0.056
ERROR SCALED BY 1.3



Values above of weighted average, error, and scale factor are for the reader's convenience only. The data were actually processed by a constrained fit program, which calculates its own values of $\overline{x}$, $\delta\overline{x}$, and scale factor, which are different from the values shown here.

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                    18  LAMDA - ANTILAMBDA MASS DIFFERENCE (MEV)
DM              0.05     0.06           CHIEN     66 HBC      6.9 PBAR P      9/67
DM              0.29     0.15           BADIER    67 HBC     2.4 PBAR P       8/67
DM          . . . . . . . . . . .
DM  AVG         0.083    0.083   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
DM  STUDENT     0.080    0.063   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    18  LAMBDA MEAN LIFE (UNITS 10**-10)

T       188     2.63     0.21     0.21  BOLDT     58 CC
T       825     2.72     0.16     0.16  CRAWFORD  59 HBC
T       140     2.72     0.29     0.27  BOWEN     60 CC
T       186     2.60     0.28     0.20  CHANG     62 HBC
T       799     2.69     0.11     0.11  HUMPHREY  62 HBC
T      2239     2.36     0.06     0.06  BLOCK     63 HEBC
T       706     2.76     0.20           CHRETIEN  63 HLBC
T       794     2.59     0.09           HUBBARD   64 HBC
T      2260     2.31     0.10           KREISLER  64 OSPK
T      1378     2.59     0.07           SCHWARTZ  64 HBC
T       635     2.51     0.16           BALTAY    65 HBC                      6/66
T      2534     2.6      0.1            HILL      65 OSPK
T       916     2.35     0.09           BURAN     66 HLBC                     6/66
T   S  1147    (2.50)   (0.14)          CHIEN     66 HBC      6.9 PBAR P      9/67
T   S   972    (2.70)   (0.20)          CHIEN     66 HBC      6.9 PBAR P,ANTI 9/67
T      2213     2.452    0.056    0.054 ENGELMANN 66 HBC                      9/66
T       585     2.68     0.13     0.11  AUERBACH  67 OSPK                     8/67
T               2.44     0.15           BADIER    67 HBC     2.4 PBAR P       6/68
T               2.55     0.15           BADIER    67 HBC     2.4 PBAR P,ANTIL 6/68
T      8342     2.535    0.035          GRIMM     68 HBC                      6/68
T      2600     2.47     0.08           HEPP      68 HBC                      8/68
T      1059     2.39     0.10           DEMIDOV   70 HLBC PI-P, 3.86 GEV/C   12/70
T      4572     2.54     0.04           BALTAY    71 HBC     K-P AT REST      6/71
T      6582     2.69     0.05           ALTHOFF2  73 OSPK    PI+N TO K+LAMBDA 2/74
T       36K     2.626    0.020          POULARD   73 HBC     K-P,KMOM .4TO2.3 9/73
T   S   ERROR PURELY STATISTICAL.
T          . . . . . . . . . . .
T   AVG         2.578    0.021    0.021  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.6)
T   STUDENT     2.577    0.020    0.020  AVG. USING STUDENT10(H/1.11) -- SEE TEXT
                        (SEE IDEOGRAM BELOW )
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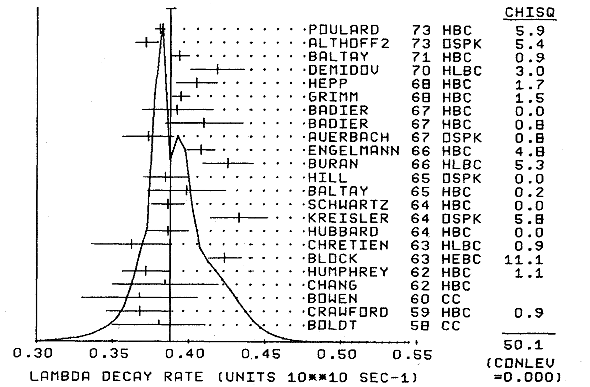
WEIGHTED AVERAGE = 0.3879 ± 0.0031
ERROR SCALED BY 1.6

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                    18  (LAMBDA - ANTILAMBDA)/AVG., MEAN LIFE DIFFERENCE

DT              0.044    0.085          BADIER    67 HBC     2.4 PBAR P       8/67

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                    18  LAMBDA MAGNETIC MOMENT (MAGNETONS,938.26 MEV)

MM             -1.5      0.5            COOL      62 OSPK
MM              0.0      0.6            KERNAN    63 CC
MM     8553    -1.39     0.72           ANDERSON  64 HBC
MM      151    -0.5      0.28           CHARRIERE 65 EMUL
MM       49    -0.67     0.31     0.37  BARKOV    71 EMUL    PRELIM. RESULT   2/72
MM     1300    -0.66     0.07           DAHLJENSE 71 EMUL    MAG FIELD=200KG  6/71
MM     3868    -0.73     0.18           HILL      71 OSPK                    10/71
MM          . . . . . . . . . . .
MM  AVG        -0.672    0.061   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
MM  STUDENT    -0.670    0.067   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    18  LAMBDA ELECTRIC DIPOLE MOMENT (UNITS 10**-14 E CM)
          NONZERO VALUE IMPLIES VIOLATION OF T AND P

EDM             5.0   OR LESS  CL=.95   GIBSON    66 EMUL                     2/72
EDM  B          1.0   OR LESS  CL=.95   BARONI    71 EMUL                     2/72
EDM  B  BARONI MEASURES (-5.9+-2.9)*10**-15 E CM                              2/72

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                    18  LAMBDA PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      LAMBDA INTO PROTON PI-                           938+ 139
P2      LAMBDA INTO NEUTRON PIO                          939+ 134
P3      LAMBDA INTO PROTON MU- NEUTRINO                  938+ 105+   0
P4      LAMBDA INTO PROTON E- NEUTRINO                   938+  .5+   0
P5      LAMBDA INTO PROTON PI- GAMMA                     938+ 139+   0

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                    18  LAMBDA BRANCHING RATIOS

R1      LAMBDA INTO (P PI-)/((P PI-)+(N PIO))          (P1)/(P1+P2)
R1              0.627    0.031          CRAWFORD  59 HBC
R1              0.65     0.05           COLUMBIA  60 HBC
R1  U          (0.685)  (0.017)         ANDERSON  62 HBC
R1      903     0.643    0.016          HUMPHREY  62 HBC
R1 U  6736      0.635    0.007          DOYLE     69 HBC     PI-P TO LAM. KO  2/71
R1    4572      0.646    0.008          BALTAY    71 HBC     K-P AT REST      6/71
R1  U   ANDERSON RESULT NOT PUBLISHED, EVENTS ADDED TO DOYLE SAMPLE.          2/71
R1          . . . . . . . . . . .
R1  AVG         0.6399   0.0049  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  STUDENT     0.6398   0.0055  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1  FIT         0.6419   0.0049 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      LAMBDA INTO (N PIO)/((P PI-)+(N PIO))          (P2)/(P1+P2)
R2              0.23     0.09           EISLER    57 HLBC
R2              0.43     0.14           CRAWFORD  59 HBC
R2              0.28     0.08           BAGLIN    60 HLBC
R2              0.35     0.05           BROWN     63 HLBC
R2       75     0.291    0.034          CHRETIEN  63 HLBC
R2          . . . . . . . . . . .
R2  AVG         0.304    0.025   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  STUDENT     0.304    0.028   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2  FIT         0.3581   0.0049 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3      LAMBDA INTO (P E- NEU)/TOTAL (UNITS 10**-3)    (P4)/(P1+P2)
R3  O   15    (2.0)     (0.5)           HUMPHREY  61 RVUE
R3  O    8    (2.9)     (1.5)     (1.2) AUBERT    62 FBC
R3  N  150    (0.82)    (0.12)          ELY       63 FBC     K- AT REST
R3  N  102    (0.78)    (0.12)   (0.13) BAGLIN    64 FBC     K- AT 1.45 GEV/C
R3  O   20    (1.55)    (0.34)          LIND      64 HBC
R3  N  143    (0.80)    (0.08)          MALONEY   69 HBC                     10/69
R3  N   86    (0.78)    (0.09)          CANTER    71 HBC     K-P AT REST      4/71
R3  N  218    (0.88)    (0.10)          LINDQUIST 71 OSPK    PI- P TO KO LAM  2/72
R3  N   THESE VALUES HAVE BEEN CHANGED BY US INTO RATIOS TO PROTON PI-,      3/72
R3  N   BECAUSE THAT IS THE DIRECTLY MEASURED QUANTITY. SEE R5 BELOW          3/72
R3  O   LOW STATISTICS EXPERIMENTS.  NOT AVERAGED                             7/70
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

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R4      LAMBDA INTO (P MU- NEU)/TOTAL (UNITS 10**-4)       (P3)/(P1+P2)
R4        1    (0.2)  OR MORE              GOOD       62 HBC
R4        1    (1.0)  OR LESS              ALSTON     63 HBC
R4        2    (1.0)  OR LESS              KERNAN     64 FBC
R4       BETWEEN 1.3  AND 6.0              LIND       64 HBC
R4        3     1.3      0.7               LIND       64 RVUE                   7/66
R4        2     1.5      1.2               RONNE      64 FBC
R4        9     2.4      0.8               CANTER1    71 HBC      STOPPED K-P   7/71
R4       14     1.4      0.5               BAGGETT2   72 HBC      STOP K-       8/72
R4              . . . . . . . . .
R4  AVG         1.57     0.35   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R4  STUDENT     1.56     0.38   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R5      LAMBDA INTO (P E- NEU)/(P PI-) (UNITS 10**-3)      (P4)/(P1)
R5      150     1.23     0.20              ELY        63 FBC                    2/72
R5      120     1.17     0.18              BAGLIN     64 FBC                    2/72
R5      143     1.20     0.12              MALONEY    69 HBC                    2/72
R5     1078     1.31     0.06              ALTHOFF1   71 OSPK                   2/72
R5    C  86     1.17     0.13              CANTER     71 HBC      K-P AT REST   3/72
R5    C 218     1.32     0.15              LINDQUIST 71 OSPK      PI-P TO K0 LAM 3/72
R5    C  CALCULATED BY US FROM R3 ASSUMING THE AUTHORS USED (P PI-)/TOT=2/3      3/72
R5              . . . . . . . . .
R5  AVG         1.267    0.044  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  STUDENT     1.267    0.050  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R6      LAMBDA INTO (P PI- GAMMA)/(P PI-) (UNITS 10**-3) (P5)/(P1)              1/73
R6       72     1.32     0.22              BAGGETT3   72 HBC  PI- MOM LT 95 MEV/C 1/73
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18 LAMBDA DECAY PARAMETERS

RELATED TEXT SECTION VI D AND APPENDIX III

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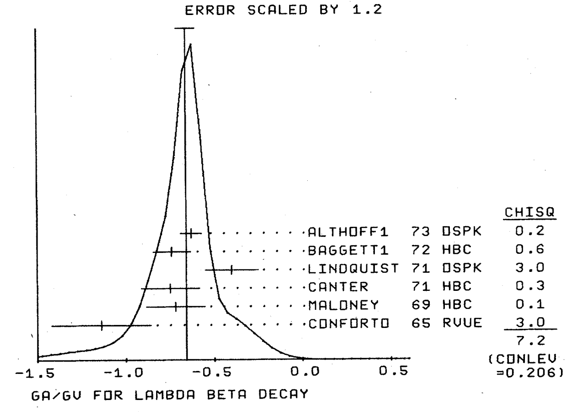
A-      ALPHA LAMBDA- (LAMBDA INTO PI- PROTON)
A-     1156     0.62     0.07              CRONIN     63 CNTR    LAMBDA FROM PI-P  8/67
A-             (0.663)  (0.022)            BERGE      66 RVUE  INCLUDES ABOVE      9/66
A-    10130     0.645    0.017             OVERSETH   67 OSPK    LAMBDA FROM PI-P  8/67
A-   M 2529    (0.747)  (0.086)            MERRILL    68 HBC   REPL BY DAUBER 68   6/68
A-     3520     0.67     0.06              DAUBER     69 HBC   FROM XI DECAY       6/68
A-    10325     0.649    0.023             CLELAND    72 OSPK    LAMBDA FROM PI-P  5/72
A-              . . . . . . . . .
A-  AVG         0.647    0.013  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A-  STUDENT     0.647    0.014  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

A0      ALPHA0 /ALPHA- FOR LAMBCA (L INTO PI0 N/L INTO PI- P)
A0              1.10     0.27              CORK       60 CNTR
A0 O  4760      1.000    0.068             OLSEN      70 OSPK PI+N TO K+ LAMBDA    5/70
A0              . . . . . . . . .
A0  AVG         1.006    0.066  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A0  STUDENT     1.006    0.071  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
A0 O    DONE BY COMPARING PROTON DISTR.WITH N DISTR. FROM LAMBDA DECAY.

F-      PHI ANGLE (SIN(PHI)/COS(PHI)=BETA/GAMMA)   (DEGREES)
F-     1156    13.0     17.0               CRONIN     63 OSPK    LAMBDA FROM PI-P 11/67
F-    10130    -8.0      6.0               OVERSETH   67 OSPK    LAMBDA FROM PI-P 11/67
F-     7377   (-9.2)    (5.2)              CLELAND    67 OSPK REPL BY CLELAND 72   5/72
F-    10325    -7.0      4.5               CLELAND    72 OSPK    LAMBDA FROM PI-P  5/72
F-              . . . . . . . . .
F-  AVG        -6.5      3.5    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
F-  STUDENT    -6.6      3.8    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

AV      GA/GV FOR LAMBDA BETA DECAY (SEE TEXT SEC. VI D.1 FOR SIGN CONV.)
AV  C   22  (-1.03)                        LIND       64 HBC                       6/68
AV  C  102   (0.6)  OR MORE                BAGLIN     65 HLBC    NO SIGN GIVEN     1/71
AV  C        BETW 0. AND -1.1              BARLOW     65 OSPK                      6/68
AV  C  102   (0.7)  OR MORE  CL=.95        ELY        65 HLBC     ABS. VALUE       1/71
AV  C   EXPERIMENTS INCLUDED IN CONFORTO 65, RVUE                                  6/68
AV            -1.14      0.23      0.33 CONFORTO   65 RVUE                        11/67
AV M   148    -0.72      0.14      0.19 MALONEY    69 HBC                         10/69
AV  A 1078   (-0.62)    (0.08)    (0.09) ALTHOFF2  71 OSPK    POLARIZED LAMBDA     7/73
AV M   141    -0.75      0.15      0.18 CANTER     71 HBC                          4/71
AV  L  173   (-0.32)    (0.13)    (0.17) LINDQUIST 71 OSPK   UP-DOWN ASYMMETRY     9/71
AV ML  173   (-0.68)    (0.27)    (0.54) LINDQUIST 71 OSPK   E-NEU CORRELATION     9/71
AV L   173    -0.40      0.13      0.17 LINDQUIST 71 OSPK    E-NEU AND UP-DOWN     9/71
AV M   352    -0.74      0.09      0.12 BAGGETT1   72 HBC      STOP.K-             2/72
AV A   817    -0.63      0.06           ALTHOFF1   73 OSPK    POLARIZED LAMBDA     7/73
AV  A   ALTHOFF1 73 INCLUDES DATA OF ALTHOFF2 71.  USES PROT SPECTRUM AND          7/73
AV  A   THREE SPIN ASYMMETRIES.                                                    7/73
AV M    EXPT MEASURES ONLY THE ABSOLUTE VALUE OF A/V                               7/73
AV  L   LINDQUIST 71 GETS THREE VALUES.  WE AVERAGE THE ONE THAT USES             10/71
AV  L   ALL DATA.                                                                 10/71
AV              . . . . . . . . .
AV  AVG       -0.658     0.054  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
AV  STUDENT   -0.660     0.051  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                               (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = -0.658 ± 0.054
ERROR SCALED BY 1.2



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REFERENCES FOR LAMBDA


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EISLER    57 NC      5 1700         EISLER,PLANO,SAMIOS,SCHWARTZ +    (COLU+BNL)
BOLDT     58 PRL     1  148         E BOLDT,D O CALDWELL,Y PAL                (MIT)
CRAWFORD  59 PRL     2  266         CRAWFORD,CRESTI,DOUGLASS,GOOD +           (LRL)

BAGLIN    60 NC     18 1043         BAGLIN,BLOCH,BRISSON,HENNESSY +          (EPOL)
BOWEN     60 PR    119 2030         BOWEN,HARDY,REYNOLDS,SUN +          (PRINCETON)
CORK      60 PR    120 1000         CORK,KERTH,WENZEL,CRONIN+      (LRL+PRIN+BNL)
COLUMBIA  60 ROCH CONF 726          M SCHWARTZ +                         (COLUMBIA)
HUMPHREY  61 PRL     6  478         HUMPHREY,KIRZ,ROSENFELD,RHEE +     (LRL+SYRA)

ANDERSON  62 CERN CONF-832          ANDERSON,CRAWFORD,GOLDEN,LLOYD +          (LRL)
AUBERT    62 NC     25  479         AUBERT,BRISSON,HENNESSY,SIX +            (EPOL)
CHANG     62 THESIS DUKE            CHUEN CHUEN CHANG                        (DUKE)
COOL      62 PR    127 2223         COOL,HILL,MARSHALL +        (BNL+MIT+NYU+ANL)
GOOD      62 PRL     9  518         M L GOOD,V G LIND                   (WISCONSIN)
HUMPHREY  62 PR    127 1305         W E HUMPHREY,R R ROSS                     (LRL)

ALSTON    63 UCRL 10926             ALSTON,KIRZ,NEUFELD,SOLMITZ,WOHLMUT       (LRL)
BHOWMIK   63 NC     28 1494         B BHOWMIK,D P GOYAL                     (DELHI)
BLOCK     63 PR    130  766         BLOCK,GESSAROLI,RATTI+(NWES+BGNA+SYRA+ORNL)
BROWN     63 PR    130  769         BROWN,KADYK,TRILLING,ROE +          (LRL+MICH)
CHRETIEN  63 PR    131  2208        CHRETIEN,CROUCH+    (BRAN+BROWN+HARVARD+MIT)
CRONIN    63 PR    129 1795         J W CRONIN,O E OVERSETH             (PRINCETON)
ELY       63 PR    131  868         ELY,GIDAL,KALMUS,OSWALD,POWELL +          (LRL)
KERNAN    63 PR    129  870         KERNAN,NOVEY,WARSHAW,WATTENBERG     (ANL+ILL)

ANDERSON  64 PRL    13  167         J A ANDERSON,F S CRAWFORD                 (LRL)
BAGLIN    64 NC     35  977         BAGLIN,BINGHAM+  (EPOL+CERN+LOUC+RHEL+BERG)
HUBBARD   64 PR    135 B 183        HUBBARD,BERGE,KALBFLEISCH,SHAFER +        (LRL)
KERNAN    64 PR    133 B 1271       KERNAN,POWELL,SANDLER +              (LRL+LOUC)
KREISLER  64 PR 136 B 1074          M N KREISLER,O OVERSETH,J CRONIN         (PRIN)
LIND      64 PR    135 B 1483       LIND,BINFORD,GOOD,STERN             (WISCONSIN)
RONNE     64 PL     11   357        RONNE+           (CERN+EPOL+LOUC++UNIV.BERGEN)
SCHWARTZ  64 UCRL 11360 THESIS      JOSEPH ADAM SCHWARTZ                      (LRL)

BAGLIN    65 NC 35 977              BAGLIN +           (EPOL,CERN,LOUC,RHEL,BERGEN)
BALTAY    65 PR 140 B 1027          BALTAY,SANDWEISS,CULWICK,KOPP +     (YALE+BNL)
BARLOW    65 PL    18   64          J BARLOW,BLAIR,CONFORTO+       (CERN+RHEL+PENN)
CHARRIER  65 PL    15       66      CHARRIERE,GIBSON+         (EPOL+BRIS+CERN+MPIM)
    ALSO  66 NC    46A  205         CHARRIERE,GIBSON +        (EPOL,BRIS,CERN,MPIM)
CONFORTO  65 EC INT HERZEGNOVI      G CONFORTO                               (CERN)
ELY       65 PR 137 B1302           ELY,GIDAL,KALMUS,POWELL +           (LPL,LOUC)
HILL      65 PRL 15 85              HILL,LI,JENKINS,KYCIA,RUDERMAN        (MIT,BNL)
SCHMIDT   65 PR 140 B 1328          P SCHMIDT                            (COLUMBIA)

BERGE     66  BERKELEY 46           BERGE,CABIBBO                ((RVUE) LRL,CERN)
BURAN     66 PL 20 318              BURAN,EIVINDSON,SKJEGGESTAD,TOFTE +      (OSLO)
CHIEN     66 PR   152  1171         +LACH,SANDWEISS,TAFT,YEH,OREN +     (YALE+BNL)
ENGELMAN  66 NC 45A  1038           ENGELMANN,FILTHUTH,ALEXANDER+       (HEID,REHO)
GIBSON    66 NC 45A 882             W M GIBSON,K GREEN                       (BRIS)
LONDON    66 PR 143 1034            LONDON,RAU,GOLDBERG,LICHTMAN+       (BNL, SYRA)

AUERBACH  67 NC   47A  19           AUERBACH,BOWEN,DOBBS,LANDE,MANN+         (PENN)
BADIER    67 PL 25B 152             +BONNET,BRIANDET,SADOULET                (EPOL)
CLELAND   67 PL 26B 45              CLELAND,BIENLEIN,CONFORTO+ (CERN+GEVA+LUND)
MAYEUR    67 U.LIBR.BRUX.BUL32      C.MAYEUR,E.TOMPA,J.WICKENS          (BELG,LOUC)
OVERSETH  67 PRL   19  391          O E OVERSETH, R F ROTH              (MICH+PRIN)
GRIMM     68 NC 54A 187             H.-J.GRIMM                        (HEIDELBERG)
HEPP      68 ZPHYS 214 71           V.HEPP,H. SCHLEICH                (HEIDELBERG)
MERRILL   68 PR 167 1202            MERRILL,SHAFER                            (LRL)

DAUBER    69 PR   179 1262          +BERGE,HUBBARD,MERRILL,MILLER             (LRL)
DOYLE     69 UCRL 18139-THESIS      J.C. DOYLE                                (LRL)
MALONEY   69 PRL 23 425             MALONEY,SECHI-ZORN              (UNIV MARYLAND)
BOHM      70 NC 70A 384             + KRECKER + (BERL+BRUX+DUUC+LOUC+LOWC+WARS)
DEMIDOV   70 SJNP 10 681            +KIRILLOV-UGRYUMOV,PONOSOV,PROTASOV+ (ITEP)
OLSEN     70 PRL 24 843             +PONDROM,HANDLER,LIMON,SMITH +      (WISC,MICH)

ALTHOFF1  71 PL 37B 531             +BROWN,FREYTAG,HEARD,HEINTZE +      (CERN,HEID)
ALTHOFF2  71 PL 37B 535             +BROWN,FREYTAG,HEARD,HEINTZE +      (CERN,HEID)
BALTAY    71 PR D4 670              +BRIDGEWATER,COOPER,HABIBI+         (COLU+BING)
BARKOV    71 JETPL 14 60            +GUREVICH,MAKARINA,MARTEMYANOV+          (ITEP)
BARONI    71 LNC 2 1256             G BARONI,S PETRERA,G ROMANO              (ROMA)
CANTER    71 PRL 26 868             +COLE,LEE-FRANZINI,LOVELESS +       (STON+COLU)

CANTER1   71 PRL 27 59              +COLE,LEE-FRANZINI,LOVELESS+        (STON+COLU)
DAHLJENS  71 NC 3A 1                DAHL-JENSEN +     (CERN+ANKA+LAUS+MPIM+ROMA)
HILL      71 PR D4 1979             +LI,JENKINS,KYCIA,RUDERMAN            (MIT,BNL)
    ALSO  65 PRL 15 85              HILL,LI,JENKINS,KYCIA,RUDERMAN        (MIT,BNL)
LINDQUIS  71 PRL 27 612             LINDQUIST,SUMNER+              (EFI,WUSL,OSU,ANL)

BAGGETT1  72 ZPHY 249 279           +BAGGETT,EISELE,FILTHUTH,FREHSE+          (HEID)
BAGGETT2  72 ZPHY 252 362           +BAGGETT,EISELE,FILTHUTH,FREHSE+          (HEID)
BAGGETT3  72 PL 42B 379             +BAGGETT,EISELE,FILTHUTH,FREHSE,HEPP+(HEID)
CLELAND   72 NP B40 221             +CONFORTO,EATON,GERBER+        (CERN+GEVA+LUND)
HYMAN     72 PR D5 1063             +BUNNELL,DERRICK,FIELDS,KATZ+        (ANL+CARN)

ALTHOFF1  73 PL 43B 237             +BROWN,FREYTAG,HEARD,HEINTZE+       (CERN+HEID)
ALTHOFF2  73 NP B66 29              +BROWN,FREYTAG,HEARD,HEINTZE+       (CERN+HEID)
POULARD   73 PL 46B 135             +GIVERNAUD,BORG                          (SACL)

                                    PAPERS NOT REFERRED TO IN DATA CARDS

ARMENTER  62 CERN CONF 236          ARMENTEROS+ (CERN+EPOL+LOIC+BIRM+CEN-SACLAY)
BALTAY    62 CERN CONF 233          BALTAY,FOWLER,SANDWEISS,CULWICK+ (YALE+BNL)
BERGE     63 THESIS (BERKELEY)      J PETER BERGE                             (LRL)
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Σ^+ 19 SIGMA+(1189,JP=1/2+) I=1

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19 SIGMA+ MASS (MEV)

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M    N SEE NOTE PRECEDING LAMBDA MASS LISTINGS

M       144 1189.38      0.15              BARKAS     63 EMUL +  SEE NOTE S BELOW
M        58 1189.48      0.22              BHOWMIK    64 EMUL +  SEE NOTE S BELOW
M    S  ABOVE SIGMA+ MASSES HAVE BEEN RAISED 30  KEV TO ACCOUNT FOR 46 KEV
M    S  INCREASE IN PROTON MASS AND 21 KEV DECREASE IN PION MASS
M      4205 1189.61      0.08              SCHMIDT    65 HBC  SEE NOTE N            3/74
M           1189.16      0.12              HYMAN      67 HEBC                       6/68
M     B 607 1189.33      0.04              BOHM       72 EMUL                      12/73
M     B  BOHM 72 UPDATED WITH PDG APR. 73 K-, PI- AND PI0 MASSES.                  12/73
M              . . . . . . . . .
M    AVG     1189.371    0.060   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.8)
M    STUDENT1189.354     0.041   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
M    FIT     1189.366    0.057   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.8)  2/76*
                                 (SEE IDEOGRAM BELOW )
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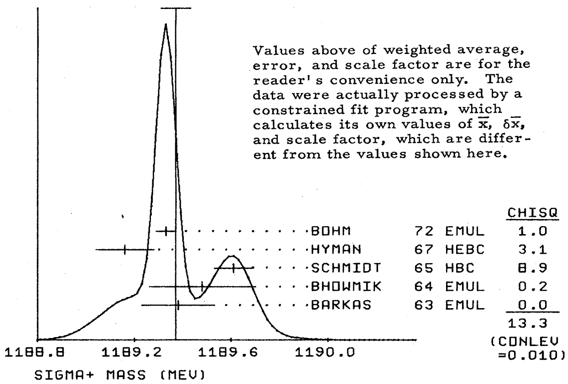
Stable Particles

Σ^+

Data Card Listings

For notation, see key at front of Listings.

WEIGHTED AVERAGE = 1189.371 ± 0.060
ERROR SCALED BY 1.8



Values above of weighted average, error, and scale factor are for the reader's convenience only. The data were actually processed by a constrained fit program, which calculates its own values of $\bar{x}$, $\delta\bar{x}$, and scale factor, which are different from the values shown here.

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                   19  SIGMA+ MEAN LIFE (UNITS 10**-10)

T                                               GLASER    58 RVUE
T      127    0.98      0.16      0.12  PUSCHEL   60 EMUL
T       41    0.82      0.34      0.20  EVANS     60 EMUL
T      117    0.85      0.14      0.11  FREDEN    60 EMUL
T       54    0.80      0.10      0.067 KAPLON    60 EMUL
T       23    0.76      0.22      0.14  CHIESA    61 EMUL
T       49    0.75      0.13      0.09  BERTHELOT 61 HLBC
T      140    0.82      0.10      0.08  BARKAS    61 EMUL
T      192    0.749     0.056     0.052 GRARD     62 HBC
T      456    0.765     0.04      0.04  HUMPHREY  62 HBC
T      203    0.84      0.12      0.08  BHOWMIK   64 EMUL
T      181    0.84      0.09            BALTAY    65 HBC                      6/66
T      900    0.76      0.03            CARAYAN   65 HBC                      6/66
T  C  1300    0.83      0.032           CHANG     66 HBC                      6/66
T   S  125   (0.86)    (0.15)           CHIEN     66 HBC  +   6.9 PBAR P       9/67
T   S  117   (1.10)    (0.24)           CHIEN     66 HBC  -   6.9 PBAR P,ANTI  9/67
T      381    0.80      0.07            COOK      66 OSPK                     7/66
T    10664    0.803     0.008           BARLOUTAU 69 HBC     K-P .4-1.2 GEV/C 11/69
T      20K    0.795     0.010           EISELE    70 HBC     K-P AT REST       2/71
T      526    0.83      0.04            BAKKER    71 DBC  -  K-N TO SIG+ 2PI- 10/71
T  C    CHANG ERROR 0.018 RAISED BY US.  SEE 1970 EDITION, RMP 42,123(1970)   1/73
T   S   ERROR PURELY STATISTICAL
T          . . . . . . . . .
T   AVG       0.8004    0.0058    0.0057 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T   STUDENT   0.8004    0.0064    0.0063 AVG. USING STUDENT10(H/1.11) -- SEE TEXT

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                   19  SIGMA+ MAGNETIC MOMENT (MAGNETONS,938.26 MEV)

MM     381    1.5       1.1                 COOK      66 OSPK                 7/66
MM      52    3.5       1.5                 KOTELCHUC 67 EMUL   K-P AT 1.15BEV/C  8/67
MM      51    3.0       1.2                 SULLIVAN  67 EMUL   PHOTOPRODUCTION   8/67
MM      69    3.5       1.2                 COMBE     68 EMUL                    10/68
MM   29333    2.1       1.0                 MAST      68 HBC    K-P AT .4 GEV/C   6/68
MM     955    2.67      0.97                ALLEY     71 OSPK   1.28 GEV/C PI+P  10/70
MM    2651    2.7       0.9                 SAHA      73 HLBC   K-P.25TO.55GEV/C  6/73
MM         . . . . . . . . .
MM  AVG       2.62      0.41     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
MM  STUDENT   2.62      0.45     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                   19  SIGMA+ PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      SIGMA+ INTO PROTON PIO                              938+ 134
P2      SIGMA+ INTO NEUTRON PI+                             939+ 139
P3      SIGMA+ INTO NEUTRON PI+ GAMMA                       939+ 139+   0
P4      SIGMA+ INTO LAMBDA E+ NEU                          1115+  .5+   0
P5      SIGMA+ INTO PROTON GAMMA                            938+   0
P6      SIGMA+ INTO NEUTRON MU+ NEUTRINO                    939+ 105+   0
P7      SIGMA+ INTO NEUTRON E+ NEUTRINO                     939+  .5+   0
P8      SIGMA+ INTO PROTON E+ E-                            938+  .5+  .5

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                   19  SIGMA+ BRANCHING RATIOS

R1      SIGMA+ INTO (NEUTRON PI+)/(NUCLEON PI)             (P2)/(P1+P2)
R1      308    0.490     0.024          HUMPHREY  62 HBC
R1      534    0.46      0.02           CHANG     66 HBC                      6/66
R1     1331    0.488     0.010          BARLOUTAU 69 HBC     K-P .4-1.2 GEV/C 11/69
R1      537    0.484     0.015          TOVEE     71 EMUL                    12/71
R1         . . . . . . . . .
R1  AVG       0.4835    0.0073   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  STUDENT   0.4838    0.0081   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R2      SIGMA+ INTO (NEUT PI+ GAM)/(PI+N) (UNITS 10**-3) (P3)/P2)
R2            (1.8)     ABOUT           BAZIN2    65 HBC     PI+ LT 116 MEV/C  8/67
R2       29    0.27      0.05           ANG       69 HBC     PI+ LT 110 MEV/C 11/68
R2      180    0.93      0.10           EBENHOH   73 HBC     PI+ LT 150 MEV/C  3/74

R3      SIGMA+ INTO (LAMBDA E+ NEU)/TOTAL (UNITS 10**-5) (P4)
R3  W     4   (3.3)     (1.7)           WILLIS    64 HBC     STOP. K-          9/66
R3  W                   EVENTS FROM THIS EXPERIMENT,INCLUDED IN EISELE1 69   11/69
R3        6    2.0       0.8            BARASH    67 HBC     STOP K-           8/67
R3        5    1.6       0.7            BALTAY    69 HBC     STOP K-          11/69
R3       10    2.9       1.0            EISELE1   69 HBC     STOP K-          10/69
R3         . . . . . . . . .
R3  AVG       2.02      0.47     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  STUDENT   2.01      0.52     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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R4      SIGMA+ INTO (P GAMMA)/(P PIO) (UNITS 10**-2)      (P5)/(P1)
R4       1    (0.68) OR LESS                CARRARA   64 HBC
R4      24     0.37      0.08               BAZIN     65 HBC
R4       4    (0.17)                        QUARENI   65 EMUL                  6/66
R4      45     0.21      0.03               ANG       69 HBC     STOP K-      10/69
R4      31     0.276     0.051              GERSHWIN  69 HBC                  10/69
R4         . . . . . . . . .
R4  AVG        0.240     0.035    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R4  STUDENT    0.239     0.030    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                         (SEE IDEOGRAM BELOW )
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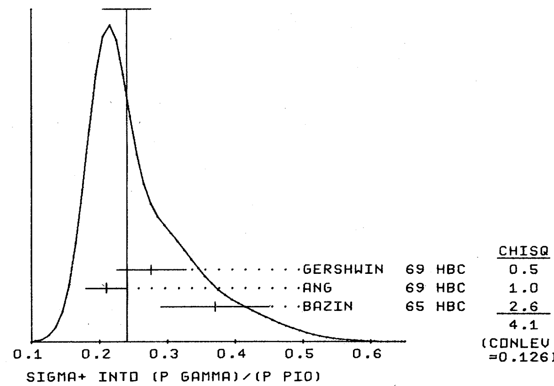
WEIGHTED AVERAGE = 0.240 ± 0.035
ERROR SCALED BY 1.4

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R5      SIGMA+ INTO (N E+ NEU)/(N PI+) (UNITS 10**-5)     (P7)/(P2)
R5 EO    0    (16220)EFFECTIVE DENOM.  COURANT   64 HBC      SEE NOTE E      11/67
R5 EO    0     (2720)EFFECTIVE DENOM.  MURPHY    64 HBC      SEE NOTE E      11/67
R5 EO    1     (9690)EFFECTIVE DENOM.  NAUENBERG 64 HBC      SEE NOTE E       6/68
R5  O    0    (32406)EFFECTIVE DENOM.  BIERMAN   68 HBC                       6/68
R5 UA    0    (80400)EFFECTIVE DENOM.  EISELE2   69 HBC   +  STOP K-          6/68
R5 UO    1    (30000)EFFECTIVE DENOM.  NORTON    69 HBC                      11/69
R5  O    OLDER LOWER STATISTICS EXPTS. NOT INCLUDED IN AVERAGE.               2/76*
R5 U     0    105000 EFFECTIVE DENOM.  SECHIZORN 73 HBC      STOP K-          2/76*
R5 U A   0    111000 EFFECTIVE DENOM.  EBENHOH   74 HBC      STOP K-          1/76*
R5 U                 EFFECTIVE DENOM.  CALCULATED BY US
R5 E                 EFFECTIVE DENOM.  TAKEN FROM EISELE 67                  11/67
R5    A  EISELE2 69 REPLACED BY BY EBENHOH 74.                                1/76*
R5         . . . . . . . . .
R5           1.1   OR LESS  CL=.90    OUR AVERAGE (2.3 EVTS)/(EFF.DNOM.SUM)   2/76*
R5       NUMBER OF EVENTS INCREASED TO 2.3 FOR 90PC CONFIDENCE LEVEL          2/76*

R6      SIGMA+ INTO (N MU+ NEU)/(PI+N) (UNITS 10**-5)     (P6)/(P2)
R6       1      (120)ANALYSED EVENTS   GALTIERI  62 EMUL     NO RATIO QUOTED 11/67
R6 E     0     10150 EFFECTIVE DENOM.  COURANT   64 HBC      SEE NOTE E      11/67
R6 E     0      1710 EFFECTIVE DENCM.  NAUENBERG 64 HBC      SEE NOTE E      11/67
R6 U     2     62000 EFFECTIVE DENOM.  EISELE2   69 HBC                       6/68
R6       0     33800 EFFECTIVE DENOM.  BAGGETT   69 HBC                      11/68
R6 E                 EFFECTIVE DENOM.  TAKEN FROM EISELE 67                  11/67
R6 U                 EFFECTIVE DENOM.  CALCULATED BY US
R6         . . . . . . . . .
R6           6.2   OR LESS  CL=.90    OUR AVERAGE (6.7 EVTS)/(EFF.DNOM.SUM)   2/76*
R6       NUMBER OF EVENTS INCREASED TO 6.7 FOR 90PC CONFIDENCE LEVEL          2/76*

R7      (SIGMA+ INTO LEPTONS)/(SIGMA- INTO LEPTONS)
R7       0     0.034 OR LESS               BAGGETT   67 HBC                   6/68
R7       1     0.08  OR LESS               NORTON    69 HBC                  10/69
R7         . . . . . . . . .
R7             0.043 OR LESS  CL=.90    OUR AVERAGE  USING R5 AND R6          2/76*

R8      SIGMA+ INTO (PROTON E+ E-)/TOTAL (UNITS 10**-6)  (P8)
R8             7.0   OR LESS               ANG       69 HBC      STOP K-     10/69
R8    A  ANG 69 FOUND 3 E+E- EVENTS IN AGREEMENT WITH GAMMA CONVERSION OF
R8    A  PROTON GAMMA DECAY -LIMIT GIVEN HERE IS FOR NEUTRAL CURRENT

R9      (SIGMA+ INTO N MU+ NEU)/(SIGMA- INTO N MU- NEU)
R9       2  0.06       0.045    0.03    EISELE2   69 HBC  +-   STOP K-       10/69
R9         . . . . . . . . .
R9             0.12  OR LESS  CL=.90    OUR AVERAGE  USING R6                 2/71

R10     (SIGMA+ INTO N E+ NEU)/(SIGMA- INTO N E- NEU)
R10 E    0   (0.03) OR LESS  CL=.90    EISELE2   69 HBC  +- STOP K-          10/69
R10 O    0   (0.12) OR LESS  CL=.95    COLE      71 HBC     STOP K-          10/71
R10 O   LOWER STATISTICS EXPERIMENT NOT INCLUDED IN AVERAGE                   2/76*
R10      0    0.018 OR LESS  CL=.90    SECHIZORN 73 HBC     STOP K-,POISSON   8/73
R10  E   0    0.019 OR LESS  CL=.90    EBENHOH   74 HBC  +- STOP K-          12/75*
R10  E  EISELE2 69 REPLACED BY EBENHOH 74.                                   12/75*
R10        . . . . . . . . .
R10           0.009 OR LESS  CL=.90    OUR AVERAGE  USING R5                  2/76*

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                   19  SIGMA+ DECAY PARAMETERS

        RELATED TEXT SECTION VI D AND APPENDIX III

A+0     ALPHA+/ALPHAO FOR SIGMA+ (SIG+ TO PI+ N)/(SIG+ TO PIO P)
A+0          +0.04      0.11               CORK      60 CNTR    SIG+ FROM PI+P
A+0         (+0.20)    (0.24)              TRIPP     62 HBC  +  REPLAC.BY BANGER
A+0 O 3500   (-.014)   (0.052)             BANGERTER 66 HBC  +  SIG+ FROM K-P    9/66
A+0 O 2600   (-.047)    (.07)              BERLEY    66 HBC  +  SIG+ FROM K-P    9/66
A+0   20K   (-0.104)   (0.028)             REUCROFT  76 HBC     PRELIMINARY      2/76*
A+0 O        OLD RESULTS,HAVE BEEN REPLACED . SEE BELOW -

A+      ALPHA SIGMA++(SIG+ TO PI+ N)
A+    35000    0.069      0.017            BANGERTER 69 HBC     K-P AT 400 MEV/C 11/69
A+     4101    0.037      0.049            BERLEY    70 HBC                     12/70
A+         . . . . . . . . .
A+  AVG        0.066      0.016    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A+  STUDENT    0.066      0.017    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

Σ^+, Σ^-

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AO      ALPHA SIGMAO (SIG+ INTO PIO PROTON)
AO             -0.80     0.16               BEALL      62 CNTR
AO            (-0.90)   (0.25)              TRIPP      62 HBC    REPLAC. BY BANGE
AO   O 5200   (-0.986)  (0.072)             BANGERTER  66 HBC    K-P TO SIG+ PI-    7/66
AO    32000   -0.999     0.022              BANGERTER  69 HBC                      10/69
AO H  1335    -0.98      0.05       0.02    HARRIS     70 OSPK   PI+P TO SIG+ K+    5/70
AO      16K   -0.940     0.045              BELLAMY    72 ASPK   PI+P TO SIG+ K+   11/72
AO L  1259    -0.945     0.055      0.042   LIPMAN     73 OSPK   PI+P TO SIG +      7/73
AO L    DECAY PROTONS SCATTERED OFF ALUMINUM.                                       7/73
AO H    DECAY PROTCNS SCATTERED OFF CARBON.
AO            . . . . . . . . .
AO  AVG       -0.979     0.016    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
AO  STUDENT   -0.979     0.018    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

F+      PHI+ ANGLE (SIG+ INTO N PI)  SIN(PHI)/COS(PHI)=BETA/GAMMA  (DEGREE)
F+  O  370 (180.)     (30.)                 BERLEY     66 HBC  + NEUTRON RESCATT.   9/66
F+     560  143.       29.                  BANGERT1   69 HBC                      10/69
F+   C1054  184.       24.                  BERLEY     70 HBC    K-P AT 400 MEV/C  11/69
F+   C  CHANGED FROM 176 TO 184 TO AGREE WITH SIGN CONVENTION.
F+            . . . . . . . . .
F+  AVG       167.3      20.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
F+  STUDENT   167.5      21.2     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

AG      ALPHA SIGMAG (SIG+ INTO PROTON GAMMA)
AG      61    -1.03      0.52       0.42    GERSHWIN   69 HBC    K-P TO SIG PI     11/69

FO      PHIO ANGLE (SIG+ INTO PIO PROTON) SIN(PHI)/COS(PHI)=BETA/GAMMA (DEG)
FO H           22.0      90.0               HARRIS     70 OSPK PI+P TO SIG+ K+      5/70
FO L  1259     38.1      35.7       37.1    LIPMAN     73 OSPK   PI+P TO SIG+K+     7/73
FO L    DECAY PROTON SCATTERED OFF ALUMINUM.                                        7/73
FO H    DECAY PROTONS SCATTERED OFF CARBON.
FO            . . . . . . . . .
FO  AVG        35.8      33.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
FO  STUDENT    35.8      36.3     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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REFERENCES FOR SIGMA+


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CORK      60 PR 120 1000        CORK,KERTH,WENZEL,CRONIN,COOL(LRL+PRIN+BNL)
EVANS     60 NC 15 873          BRIST+BRUSS+IAS-U.COL-DUBLIN+LON+MILAN+PAD
FREDEN    60 NC 16 611          S FREDEN,H KORNBLUM,R WHITE              (LRL)
KAPLON    60 ANP 9 139          M KAPLON,A MELISSINOS,YAMANOUCHI        (ROCH)
PUSCHEL   60 NP 20 254          W PUSCHEL                   (MAX PLANCK INST)

BARKAS    61 PR 124 1209        BARKAS,DYER,MASON,NICHOLS,SMITH          (LRL)
BERTHELO  61 NC 21 693          BERTHELOT,DAUDIN,GOUSSU +      (SACLAY+ORSAY)
CHIESA    61 NC 19 1171         CHIESA,QUASSIATI,RINAUDO         (INFN-TURIN)

BEALL     62 PRL 8 75           BEALL,CORK,KEEFE,MURPHY,WENZEL           (LRL)
GRARD     62 PR 127 607         F GRARD,G A SMITH                        (LRL)
GALTIERI  62 PRL 9 26           GALTIERI,BARKAS,HECKMAN,PATRICK,SMITH    (LRL)
HUMPHREY  62 PR 127 1305        W E HUMPHREY,R R ROSS                    (LRL)
TRIPP     62 PRL 9 66           R D TRIPP,M B WATSON,M FERRO-LUZZI       (LRL)

BARKAS    63 PRL 11 26          W H BARKAS,J N DYER,H H HECKMANN         (LRL)
    ALSO  61 UCRL 9450          JOHN DYER (THESIS, BERKELEY)             (LRL)

BHOWMIK   64 NP 53 22           B BHOWMIK,P JAIN,P MATHUR,LAKSHMI     (DELHI)
CARRARA   64 PL 12 72           CARRARA,CRESTI,GRIGOLETTO,PERUZZO+   (PADOVA)
COURANT   64 PR 136 B 1791      COURANT,FILTHUTH+     (CERN+HEID+UMD+NRL+BNL)
MURPHY    64 PR 134 B 188       C THORNTON MURPHY                 (WISCONSIN)
NAUENBER  64 PRL 12 679         NAUENBERG,MARATECK,+         (COLU+RUTG+PRIN)
WILLIS    64 PRL 13 291         WILLIS,COURANT,ENGELMAN+(BNL,CERN,HEID,UMD)

BALTAY    65 PR 140 B 1027      BALTAY,SANDWEISS,CULWICK,KOPP +   (YALE+BNL)
BAZIN     65 PRL 14 154         BAZIN,BLUMENFELD,NAUENBERG +      (PRIN+COLU)
BAZIN2    65 PR 140  B1358      BAZIN,PLANO,SCHMIDT+          (PRIN,RUTG,COLU)
CARAYAN   65 PR 138 B 433       CARAYANNOPOULOS,TAUTFEST,WILLMANN   (PURDUE)
QUARENI   65 NC 40 A 928        QUARENI,CARTACCI +     (BGNA,FIRZ,GENO,PARMA)
SCHMIDT   65 PR 140 B 1328      P SCHMIDT                          (COLUMBIA)

BANGERTE  66 PRL  17  495       BANGERTER,GALTIERI,BERGE,MURRAY+         (LRL)
BERLEY    66 PRL 17 1071        +HERZBACH,KOFLER,YAMAMOTO + (BNL+MASA+YALE)
CHANG     66 PR  151  1081      CHUNG YUN CHANG                    (COLUMBIA)
    ALSO  65 NEVIS 145  THESIS  CHUNG YUN CHANG                    (COLUMBIA)
CHIEN     66 PR  152  1171      +LACH,SANDWEISS,TAFT,YEH,OREN +   (YALE+BNL)
COOK      66 PRL  17  223       V COOK,EWART,MASEK,ORR,PLATNER (WASHINGTON)

BAGGETT   67 PRL 19 1458        BAGGETT,DAY,GLASSER,KEHOE,KNOP+   (MARYLAND)
    ALSO  68 VIENNA ABS. 374    BAGGETT,KEHOE                      (MARYLAND)
    ALSO  68 PRIVATE COMM.      N. BAGGETT                         (MARYLAND)

BARASH    67 PRL 19  181        BARASH,DAY,GLASSER,KEHOE,KNOP +   (MARYLAND)
EISELE    67 ZPHYS 205 409      +ENGELMANN,FILTHUTH,FOLISH,HEPP+        (HEID)
HYMAN     67 PL 25 B 376        +LOKEN,PEWITT,MCKENZIE,+     (ANL+CARN+NWES)
KOTELCHU  67 PRL 18 1166        KOTELCHUCK,GOZA,SULLIVAN,ROSS  (VANDERBILT)
SULLIVAN  67 PRL 18 1163        SULLIVAN,MCINTURFF,KOTELCHUCH  (VANDERBILT)
    ALSO  64 PRL 13 246         A D MCINTURFF,C E ROOS         (VANDERBILT)

BIERMAN   68 PRL 20 1459        BIERMAN,KOUNOSU,NAUENBERG +      (PRINCETON)
COMBE     68 NC 57A 54          CERN-BRISTOL-LAUSANNE-MUNICH-ROME-COLLABOR
MAST      68 PRL 20 1312        MAST,GERSHWIN,ALSTON-GARNJOST +          (LRL)

ANG       69 ZPHYS 228 151      +EBENHOH,EISELE,ENGELMANN,FILTHUTH+     (HEID)
BAGGETT   69 MDDP-TR-973        N V BAGGETT (THESIS)                     (UMD)
BALTAY    69 PRL 22 615         BALTAY,FRANZINI,NEWMAN,NORTON+   (COLU,STCN)
BANGERTE  69 UCRL-19244         ROGER ODELL BANGERTER (THESIS)           (LRL)
BANGERT1  69 PR 187 1821        BANGERTER,GARNJOST,GALTIERI,GERSHWIN+  (LRL)
BARLOUTA  69 NP B14 153         BARLOUTAUD,BELLEFON,GRANET+(SACL+CERN+HEID)
EISELE1   69 ZPHYS 221 1        +ENGELMANN,FILTHUTH,FOHLISCH,HEPP+      (HEID)
EISELE2   69 ZPHYS 221 401      +ENGELMANN,FILTHUTH,FOHLISCH,HEPP+      (HEID)
GERSHWIN  69 PR 188 2077        +ALSTON-GARNJOST,BANGERTER +             (LRL)
    ALSO     UCRL 19246 THESIS  LAWRENCE K GERSHWIN                      (LRL)
NORTON    69 NEVIS 175 (THESIS) HERBERT NORTON                     (COLUMBIA)

BERLEY    70 PR D1 2015         +YAMIN,HERTZBACH,KOFLER +    (BNL,MASA,YALE)
EISELE    70 ZPHY 238 372       +FILTHUTH,HEPP,PRESSER,ZECH    (HEIDELBERG)
HARRIS    70 PRL 24 165         +OVERSETH,PONDROM,DETTMANN        (MICH,WISC)

ALLEY     71 PR  D3  75         +BENBROOK,COOK,GLASS,GREEN,HAGUE +    (WASH)
BAKKER    71 LNC 1 37           +,SABRE COLLAB.  (ZEEM+SACL+BGNA+REHO+EPOL)
COLE      71 PR D4 631          +LEE-FRANZINI,LOVELESS,BALTAY+   (STON,COLU)
TOVEE     71 NP B33 493         LOUC,BELGRADE,BERL,BRUX,DUBLIN,WARS COLLAB
BELLAMY   72 PL 39B 299         +ANDERSON,CRAWFORD,OSMON+  (LOWC+RHEL+SUSS)
BOHM      72 NP B48 1           BERLIN+BELGRADE+BRUX+DUBLIN+LOUC+WARSAW
    ALSO  73 IIHE-73.2 NOV      BRUSSELS BULLETIN, SAME COLLABORATION

EBENHOH   73 ZPHY 264 413       +EISELE,FILTHUTH,HEPP,LEITNER,THOUW+ (HEID)
LIPMAN    73 PL 43B 89          +UTO,WALKER,MONTGOMERY+     (RHEL+SUSS+LOWC)
SAHA      73 PR D7 3295         +FETKOVICH,HEINTZELMAN,MELTZER +      (CARN)
SECHIZOR  73 PR D8 12           B.SECHI-ZORN,G.SNOW                      (UMD)
EBENHOH   74 ZPHY 266 367       +EISELE,ENGELMANN,FILTHUTH,HEPP +       (HEID)
REUCROFT  76 PREPRINT           +ROOS,WATERS,WEBSTER,HANSL+       (VAND,MPIM)
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PAPERS NOT REFERRED TO IN DATA CARDS


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GLASER    58 CERN CONF 270      GLASER,GOOD,MORRISON                (MICH+LRL)
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QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS


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TRIPP     62 PRL 8 175          R TRIPP,M WATSON,M FERRO-LUZZI        (LRL) P
ALFF      63 SIENA CONF 1 205   ALFF,NAUENBERG,KIRSCH,+        (COLU+RUTG+BNL)
    ALSO  65 PR 137 B 1105      ALFF,GELFAND,BRUGGER,BERLEY+(COLU+RUTG+BNL)
COURANT   63 SIENA CONF 1 73    COURANT,FILTHUTH,BURNSTEIN,DAY+  (CERN+UMD)
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                  20  SIGMA-(1198,JP=1/2+) I=1

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                  20  SIGMA- MASS (MEV)

M   N   SEE NOTE PRECEDING LAMBDA MASS LISTINGS

M     3000 1197.43    0.08           SCHMIDT   65 HBC  SEE NOTE N        3/74
M           . . . . . . . . .
M   FIT    1197.35    0.06    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*

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                  20  (SIGMA-) - (SIGMA+) MASS DIFFERENCE (MEV)

D       87    8.25    0.40           BARKAS    63 EMUL  -
D     2500    8.25    0.25           DOSCH     65 HBC
D       86    7.91    0.23           BOHM      72 EMUL                   1/73
D           . . . . . . . . .
D   AVG       8.09    0.16    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D   STUDENT   8.10    0.18    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
D   FIT       7.98    0.08    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)  2/76*

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                  20  (SIGMA-) - (LAMBDA) MASS DIFFERENCE (MEV)

DL  N   SEE NOTE PRECEDING LAMBDA MASS LISTINGS.

DL           81.70    0.19           BURNSTEIN 64 HBC                    9/66
DL      85   81.80    0.13           SCHMIDT   65 HBC  SEE NOTE N        3/74
DL    2279   81.64    0.09           HEPP      68 HBC                    8/68
DL          . . . . . . . . .
DL  AVG      81.693   0.069   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
DL  STUDENT  81.692   0.077   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
DL  FIT      81.750   0.054   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*

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                  20  SIGMA- MEAN LIFE (UNITS 10**-10)

T             1.67    0.40     0.28  BROWN     58 HLBC
T             1.89    0.33     0.25  EISLER    58 HLBC
T       45    1.35    0.32     0.17  CHIESA    61 EMUL
T       41    1.75    0.39     0.30  BARKAS    61 EMUL
T     1208    1.58    0.06     0.06  HUMPHREY  62 HBC     STOP. K-
T  C  3267    1.666   0.075          CHANG     66 HBC     STOP. K-           6/66
T  S    61   (2.08)  (0.22)          CHIEN     66 HBC   -  6.9 PBAR P        9/67
T  S    64   (1.46)  (0.31)          CHIEN     66 HBC   +  6.9 PBAR P,ANTI   9/67
T      506    1.38    0.07           WHITESIDE 68 HBC     STOP. K-           6/68
T    10253    1.472   0.016          BARLOUTAU 69 HBC     K-P .4-1.2 GEV/C  11/69
T      .1M    1.485   0.022          EISELE    70 HBC     K-P AT REST        2/71
T     1383    1.42    0.05           BAKKER    71 DBC   - K-N TO SIG- 2PI   10/71
T             1.41    0.09     0.08  TOVEE     71 EMUL                      12/71
T     2400    1.463   0.039          ROBERTSON 72 HBC     K-P .25 GEV/C      3/74
T  C    CHANG ERROR 0.018 RAISED BY US.  SEE 1970 EDITION, RMP 42,123(1970)  1/73
T  S    ERROR PURELY STATISTICAL.
T           . . . . . . . . .
T   AVG       1.482   0.017    0.017  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.5)
T   STUDENT   1.479   0.013    0.013  AVG. USING STUDENT10(H/1.11) -- SEE TEXT
                     (SEE IDEOGRAM BELOW )
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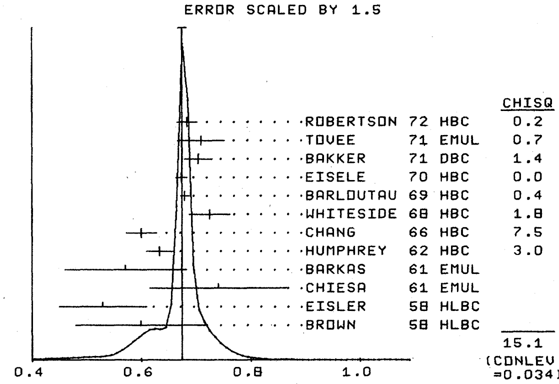
WEIGHTED AVERAGE = 0.6746 ± 0.0076
ERROR SCALED BY 1.5



SIGMA- DECAY RATE (UNITS 10**10 SEC-1)

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                  20  SIGMA- MAGNETIC MOMENT (MAGNETONS,938.26 MEV)

MM  R     BTWN -1.6 AND +0.8        FOX       73 CNTR   SIG-ATOM FINE ST  3/74
MM  R      -1.48     0.37           ROBERTS   74 CNTR   SIG-ATOM FINE ST 12/75*
MM  R  ROBERTS 74 INCLUDES DATA FROM FOX 73.                             12/75*

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Stable Particles

Σ^-, Σ^0

Data Card Listings

For notation, see key at front of Listings.

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                    20  SIGMA- PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      SIGMA- INTO NEUTRON PI-                          939+ 139
P2      SIGMA- INTO NEUTRON PI- GAMMA                    939+ 139+    0
P3      SIGMA- INTO NEUTRON MU- NEUTRINO                 939+ 105+    0
P4      SIGMA- INTO NEUTRON E- NEUTRINO                  939+  .5+    0
P5      SIGMA- INTO LAMBDA E- NEUTRINO                  1115+  .5+    0

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                    20  SIGMA- BRANCHING RATIOS

R1      SIGMA- INTO (N MU- NEU)/(N PI-) (UNITS 10**-3)    (P3)/(P1)
R1       22     0.66      0.15             COURANT    64 HBC
R1       11     0.56      0.20             BAZIN      65 HBC      FROM STOP. K-     6/66
R1       56     0.43      0.09             BAGGETT    69 HBC     STOP. K-          10/69
R1       72     0.43      0.06             ANG 1      69 HBC     STOP K-           10/69
R1       13     0.38      0.11             COLE       71 HBC     STOP K-           10/71
R1           . . . . . . . . . . .
R1   AVG        0.447     0.043   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1   STUDENT    0.445     0.047   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R2      SIGMA- INTO (N E- NEU)/(N PI-) (UNITS 10**-3)     (P4)/(P1)
R2        9     1.0       0.4       0.3    MURPHY     64 HLBC
R2       16     1.37      0.34             NAUENBERG  64 HBC
R2       16     1.15      0.4              MILLER     64 FBC
R2       31     1.4       0.3              COURANT    64 HBC
R2      180     1.11      0.09             BIERMAN    68 HBC                        6/68
R2   A  331    (1.02)    (0.08)            ANG 1      69 HBC     - STOP K-         10/69
R2       57     0.97      0.15             COLE       71 HBC      STOP K-          10/71
R2      455     1.05      0.07             SECHIZORN  73 HBC      STOP K-           8/73
R2    A 601     1.09      0.06             EBENHOH    74 HBC      STOP K-           1/76*
R2    A  ANG 1 69 REPLACED BY EBENHOH 74.                                           1/76*
R2           . . . . . . . . . . .
R2   AVG        1.082     0.038   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2   STUDENT    1.082     0.041   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R3      SIGMA- INTO (LAMBDA E- NEU)/(N PI-) (UNITS 10**-4)
R3                                                        (P5)/(P1)
R3       11     0.75      0.28             COURANT    64 HBC      STOP. K-
R3       35     0.64      0.12             BARASH     67 HBC      STOP K-           8/67
R3       31     0.69      0.12             EISELE1    69 HBC      STOP K-          10/69
R3       31     0.52      0.09             BALTAY     69 HBC      STOP K-           4/69
R3           . . . . . . . . . . .
R3   AVG        0.604     0.060   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3   STUDENT    0.605     0.069   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R4      SIGMA- INTO (N PI- GAMMA)/(N PI-) (UNITS 10**-3) (P2)/(P1)
R4          (1.1)APPROXIM.                 BAZIN      65 HBC      PI- LT 166 MEV/C  8/67
R4       23     0.10       .02             ANG 2      69 HBC      PI- LT 110 MEV/C 10/69
R4      292     0.46      0.06             EBENHOH    73 HBC      PI+ LT 150 MEV/C  3/74

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                    20  SIGMA- DECAY PARAMETERS

        RELATED TEXT SECTION VI D AND APPENDIX III

A-      ALPHA SIGMA-
A-          (-0.16)    (0.21)              TRIPP      62 HBC      REPL.BY BANGERTE
A-   O 6500 (-0.010)   (0.043)             BANGERTER  66 HBC      K-P TO SIG- PI+   7/66
A-   O 6068 (-0.104)   (0.04)              BERLEY     67 HBC      K-P TO SIG- PI+  11/67
A-    51000  -0.071     0.012              BANGERTER  69 HBC                       10/69
A-   B 5978 (-0.134)   (0.034)             BERLEY     70 HBC    . K-P AT 400 MEV/C  2/71
A-    60000  -0.067     0.011              BOGERT     70 HBC      K-P AT 400 MEV/C 12/70
A-   O   OLD RESULTS.  HAVE BEEN REPLACED.
A-   B   BERLEY 70 REPLACED BY BOGERT 70                                            2/71
A-           . . . . . . . . . . .
A-   AVG       -0.0688    0.0081  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A-   STUDENT   -0.0688    0.0087  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

F-      PHI ANGLE (SIN(PHI)/COS(PHI)=BETA/GAMMA)   (DEGREES)
F-   O 1006 (+22.)     (30.)               BERLEY     67 HBC      K-P TO SIG- PI+  11/67
F-     1385   14.       19.                BANGERT1   69 HBC                       10/69
F-    C1092  + 5.       23.                BERLEY     70 HBC      NEUTRON RESCATT. 11/69
F-   C   CHANGED FROM -5 TO +5 TO AGREE WITH SIGN CONVENTION
F-           . . . . . . . . . . .
F-   AVG        10.3      14.6    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
F-   STUDENT    10.4      15.8    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

AV      GV/GA FOR SIGMA TO LAMBDA BETA DECAY (TEXT SEC VI D.1 FOR SIGN CONV)
AV       PREDICTED TO BE ZERO BY CONSERVED VECTOR CURRENT THEORY
AV   FB  45    (0.31)    (0.30)            BARASH     67 HBC                       11/67
AV   FS  51    (0.7)     (0.4)             BALTAY     69 HBC      USING SIG+-       4/69
AV   FS  81   (+0.22)    (0.28)            EISELE1    69 HBC                       10/68
AV F S 186      0.37      0.20             FRANZINI   72 HBC      USING SIG+-       1/73
AV    T  55    -0.17      0.35             TANENBAUM  75 SPEC                      12/75*
AV    B  BARASH 67 MEASURED ABSOLUTE VALUE.
AV    S  SIGN CHANGED TO AGREE WITH OUR CONVENTION.
AV F     FRANZINI 72 INCLUDES EVENTS OF BARASH 67, EISELE1 69, BALTAY 69.          1/73
AV    T  WE QUOTE TANENBAUM 75 WHICH ASSUMES CVC WK MAG TERM.                      1/76*
AV           . . . . . . . . . . .
AV   AVG        0.24      0.23    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
AV   STUDENT    0.24      0.20    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

AV1     GA/GV FOR SIGMA TO NEUTRON BETA DECAY(TEXT SEC VI D.1 FOR SIGN CONV)
AV1      57    (0.05)    (0.23)   (0.32) GERSHWIN   68 HBC  REPLACED BY GER.69    6/68
AV1  C   49     0.23      0.16           COLLERAIN  69 HBC  NEUTRON SCATTER.     10/69
AV1  C   33     0.37      0.26      0.19 EISELE2    69 HBC  NEUTRON SCATTER.    .10/69
AV1      61    +0.19      0.20      0.17 GERSHWIN   69 HBC  POLARIZED SIGMAS     10/69
AV1      63    -0.33      0.30      0.85 BOGERT     70 HBC  K-P AT 400 MEV/C     10/70
AV1  S         -0.20      0.28           EBENHOH    70 HBC     E- SPECTRUM        3/72
AV1  C   36     0.29      0.28      0.29 BALTAY     72 HBC     NEUTRON SCATTER    6/72
AV1      43    -0.4       0.52      1.5  ELLIS      72 ASPK    POLARIZED SIGMAS  10/71
AV1 E         (+0.10)    (0.11)          ELLIS      72 RVUE    SUM LIKEL.(+SCL)  10/71
AV1 E         (-0.27)    (0.13)   (0.17) ELLIS      72 RVUE    SUM LIKEL.(-SOL)  10/71
AV1  C3507      0.435     0.035          TANENBAU   74 ASPK                      10/74*
AV1  C   COLLERAINE,EISELE,BALTAY,TANENBAUM MEASURE ABSOLUTE VALUE OF GA/GV. 11/75*
AV1      GERSHWIN 69, BOGERT 70, EBENHOH 70, AND ELLIS 72 MEASURE THE SIGN.
AV1      BUT NEITHER HAS A DEFINITE SIGN DETERMINATION. SINCE THE SIGN IS
AV1      UNDETERMINED THE AVERAGE OF THE SIX VALUES IS MEANINGLESS.
AV1 E    ELLIS 72 HAS COMBINED THE MAXIMUM LIKELIHOODS OF COLLERAINE 69,           3/72
AV1 E    EISELE2 69, GERSHWIN 69, ELLIS 72, AND GETS TWO POSSIBLE VALUES.          3/72
AV1  S   SIGN CHANGED TO AGREE WITH OUR CONVE. INCLUDES BIERMAN 68 EVENTS.        3/72

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REFERENCES FOR SIGMA-


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BROWN      58 CERN CONF 270      BROWN,GLASER,GRAVES,PERL,CRONIN +      (MICH)
EISLER     58 NC SER10 10 150    EISLER,BASSI,CONVERSI+ (COLU,BNL,BGNA,PISA)
BARKAS     61 PR 124 1209        BARKAS,DYER,MASON,NICKOLS,SMITH          (LRL)
CHIESA     61 NC 19 1171         A M CHIESA,B QUASSIATI,G RINAUDO       (TURIN)
HUMPHREY 62 PR 127 1305          W E HUMPHREY,R R ROSS                    (LRL)
TRIPP      62 PRL 9 66           R D TRIPP,M WATSON,M FERRO-LUZZI         (LRL)

BARKAS     63 PRL 11 26          W H BARKAS,J N DYER,H H HECKMAN          (LRL)
BURNSTEI 64 PRL 13 66            BURNSTEIN,DAY,KEHOE,SECHI ZORN,SNOW      (UMD)
COURANT    64 PR 136 B 1791      COURANT,FILTHUTH+    (CERN+HEID+UMD+NRL+BNL)
MILLER     64 PL 11 262          MILLER,STANNARD,BEZAGUET+  (LOUC,EPOL+BERG)
MURPHY     64 PR 134 B 188       C THORNTON MURPHY                  (WISCONSIN)
NAUENBER 64 PRL 12 679           NAUENBERG,SCHMIDT,MARATECK+(COLU+RUTG+PRIN)

BAZIN      65 PR 140 B 1358      BAZIN,PLANO,SCHMIDT +         (PRIN+RUTG+COLU)
DOSCH      65 PL 14 239          DOSCH,ENGELMANN,FILTHUTH,HEPP,KLUGE+ (HEID)
    ALSO 66 PR   151  1081       CHUNG YUN CHANG                     (COLUMBIA)
SCHMIDT    65 PR 140 B 1328      P SCHMIDT                           (COLUMBIA)
BANGERTE 66 PRL   17  495        BANGERTER,GALTIERI,BERGE,MURRAY+         (LRL)
CHANG      66 PR   151 1081      CHUNG YUN CHANG                     (COLUMBIA)
CHIEN      66 PR   152  1171     +LACH,SANDWEISS,TAFT,YEH,OREN +    (YALE+BNL)

BARASH     67 PRL 19  181        BARASH,DAY,GLASSER,KEHOE,KNOP +   (MARYLAND)
BERLEY     67 PRL  19  979       BERLEY,HERTZBACH,KOFLER +    (BNL,MASA,YALE)
BIERMAN    68 PRL 20 1459        BIERMAN,KOUNOSU,NAUENBERG +      (PRINCETON)
GERSHWIN 68 PRL 20 1270          GERSHWIN,ALSTON-GARNJOST,BANGERTER+      (LRL)
HEPP       68 ZPHY        214 71 V.HEPP,H. SCHLEICH                (HEIDELBERG)
WHITESID 68 NC  54A  537         H. WHITESIDE,J. GOLLUB               (OBERLIN)

ANG 1      69 ZPHY 223 103       ANG,EISELE,ENGELMANN,FILTHUTH +         (HEID)
ANG 2      69 ZPHY 228 151       +EBENHOR,EISELE,ENGELMANN,FILTHUTH+     (HEID)
BAGGETT    69 PRL 23 249         BAGGETT,KEHOE,SNOW            (UNIV MARYLAND)
BALTAY     69 PRL 22 615         BALTAY,FRANZINI,NEWMAN,NORTON+  (COLU,STON)
BANGERTE 69 UCRL-19244           ROGER ODELL BANGERTER (THESIS)           (LRL)
BANGERT1 69 PR 187 1821          BANGERTER,GARNJOST,GALTIERI,GERSHWIN+ (LRL)

BARLOUTA 69 NP B14 153           BARLOUTAUD,BELLEFON,GRANET+(SACL+CERN+HEID)
COLLERAI 69 PRL 23 198           COLLERAINE,DAY,GLASSER,KNOP+(UNIV MARYLAND)
EISELE1    69 ZPHY 221 1         +ENGELMANN,FILTHUTH,FOHLISCH,HEPP+      (HEID)
EISELE2    69 ZPHY 223 487       EISELE,ENGELMANN,FILTHUTH,FOHLISCH+     (HEID)
GERSHWIN 69 UCRL-19246           LAWRENCE KENNETH GERSHWIN (THESIS)       (LRL)

BERLEY     70 PR D1 2015         +YAMIN,HERTZBACH,KOFLER +     (BNL,MASA,YALE)
BOGERT     70 PR D2 6            +LUCAS,TAFT,WILLIS,BERLEY + (BNL,MASA,YALE)
EBENHOH    70 KIEV CONF          +EISELE,ENGELMANN,FILTHUTH,FOHLISCH+ (HEID)
EISELE     70 ZPHY 238 372       +FILTHUTH,HEPP,PRESSER,ZECH      (HEIDELBERG)

BAKKER     71 LNC 1 37           +,SABRE COLLAB.  (ZEEM+SACL+BGNA+REHO+EPOL)
COLE       71 PR D4 631          +LEE-FRANZINI,LOVELESS,BALTAY+  (STON,COLU)
    ALSO 69 NEVIS-175 THESIS     HERBERT NORTON                      (COLUMBIA)
TOVEE      71 NP B33 493         LOUC,BELGRADE,BERL,BRUX,DUBLIN,WARS COLLAB
BALTAY     72 PR D5 1569         +FEINMAN,FRANZINI,NEWMAN,YEH+    (COLU+STON)
BOHM       72 NP B48 1           BERLIN+BELGRADE+BRUX+DUBLIN+LOUC+WARSAW
ELLIS      72 NP B39 77          OXF+AERE+RHEL+LOQM+LYON+NWES+ITEP COLLABOR
FRANZINI 72 PR D6 2417           COLUMBIA+HEIDELBERG+MARYLAND+STONY BROOK
ROBERTSO 72 THESIS               R.M.ROBERTSON                            (IIT)
EBENHOH    73 ZPHY 264 413       +EISELE,FILTHUTH,HEPP,LEITNER,THOUW+ (HEID)
FOX        73 PRL 31 1084        +LAM,BARNES,EISENSTEIN+ (BNL+VPI+WILL+WYOM)
SECHIZOR 73 PR D8 12             B.SECHI-ZORN,G.SNOW                      (UMD)
EBENHOH    74 ZPHY 266 367       +EISELE,ENGELMANN,FILTHUTH,HEPP +       (HEID)
ROBERTS    74 PRL 32 1265        WILL+VPI+CARN+WYOM+CIT COLLABORATION
    ALSO 74 PRL 33 122           ERRATUM TO ROBERTS 74
    ALSO 75 PR D12 1232          ROBERTS,COX +  (WILL+VPI+CARN+WYOM+CIT+BNL)
TANENBAU 74 PRL 33 175           TANENBAUM,HUNGERBUEHLER +     (YALE+FNAL+BNL)
    ALSO 75 TANENBAUM
TANENBAU 75 PR D12 1871          TANENBAUM,HUNGERBUEHLER +     (YALE+FNAL+BNL)

                                 PAPERS NOT REFERRED TO IN DATA CARDS

BROWN      57 PR 108 1036        J BROWN, D GLASER, M PERL           (MICH+BNL)
NIETO      68 RMP 40 140         M NIETO                                 (STON)
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                    21  SIGMA0(1193,JP=1/2+) I=1

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                    21  (SIGMA-) - (SIGMA0) MASS DIFFERENCE (MEV)
D1   N    SEE NOTE PRECEDING LAMBDA MASS LISTINGS.

D1       18     4.75      0.1              BURNSTEIN 64 HBC
D1       37     4.87      0.12             DOSCH     65 HBC
D1       12     5.01      0.12             SCHMIDT   65 HBC   SEE NOTE N          3/74
D1           . . . . . . . . . . .
D1   AVG        4.860     0.076   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
D1   STUDENT    4.860     0.077   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
D1   FIT        4.882     0.063  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*
                          (SEE IDEOGRAM BELOW )
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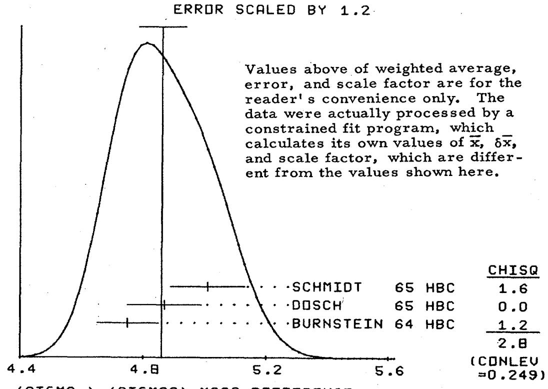


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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

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                     21  (SIGMAO) - (LAMBDA) MASS DIFFERENCE (MEV)

DL  N   SEE NOTE PRECEDING LAMBDA MASS LISTINGS.

DL      208   76.63     0.28            SCHMIDT   65 HBC  SEE NOTE N          6/68
DL      109   76.23     0.55            COLAS     75 HLBC   LAMBDA-GAMMA DEC 12/75*
DL             . . . . . . . . .
DL  AVG       76.55     0.25    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
DL  STUDENT   76.55     0.27    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
DL  FIT       76.87     0.08   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*

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                     21  SIGMAO MEAN LIFE (UNITS 10**-14)

T             (1.0)  OR LESS            DAVIS     62 EMUL

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                     21  SIGMAO PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      SIGMAO INTO LAMBDA GAMMA                           1115+   0
P2      SIGMAO INTO LAMBDA E+ E-                           1115+  .5+  .5
P3      SIGMAO INTO LAMBDA GAMMA GAMMA                     1115+   0+   0

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                     21  SIGMAO BRANCHING RATIOS

R1      SIGMAO INTO(LAMBDA E+ E-)/TOTAL                 (P2)/(P1+P2)
R1            (0.00545)   THEORET. CAL. FEINBERG  58        QUANTUM ELECT.    9/66

R2      SIGMAO INTO (LAMBDA GAMMA GAMMA)/(LAMBDA GAMMA)  (P3)/(P1)          12/75*
R2              0.03  OR LESS  CL=.90   COLAS     75 HLBC                   12/75*

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                                 REFERENCES FOR SIGMAO
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FEINBERG 58 PR 109 1019        G.FEINBERG                             (BNL)
DAVIS    62 PR 127 605         D DAVIS,R SETTI,M RAYMOND,G TOMASIN    (EFI)
BURNSTEI 64 PRL 13 66          BURNSTEIN,DAY,KEHOE,SECHI ZORN,SNOW    (UMD)
DOSCH    65 PL 14 239          DOSCH,ENGELMANN,FILTHUTH,HEPP,KLUGE+ (HEID)
SCHMIDT  65 PR 140 B 1328      P SCHMIDT                         (COLUMBIA)
COLAS    75 NP B91 253         +FARWELL,FERRER,SIX                   (ORSA)

                               PAPERS NOT REFERRED TO IN DATA CARDS.

COURANT  63 PRL 10 409         COURANT,FILTHUTH,FRANZINI+   (CERN+UMD+NRL)

       QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

ALFF     65 PR 137 B1105       ALFF,GELFAND,NAUENBERG+ (COLUMBIA+RUTG+BNL)P
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                     22  XI-(1321,JP=1/2 ) I=1/2

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                     22  XI- MASS (MEV)

M   H   11(1317.0)    (2.2)             WANG      61 HLBC
M   H   18(1317.9)    (1.9)             FOWLER    61 HLBC
M   H   (OLD DATA AND LOW STATISTICS DROPPED ON SUGGESTION OF J R HUBBARD)
M      517 1321.4     0.4               JAUNEAU   63 FBC
M       62 1321.1     0.65              SCHNEIDER 63 HBC
M      241 1321.1     0.3               BADIER1   64 HBC
M       ALL MASSES ABOVE WERE RAISED 0.09 MEV BECAUSE LAMBDA MASS RAISED
M      149 1321.3     0.4               PJERROU   65 HBC                    11/67
M        6 1321.67    0.52              CHIEN     66 HBC   -  6.9 PBAR P     9/67
M      299 1321.4     1.1               LONDON    66 HBC                     6/66
M  G   195 1321.87    0.51              GOLDWASSE 70 HBC     5.5 K-P         8/70
M   G   USES LAMBDA MASS OF 1115.58-M(XI) IS 1322.18 IF M(LAMBDA)=1115.84    8/70
M      268 1321.12    0.41              WILQUET   72 HLBC                    1/73
M            . . . . . . . . .
M   AVG     1321.31    0.16     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1321.31     0.17     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
M   FIT     1321.29    0.14   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*
        THE FIT ASSUMES XI AND ANTI-XI MASSES EQUAL.

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                     22  ANTI-XI+ MASS (MEV)

M1        1(1322.0)    (1.3)            BROWN     62 HBC     ANTI-XI-        7/66
M1        5 1320.69     0.93            CHIEN     66 HBC  +  6.9 PBAR P,ANTI 9/67
M1  S    12(1321.7)    (0.6)            SHEN      67 HBC     ANTI-XI-       10/67
M1       34 1321.2      0.4             STONE     70 HBC                    10/70
M1       35 1321.6      0.8             VOTRUBA   72 HBC     10 GEV/C K+ P  11/72
M1  S   THE ERROR IS STATISTICAL ONLY
M1            . . . . . . . . .
M1  AVG     1321.20    0.33     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M1  STUDENT1321.20     0.36     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
M1  FIT     1321.29    0.14   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*
        THE FIT ASSUMES XI AND ANTI-XI MASSES EQUAL.

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                     22  (XI-) - (ANTI-XI+) MASS DIFFERENCE (MEV)

DM            1.0       1.1             CHIEN     66 HBC      6.9 PBAR P     9/67

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                     22  XI- MAGNETIC MOMENT (MAGNETONS,938.26 MEV)

MM    2724   -0.1       2.1             BINGHAM   70 OSPK  - 1.8 GEV/C K-P   2/71
MM    2436   -2.1       0.8             COOL      74 OSPK -  1.8 GEV/C K-P  10/74*
MM            . . . . . . . . .
MM  AVG      -1.85      0.75    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
MM  STUDENT  -1.86      0.82    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                     22  XI- MEAN LIFE (UNITS 10**-10)

T   H    11   (3.5)     (3.4)     (1.23) WANG      61 HLBC
T   H    18   (1.28)    (0.41)    (0.25) FOWLER    61 HLBC
T   H   (OLD DATA AND LOW STATISTICS DROPPED ON SUGGESTION OF J R HUBBARD)
T      517     1.86      0.15      0.14  JAUNEAU   63 FBC
T       62     1.55      0.31      0.31  SCHNEIDER 63 HBC
T      356    (1.77)    (0.12)           CARMONY   64 HBC   REP BY PJERROU 65
T      794     1.69      0.07            HUBBARD   64 HBC
T      246     1.70      0.12            PJERROU   65 HBC                   11/67
T   S    6    (1.37)    (0.51)           CHIEN     66 HBC   -  6.9 PBAR P    9/67
T      299     1.80      0.16            LONDON    66 HBC                    6/66
T   S         (1.67)    (0.07)           BURGUN    68 HBC    K-P AT 1.3-1.8  2/71
T     2610     1.61      0.04            DAUBER    69 HBC                    6/68
T      680     1.73      0.08      0.07  MAYEUR    72 HLBC   2.1 GEV/C K-    1/73
T     4303     1.63      0.03            BALTAY    74 HBC    1.75 GEV/C K-   3/74
T   S 2436    (1.637)   (0.050)          COOL      74 OSPK - 1.8 GEV/C K-P  10/74*
T   S   THE ERROR IS STATISTICAL ONLY
T             . . . . . . . . .
T   AVG        1.652     0.023     0.022  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.1) *
T   STUDENT    1.651     0.025     0.024  AVG. USING STUDENT10(H/1.11) -- SEE TEXT

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                     22  ANTI-XI+ MEAN LIFE (UNITS 10**-10)

T1  S     5   (1.51)    (0.55)           CHIEN     66 HBC  +  6.9 PBAR P,ANTI  9/67
T1  S    12   (1.9)     (0.7)      (0.5) SHEN      67 HBC    ANTI-XI-         10/67
T1       34    1.6       0.3             STONE     70 HBC                     10/70
T1  S    35   (1.55)    (0.35)    (0.20) VOTRUBA   72 HBC    10 GEV/C K+ P    11/72
T1  S   THE ERROR IS STATISTICAL ONLY

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                     22  XI- PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      XI- INTO LAMBDA PI-                             1115+ 139
P2      XI- INTO LAMBDA E- NEUTRINO                     1115+  .5+    0
P3      XI- INTO NEUTRON PI-                             939+ 139
P4      XI- INTO LAMBDA MU- NEUTRINO                    1115+ 105+    0
P5      XI- INTO SIGMAO E- NEUTRINO                     1192+  .5+    0
P6      XI- INTO SIGMAO MU- NEUTRINO                    1192+ 105+    0
P7      XI- INTO NEUTRON E- NEUTRINO                     939+  .5+    0
P8      XI- INTO NEUTRON MU- NEUTRINO                    939+ 105+    0
P9      XI- INTO SIGMA- GAMMA                           1197+   0
P10     XI- INTO PROTON PI- PI-                          938+ 139+ 139
P11     XI- INTO PROTON PI- E- NEUTRINO                  938+ 139+  .5+    0
P12     XI- INTO PROTON PI- MU- NEUTRINO                 938+ 139+ 105+    0
P13     XI- INTO XIO E- NEUTRINO                        1314+  .5+    0

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                     22  XI- BRANCHING RATIOS

R1      XI- INTO (LAMBDA E- NEU)/(LAMBDA PI-) (UNITS 10**-3)
R1                                                    (P2)/(P1)
R1       1        155 EFFECTIVE DENOM.  CARMONY   63 HBC                    11/67
R1       0        260 EFFECTIVE DENOM.  JAUNEAU   63 HBC                    11/67
R1       0        220 EFFECTIVE DENOM.  BERGE     66 HBC                    11/67
R1       1        155 EFFECTIVE DENOM.  LONDON    66 HBC                    11/67
R1       0        717 EFFECTIVE DENOM.  TRIPPE    67 HBC                    11/67
R1       2       1976 EFFECTIVE DENOM.  HUBBARD   68 HBC                     6/68
R1  H    4   (1.15)    (0.90)    (0.55) HUBBARD   68 RVUE                    6/68
R1  H   HUBBARD 68 (RVUE) INCLUDES ALL ABOVE EVENTS                          6/68
R1       1       4150 EFFECTIVE DENOM.  YEH       74 HBC                     7/75*
R1            . . . . . . . . .
R1  AVG        0.7       0.3       OUR AVERAGE USING ALL THE ABOVE           2/76*

R2      XI- INTO (NEUTRON PI-)/(LAMBDA PI-) (UNITS 10**-3)
R2                                                    (P3)/(P1)
R2             5.0    OR LESS           FERRO-LUZ 63 HBC                     6/68
R2             1.1    OR LESS           DAUBER    69 HBC                     6/68
R2       0     3.0    OR LESS  CL=.90   YEH       74 HBC      760 EFF.DENOM.  7/75*

R3      XI- INTO (LAMBDA MU- NEUTRINO)/TOTAL (UNITS 10**-3)
R3                                                    (P4)
R3            12.0    OR LESS           BERGE     66 HBC                     6/68
R3             1.3    OR LESS           DAUBER    69 HBC                     6/68
R3       1     0.35     0.35            YEH       74 HBC     2859 EFF.DENOM.  7/75*

R4      XI- INTO (SIGMAO E- NEUTRINO)/TOTAL (UNITS 10**-3)
R4                                                    (P5)
R4             3.0    OR LESS           BERGE     66 HBC                     6/68
R4             0.5    OR LESS           DAUBER    69 HBC                     6/68
R4       0     0.53   OR LESS  CL=.90   YEH       74 HBC     4363 EFF.DENOM.  7/75*

R5      XI- INTO (SIGO MU- NEU)/(LAM PI-) (UNITS 10**-3) (P6)/(P1)
R5             5.0    OR LESS           BERGE     66 HBC                     7/66
R5       0     0.76   OR LESS  CL=.90   YEH       74 HBC     3026 EFF.DENOM.  7/75*

R6      XI- INTO (N E- NEU)/(LAMBDA PI-) (UNITS 10**-3)  (P7)/(P1)
R6            10.0    OR LESS  CL=.90   BINGHAM   65 RVUE                    9/66
R6       0     3.2    OR LESS  CL=.90   YEH       74 HBC      715 EFF.DENOM.  7/75*

R7      XI- INTO (SIGMAO E- NEU + LAMBDA E- NEU)/TOTAL (10**-3)
R7                                                    (P2+P5)
R7      17     0.68     0.22            DUCLOS    71 OSPK    SEE NOTE D     10/71
R7  D   THIS EXPERIMENT CANNOT DISTINGUISH SIGMAO FROM LAMBDA. THE CABIBBO
R7  D   THEORY PREDICTS SIGMAO RATE ABOUT A FACTOR 6 SMALLER THAN THE
R7  D   LAMBDA.  TO GET A VALUE FOR THE TABLE R7 HAS BEEN AVERAGED WITH R1.

R8      XI- INTO (N MU- NEU)/(LAMBDA PI-) (UNITS 10**-3) (P8)/(P1)
R8       0    15.3    OR LESS  CL=.90   YEH       74 HBC      150 EFF.DENOM. 11/75*

R9      XI- INTO (SIGMA- GAMMA)/(LAM PI-) (UNITS 10**-4) (P9)/(P1)
R9       0    11.5    OR LESS  CL=.90   YEH       74 HBC     2000 EFF.DENOM. 11/75*

R10     XI- INTO (P PI- PI-)/(LAMBDA PI-) (UNITS 10**-4) (P10)/(P1)
R10      0     3.7    OR LESS  CL=.90   YEH       74 HBC     6200 EFF.DENCM. 11/75*

R11     XI- INTO (P PI- E- NEU)/(LAM PI-) (UNITS 10**-4) (P11)/(P1)
R11      0     3.7    OR LESS  CL=.90   YEH       74 HBC     6200 EFF.DENCM. 11/75*

R12     XI- INTO (P PI- MU- NEU)/(LAM PI-) (UNITS 10**-4) (P12)/(P1)
R12      0     3.7    OR LESS  CL=.90   YEH       74 HBC     6200 EFF.DENCM. 11/75*

R13     XI- INTO (XIO E- NEU)/(LAM PI-) (UNITS 10**-3)   (P13)/(P1)
R13      0     2.3    OR LESS  CL=.90   YEH       74 HBC     1000 EFF.DENOM. 11/75*

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Stable Particles
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Data Card Listings
For notation, see key at front of Listings.

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                    22  XI- DECAY PARAMETERS

         RELATED TEXT SECTION VI D AND APPENDIX III

A        ALPHA XI-
A    O         (-0.44)    (0.12)        JAUNEAU    63 FBC      SEE NOTE D BELOW  6/68
A    O    62   (-0.73)    (0.23)        SCHNEIDER  63 HBC      SEE NOTE D BELOW  6/68
A        240    -0.5       0.38         BADIER1    64 HBC      SEE NOTE D BELOW  6/68
A        356    -0.62      0.13         CARMONY    64 HBC      SEE NOTE D BELOW  6/68
A       1004    -0.365     0.068        BERGE      66 HBC      SEE NOTE D BELOW  6/68
A    L   364    -0.47      0.13         LONDON     66 HBC      SEE NOTE D BELOW  6/68
A              (-0.391)   (0.032)       BERGE 2    66 RVUE   INCLUDES ALL ABOVE  9/66
A    M  2529   (-0.375)   (0.051)       MERRILL    68 HBC                        6/68
A       2781    -0.391     0.045        DAUBER     69 HBC      SEE NOTE A BELOW
A       2724    -0.383     0.065        BINGHAM    70 OSPK                      10/70
A        820    -0.42      0.11         MAYEUR     72 HLBC     2.1 GEV/C K-      1/73
A       4303    -0.376     0.038        BALTAY     74 HBC      1.75 GEV/C K-     3/74
A       2436    -0.39      0.05         COOL       74 OSPK -   1.8 GEV/C K-P    10/74*
A    A    USED ALPHA LAMBDA = 0.647 +- 0.020.
A    D    ERRORS MULTIPLIED BY 1.1 DUE TO APPROXIMATIONS USED FOR XI
A    D    POLARIZATION. (SEE DAUBER 69 FOR DETAILED DISCUSSION)              6/68
A    L    LONDON 66 USES ALPHA-LAMBDA = 0.62
A    M    DATA OF MERRILL 68 INCLUDED IN DAUBER 68.
A    O    OLD DATA NOT INCLUDED IN AVERAGE.
A              . . . . . . . . .
A    AVG        -0.392     0.021     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A    STUDENT    -0.391     0.023     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

F        PHI ANGLE (SIN(PHI)/COS(PHI)=BETA/GAMMA) (DEGREES)
F    O         (-16.0)    (45.0)        JAUNEAU    63 FBC      SEE NOTE D BELOW  6/68
F    O    62   (45.0)     (36.0)        SCHNEIDER  63 HBC      SEE NOTE D BELOW  6/68
F        356    54.0       30.0         CARMONY    64 HBC      SEE NOTE D BELOW  6/68
F       1004     0.        12.          BERGE      66 HBC      SEE NOTE D BELOW  6/68
F    L   364     0.0       20.4         LONDON     66 HBC      SEE NOTE D BELOW  6/68
F    M  2529    (9.8)     (11.6)        MERRILL    68 HBC                        6/68
F       2781   -14.        11.          DAUBER     69 HBC      SEE NOTE A BELOW
F       2724   -26.0       30.0         BINGHAM    70 OSPK                      10/70
F       4303    11.0        9.0         BALTAY     74 HBC      1.75 GEV/C K-     3/74
F       2436     5.0       16.0         COOL       74 OSPK -   1.8 GEV/C K-P    10/74*
F    A    USED ALPHA LAMBDA = 0.647 +- 0.020.
F    D    ERRORS MULTIPLIED BY 1.2 DUE TO APPROXIMATIONS USED FOR XI
F    D    POLARIZATION. (SEE DAUBER 68 FOR DETAILED DISCUSSION)
F    L    LONDON 66 USES ALPHA-LAMBDA = 0.62
F    M    DATA OF MERRILL 68 INCLUDED IN DAUBER 68.
F    O    OLD DATA NOT INCLUDED IN AVERAGE.
F              . . . . . . . . .
F    AVG         2.0        5.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
F    STUDENT     2.0        6.2      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                                     (SEE IDEOGRAM BELOW )
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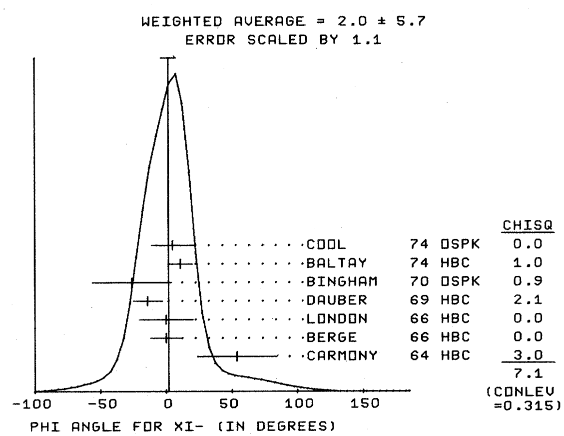


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                         REFERENCES FOR XI-
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FOWLER    61 PRL 6 134          FOWLER,BIRGE,EBERHARD,ELY,GOOD,POWELL+ (LRL)
WANG      61 JETP 13 512        K WANG,T WANG,VIRYASOV,TING,SOLOVEV+ (JINR)
BROWN     62 PRL 8 255          BROWN,CULWICK,FOWLER,GAILLOUD +   (BNL+YALE)

CARMONY   63 PRL  10  381       CARMONY,PJERROU                       (UCLA)
FERRO-LU  63 PR 130 1568        FERRO-LUZZI,ALSTON,ROSENFELD,WOJCICKI  (LRL)
JAUNEAU   63 SIENA CONF 4       JAUNEAU+         (EPOL+CERN+LOUC+RHEL+BERGEN)
  ALSO    63 PL  5  261         JAUNEAU,+         (EPOL,CERN,LOUC,RHEL,BERGEN)
SCHNEIDE  63 PL 4 360           H SCHNEIDER                           (CERN)

CARMONY   64 PRL 12 482         CARMONY,PJERROU,SCHLEIN,SLATER,STORK+(UCLA) J
BADIER1   64 DUBNA CONF I 593   BADIER,DEMOULIN,BARLOUTAUD+(EPOL,SACL,ZEEM)
HUBBARD   64 PR 135 B 183       HUBBARD,BERGE,KALBFLEISCH,SHAFER +     (LRL)
BINGHAM   65 PRSL  285  202     H H BINGHAM                           (CERN)
PJERROU   65 PRL 14 275         + SCHLEIN,SLATER,SMITH,STORK,TICHO    (UCLA)
PJERROU   65 THESIS             G M PJERROU                           (UCLA)

BERGE     66 PR  147  945       BERGE,EBERHARD,HUBBARD,MERRILL +       (LRL)
BERGE 2   66 BERKELEY CONF 46   BERGE,CABIBBO              (LRL,CERN(RVUE))
LONDON    66 PR 143 1034        LONDON,RAU,GOLDBERG,LICHTMAN+(BNL+SYRACUSE)
CHIEN     66 PR  152  1171      +LACH,SANDWEISS,TAFT,YEH,OREN +   (YALE+BNL)
SHEN      67 PL 25 B 443        B.C.SHEN,A.FIRESTONE,G.GOLDHABER  (UCB+LRL)
TRIPPE    67 PRIV. COMM.        T. TRIPPE                             (UCLA)

BURGUN    68 NP B8 447          +MEYER,PAULI,TALLINI, +    (SACL+CDEF+RHEL)
HUBBARD   68 PRL 20 465         HUBBARD,BERGE,DAUBER                   (LRL)
MERRILL   68 PR 167 1202        MERRILL,SHAFER                        (LRL)J

DAUBER    69 PR  179 1272       +BERGE,HUBBARD,MERRILL,MILLER         (LRL)J
BINGHAM   70 PR D1 3010         +COOK,HUMPHREY,SANDER,WILLIAMS+ (UCSD,WASH)
GOLDWASS  70 PR D1 1960         GOLDWASSER, SCHULTZ                    (ILL)
STONE     70 PL 32B 515         +BERLINGHIERI,BROMBERG,COHEN,FERBEL +(ROCH)
DUCLOS    71 NP B32 493         +FREYTAG,HEINTZE,HEINZELMAN,JONES+    (CERN)
MAYEUR    72 NP B47 333         +VAN BINST,WILQUET+    (BRUX+CERN+TUFT+LOUC)
VOTRUBA   72 NP B45 77          VOTRUBA,SAFDER,RATCLIFFE         (BIRM+EDIN)
WILQUET   72 PL 42B 372         +FLIAGINE,GUY,KNIGHT+ (BRUX+CERN+TUFT+LOUC)
BALTAY    74 PR D9 49           +BRIDGEWATER,COOPER,GERSHWIN+  (COLU+BING)J
COOL      74 PR D10 792         +GIACOMELLI,JENKINS,KYCIA,LEONTIC,LI+ (BNL)
  ALSO    72 PRL 29 1630        COOL,GIACOMELLI,JENKINS,KYCIA,LEONTIC+(BNL)
YEH       74 PR D10 3545        +GAIGALAS,SMITH,ZENDLE,BALTAY + (BING+COLU)
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                    23  XIO(1314,JP=1/2 ) I=1/2

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                    23  XIO MASS (MEV)

M          1 1313.4       1.8            PALMER     68 HBC                  3/68
M         49 1315.2       0.92           WILQUET    72 HLBC                 1/73
M              . . . . . . . . .
M    AVG       1314.83    0.82     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    STUDENT1314.84       0.91     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
M    FIT       1314.90    0.55   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*

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                    23  (XI-) - (XIO) MASS DIFFERENCE (MEV)

D         23    6.8       1.6            JAUNEAU    63 FBC
D         45   (6.1)     (1.6)           CARMONY    64 HBC    REP BY PJERROU 65
D         88    6.1       0.9            PJERROU    65 HBC                   11/67
D         29    6.9       2.2            LONDON     66 HBC                    6/66
D              . . . . . . . . .
D    AVG        6.34      0.74     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D    STUDENT    6.34      0.80     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
D    FIT        6.40      0.55   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*

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                    23  XIO MEAN LIFE (UNITS 10**-10)

T         24    3.9       1.4       0.80 JAUNEAU    63 FBC
T         45   (3.5)     (1.0)     (0.8) CARMONY    64 HBC    REP BY PJERROU 65
T        101    2.5       0.4       0.3  HUBBARD    64 HBC
T         80    3.0       0.5            PJERROU    65 HBC                   11/67
T        340    3.07      0.22      0.20 DAUBER     69 HBC                    6/68
T    B   469   (2.85)    (0.20)    (0.18) BRIDGEWAT 72 HBC    1.75 GEV/C K-P  1/73
T    M   157    2.90      0.32      0.27 MAYEUR     72 HLBC   2.1 GEV/C K-    1/74
T    B   652    2.88      0.21      0.19 BALTAY     74 HBC    1.75 GEV/C K-   3/74
T    M    MAYEUR 72 VALUE MODIFIED BY ERRATUM.                                1/74
T    B    BALTAY 74 INCLUDES BRIDGEWATER 72.                                  3/74
T              . . . . . . . . .
T    AVG        2.96      0.12      0.11   AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T    STUDENT    2.96      0.14      0.13   AVG. USING STUDENT10(H/1.11) -- SEE TEXT

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                    23  XIO PARTIAL DECAY MODES

                                                         DECAY MASSES
P1       XIO INTO LAMBDA PIO                            1115+ 134
P2       XIO INTO PROTON PI-                             938+ 139
P3       XIO INTO PROTON E- NEU                          938+  .5+   0
P4       XIO INTO SIGMA+ E- NEU                         1189+  .5+   0
P5       XIO INTO SIGMA- E+ NEU                         1197+  .5+   0
P6       XIO INTO SIGMA+ MU- NEUTRINO                   1189+ 105+   0
P7       XIO INTO SIGMA- MU+ NEUTRINO                   1197+ 105+   0
P8       XIO INTO PROTON MU- NEUTRINO                    938+ 105+   0
P9       XIO INTO LAMBDA GAMMA                          1115+   0
P10      XIO INTO SIGMAO GAMMA                          1192+   0

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                    23  XIO BRANCHING RATIOS

R1       XIO INTO (PROTON PI-)/(LAMBDA PIO)   (UNITS 10**-5) (P2)/(P1)
R1          2700.     OR LESS             TICHO      63 HBC                  6/68
R1           500.     OR LESS             HUBBARD    66 HBC                  6/68
R1            90.     OR LESS             DAUBER     69 HBC                  6/68
R1        0  180.     OR LESS   CL=.90    YEH        74 HBC    1300 EFF.DENOM. 11/75*
R1             3.6    OR LESS   CL=.90    GEWENIGER  75 SPEC                 11/75*

R2       XIO INTO (PROTON E- NEU)/(LAMBDA PIO) (UNITS 10**-3)
R2                                                          (P3)/(P1)
R2            27.0    OR LESS             TICHO      63 HBC                  6/68
R2             6.0    OR LESS             HUBBARD    66 HBC                  6/68
R2             1.3    OR LESS             DAUBER     69 HBC                  6/68
R2        0    3.4    OR LESS   CL=.90    YEH        74 HBC     670 EFF.DENOM. 11/75*

R3       XIO INTO (SIGMA+ E- NEU)/(LAMBDA PIO) (UNITS 10**-3)
R3                                                          (P4)/(P1)
R3            13.0    OR LESS             TICHO      63 HBC                  6/68
R3             7.0    OR LESS             HUBBARD    66 HBC                  6/68
R3             1.5    OR LESS             DAUBER     69 HBC                  6/68
R3        0    1.1    OR LESS   CL=.90    YEH        74 HBC    2100 EFF.DENOM. 11/75*

R4       XIO INTO (SIGMA- E+ NEU)/(LAMBDA PIO) (UNITS 10**-3)
R4                                                          (P5)/(P1)
R4             6.0    OR LESS             HUBBARD    66 HBC                  6/68
R4             1.5    OR LESS             DAUBER     69 HBC                  6/68
R4        0    0.9    OR LESS   CL=.90    YEH        74 HBC    2500 EFF.DENOM. 11/75*

R5       XIO INTO (SIGMA+ MU- NEU)/TOTAL (UNITS 10**-3)    (P6)
R5             7.0    OR LESS             HUBBARD    66 HBC                  6/68
R5             1.5    OR LESS             DAUBER     69 HBC                  6/68
R5        0    1.1    OR LESS   CL=.90    YEH        74 HBC    2100 EFF.DENOM. 11/75*

R6       XIO INTO (SIGMA- MU+ NEU)/TOTAL (UNITS 10**-3)    (P7)
R6             6.0    OR LESS             HUBBARD    66 HBC                  6/68
R6             1.5    OR LESS             DAUBER     69 HBC                  6/68
R6        0    0.9    OR LESS   CL=.90    YEH        74 HBC    2500 EFF.DENOM. 11/75*

R7       XIO INTO (PROTON MU- NEU)/TOTAL (UNITS 10**-3)    (P8)
R7             6.0    OR LESS             HUBBARD    66 HBC                  6/68
R7             1.3    OR LESS             DAUBER     69 HBC                  6/68
R7        0    3.5    OR LESS   CL=.90    YEH        74 HBC     664 EFF.DENOM. 11/75*

R8       XIO INTO (LAMBDA GAMMA)/(LAM PIO) (UNITS 10**-3) (P9)/(P1)
R8        1    5.           5.            YEH        74 HBC     200 EFF.DENOM. 11/75*

R9       XIO INTO (SIGMAO GAMMA)/(LAM PIO) (UNITS 10**-2) (P10)/(P1)
R9       0-1   6.5    OR LESS   CL=.90    YEH        74 HBC      60 EFF.DENOM. 11/75*

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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

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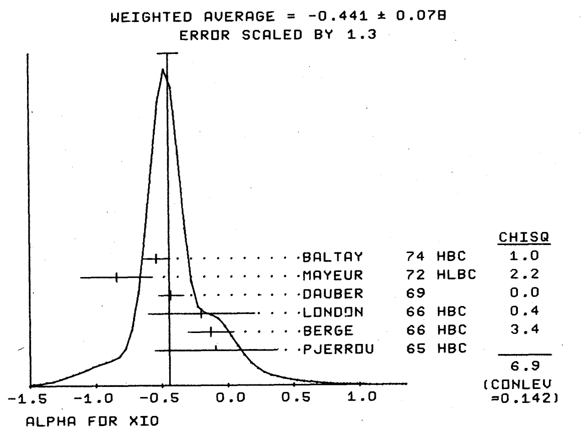
23 XIO DECAY PARAMETER

RELATED TEXT SECTION VI D AND APPENDIX III

A ALPHA XI 0
A -0.09 0.46 PJERROU 65 HBC SEE NOTE D BELOW 6/68
A 146 -0.13 0.17 BERGE 66 HBC SEE NOTE D BELOW 6/68
A L 46 -0.2 0.4 LONDON 66 HBC SEE NOTE D BELOW 6/68
A M 490 (-0.33) (0.11) MERRILL 66 HBC SEE NOTE D BELOW 6/68
A A 739 -0.43 0.09 DAUBER 69 SEE NOTE A BELOW
A B 440 (-0.52) (0.09) BRIDGEWAT 72 HBC 1.75 GEV/C K-P 1/73
A 130 -0.84 0.27 MAYEUR 72 HLBC 2.1 GEV/C K- 1/73
A B 652 -0.54 0.10 BALTAY 74 HBC 1.75 GEV/C K- 3/74
A A USED ALPHA LAMBDA = 0.647 +- 0.020.
A D ERRORS MULTIPLIED BY 1.1 DUE TO APPROXIMATIONS USED FOR XI
A D POLARIZATION. (SEE DAUBER 69 FOR DETAILED DISCUSSION)
A L LONDON 66 USES ALPHA-LAMBDA = 0.62
A M MERRILL 66 REPLACED BY DAUBER 69
A B BRIDGEWATER 72 ERROR PURELY STATISTICAL. 1/73
A B BALTAY 74 INCLUDES BRIDGEWATER 72. 3/74
A . . . .
A AVG -0.441 0.078 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
A STUDENT -0.445 0.069 AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
(SEE IDEOGRAM BELOW)



F PHI ANGLE (SIN(PHI)/COS(PHI)=BETA/GAMMA) (DEGREES)
F 146 -8. 30. BERGE 66 HBC SEE NOTE D BELOW 6/68
F M 490 (107.0) (46.0) MERRILL 66 HBC SEE NOTE D BELOW 6/68
F A 739 38. 19. DAUBER 69 HBC SEE NOTE A BELOW
F B 440 (11.2) (14.4) BRIDGEWAT 72 HBC 1.75 GEV/C K-P 1/73
F B 652 16.0 17.0 BALTAY 74 HBC 1.75 GEV/C K- 3/74
F A USED ALPHA LAMBDA = 0.647 +- 0.020.
F D ERRORS MULTIPLIED BY 1.2 DUE TO APPROXIMATIONS USED FOR XI
F D POLARIZATION. (SEE DAUBER 69 FOR DETAILED DISCUSSION)
F M MERRILL 66 REPLACED BY DAUBER 69
F B BRIDGEWATER 72 ERROR PURELY STATISTICAL. 1/73
F B BALTAY 74 INCLUDES BRIDGEWATER 72. 3/74
F . . . .
F AVG 20.7 11.7 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
F STUDENT 20.6 13.2 AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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REFERENCES FOR XIO

ALVAREZ 59 PRL 2 215 ALVAREZ,EBERHARD,GOOD,GRAZIANO,TICHO+ (LPL)
JAUNEAU 63 SIENA CONF 1 1 JAUNEAU+ (EPOL+CERN+LOUC+RHEL+BERGEN)
ALSO 63 PL 4 49 JAUNEAU+ (EPOL+CERN+LOUC+RHEL+BERGEN)
TICHO 63 BNL CONF 410 HAROLD K TICHO (UCLA)

CARMONY 64 PRL 12 482 CARMONY,PJERROU,SCHLEIN,SLATER,STORK+(UCLA)
HUBBARD 64 PR 135 B 183 HUBBARD,BERGE,KALBFLEISCH,SHAFER + (LRL)
PJERROU 65 PRL 14 275 + SCHLEIN,SLATER,SMITH,STORK,TICHO (UCLA)
PJERROU 65 THESIS G M PJERROU (UCLA)

BERGE 66 PR 147 945 BERGE,EBERHARD,HUBBARD,MERRILL + (LRL)
HUBBARD 66 UCRL 11510 J RICHARD HUBBARD (THESIS,BERKELEY) (LRL)
LONDON 66 PR 143 1034 LONDON,RAU,GOLDBERG,LICHTMAN+(BNL+SYRACUSE)
MERRILL 66 BERKELEY CONF MERRILL,SHAFER,BERGE (LRL)
ALSO 66 UCRL 16455 DEANE MERRILL (THESIS, BERKELEY) (LRL)

PALMER 68 PL 26B 323 PALMER,RADOJICIC,RAU,RICHARDSON+ (BNL,SYRA)
DAUBER 69 PR 179 1262 +BERGE,HUBBARD,MERRILL,MILLER (LRL)

BRIDGEWA 72 NEVIS 195(THESIS) ALBERT BRIDGEWATER (COLUMBIA)
MAYEUR 72 NP B47 333 +VAN BINST,WILQUET+ (BRUX+CERN+TUFT+LOUC)
ALSO 73 NP B53 268 ERRATUM TO MAYEUR 72
WILQUET 72 PL 42B 372 +FLIAGINE,GUY,KNIGHT+ (BRUX+CERN+TUFT+LOUC)
BALTAY 74 PR D9 49 +BRIDGEWATER,COOPER,GERSHWIN+ (COLU+BING)J
YEH 74 PR D10 3545 +GAIGALAS,SMITH,ZENDLE,BALTAY + (BING+COLU)
GEWENIGE 75 PL 57B 193 GEWENIGER,GJESDAL,PRESSER + (CERN+HEID)

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24 OMEGA-(1675,JP=3/2+) I=0
QUANTUM NUMBERS ASSIGNED FROM SU3

24 OMEGA- MASS (MEV)

M E 1(1615.) EISENBERG 54 EMUL 9/73
M F 1 1672.1 1. FRY1 55 EMUL 9/73
M F 1 1670.6 (1.) FRY2 55 EMUL 9/73
M 1 1673.0 8.0 ABRAMS 64 HBC INTO XI- PIO
M 3 1673.3 1.0 PALMER 68 HBC K-P 4.6,5. GEV/C 11/69
M 3 1671.8 0.8 SCHULTZ 68 HBC K-P 5.5 GEV/C 11/69
M 5 1674.2 1.6 SCOTTER 68 HBC K-P 6. GEV/C 11/69
M B 6(1671.9) (1.2) SPETH 69 HBC K-P 10. GEV/C 11/69
M B 13 1671.43 0.78 ABCLV 73 HBC K-P 10. GEV/C 12/73
M E EISENBERG 54 MASS CALCULATED FOR DECAY IN FLIGHT. ALVAREZ 73 HAS 9/73
M E SHOWN THAT THE OMEGA INTERACTED WITH AG NUCLEUS TO GIVE K- XI AG. 9/73
M F BOTH FRY EVENTS IDENTIFIED AS OMEGA- BY ALVAREZ 73. 9/73
M F FRY MASSES ASSUME DECAY TO LAMBDA K- AT REST. DECAY FROM ATOMIC 3/74
M F ORBIT COULD DOPPLER SHIFT THE K- ENERGY AND RESULTING OMEGA- MASS 3/74
M F BY SEVERAL MEV FOR FRY 2. THIS SHIFT IS NEGLIGIBLE FOR FRY 1 3/74
M F BECAUSE THE OMEGA DECAY IS APPROXIMATELY PERPENDICULAR TO ITS 3/74
M F ORBITAL VELOCITY, AS IS KNOWN BECAUSE THE LAMBDA STRIKES THE 3/74
M F NUCLEUS (L.ALVAREZ, PRIVATE COMM. 1973). WE HAVE CALCULATED THE 3/74
M F ERROR ASSUMING THAT ORBITAL N IS 4 OR LARGER. 3/74
M B ABCLV VALUE INCLUDES THE SPETH 69 EVENTS. 12/73
M . . . .
M AVG 1672.18 0.42 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M STUDENT1672.16 0.48 AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

24 ANTI-OMEGA+ MASS (MEV)

MB 1 1673.1 1.0 FIRESTONE 71 HBC 12 GEV/C K+D 3/71

24 OMEGA- MEAN LIFE (UNITS 10**-10 SEC)

T A 1 (1.63) ABRAMS 64 HBC 7/66
T A 1 (0.7) BARNES 1 64 HBC 7/66
T A 1 (1.4) BARNES 2 64 HBC 7/66
T A 1 (1.85) COLLEY 65 HBC 7/66
T A 1 (1.5) RICHARDSO 65 HBC 7/66
T A 1 (0.93) ABCLV COL 68 HBC 11/67
T A 1 (2.6) ABCLV COL 68 HBC 11/67
T A 1 (1.6) ABCLV COL 68 HBC 11/67
T A 1 (0.21) ABCLV COL 68 HBC 11/67
T A 1 (1.20) SCHULTZ 68 HBC 11/67
T A 1 (0.06) SCHULTZ 68 HBC 11/67
T A 1 (0.63) SCHULTZ 68 HBC 11/67
T A 1 (0.25) SCOTTER 68 HBC 6/68
T A 1 (0.30) SCOTTER 68 HBC 6/68
T A 1 (0.71) SCOTTER 68 HBC 6/68
T A 1 (0.08) SCOTTER 68 HBC 6/68
T A 1 (1.04) SCOTTER 68 HBC 6/68
T A 1 (2.38) SCOTTER 68 HBC 6/68
T A ALLISON INCLUDES ALL ABOVE + 3 MORE BNL EVENTS, UNPUBLISHED. 6/68
T 21 1.31 0.37 0.24 ALLISON 68 RVUE 6/68
T 16 1.39 0.45 0.31 ABCLV 73 HBC K-P 10. GEV/C 12/73
T . . . .
T AVG 1.34 0.28 0.20 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T STUDENT 1.34 0.30 0.21 AVG. USING STUDENT10(H/1.11) -- SEE TEXT

24 OMEGA- PARTIAL DECAY MODES

DECAY MASSES
P1 OMEGA- INTO LAMBDA K- 1115+ 493
P2 OMEGA- INTO XIO PI- 1314+ 139
P3 OMEGA- INTO XI- PIO 1321+ 134

24 OMEGA- BRANCHING RATIOS

R1 OMEGA- INTO LAMBDA K- (P1)
R1 F 1 EVENT FRY1 55 EMUL 11/73
R1 F 1 EVENT FRY2 55 EMUL 11/73
R1 F BOTH FRY EVENTS IDENTIFIED BY ALVAREZ 73. 11/73
R1 2 EVENTS PALMER 68 HBC 11/69
R1 3 EVENTS SCHULTZ 68 HBC 11/69
R1 5 EVENTS 1 XI PI DECAY AMB.SCOTTER 68 HBC 11/69
R1 13 EVENTS +2 AMBIG. WITH XI-ABCLV 73 HBC K-P 10. GEV/C 12/73

R2 OMEGA- INTO XIO PI- (P2)
R2 5 EVENTS PALMER 68 HBC 11/69
R2 3 EVENTS SCOTTER 68 HBC 11/69
R2 3 EVENTS +1 AMBIG.WITH SIG-ABCLV 73 HBC K-P 10. GEV/C 12/73

R3 OMEGA- INTO XI- PIO (P3)
R3 1 EVENT ABRAMS 64 HBC 11/69
R3 1 EVENT PALMER 68 HBC 11/69
R3 1 EVENT SCOTTER 68 HBC 11/69
R3 1 EVENT ABCLV 73 HBC K-P 10. GEV/C 12/73

24 OMEGA- DECAY PARAMETERS

RELATED SECTION VI D IN TEXT

AL ALPHA FOR OMEGA- TO K- LAMBDA
AL 15 -0.66 0.36 0.30 KOCHER 74 10/74*

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REFERENCES FOR OMEGA-

EISENBER 54 PR 96 541 Y EISENBERG (CORNELL)
FRY1 55 PR 97 1189 FRY,SCHNEPS,SWAMI (WISC)
FRY2 55 NC 2 346 FRY,SCHNEPS,SWAMI (WISC)
ABRAMS 64 PRL 13 670 + BURNSTEIN,GLASSER + (UMD+NPL)
BARNES 1 64 PRL 12 204 V E BARNES,CONNOLLY,CRENNELL,CULWICK+ (BNL)
BARNES 2 64 PL 12 134 V E BARNES,CONNOLLY,CRENNELL,CULWICK+ (BNL)
COLLEY 65 PL 19 152 COLLEY,DODD +(BIRM+GLAS+LOIC+MPIM+OXF+RHEL)
RICHARDS 65 BAPS 10 115 RICHARDSON,BARNES,CRENNEL+ (BNL+SYRACUSE)
SAMIOS 65 ARGONNE CONF 189 N P SAMIOS ((RVUE) BNL)

Stable Particles

Ω^-, PARTICLE SEARCHES


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ABCLV CO 68 NUC PHYS B4 326   AACHEN+BERLIN+CERN+LONDON IMP.COLL.+VIENNA
ALLISON  68 PRIV. COMM.       JOHN ALLISON                     (LANCASTER)
PALMER   68 PL 26B 323        PALMER,RADOJICIC,RAU,RICHARDSON+ (BNL,SYRA)
SCHULTZ  68 PR  168  1509     SCHULTZ+    (ILL,ARGONNE,NORTHWESTERN,WISC)
SCOTTER  68 PL 26B 474        SCOTTER+     (BIRM,GLASGOW,LOIC,MUNICH,OXF)
SPETH    69 PL  29B 252       SPETH+       (AACHEN,BERLIN,CERN,LOIC,VIEN)
FIRESTON 71 PRL 26 410        +GOLDHABER,LISSAUER,SHELDON,TRILLING  (LRL)
ABCLV    73 NP B61 102        AACHEN+BERLIN+CERN+LONDON+VIENNA COLLABOR.
ALVAREZ  73 PR D8 702         LUIS W. ALVAREZ                        (LBL)
KOCHER   74 PL 51B 193        KOCHER,WERNHARD                  (INNS+VIEN)
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PARTICLE SEARCHES

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Heavy Leptons

Two types of searches for heavy leptons have been made. The first type uses the fact that we can calculate the transition rate for the decay of a heavy lepton to states involving other leptons, with or without pions. Production mechanisms are also considered to be well known, proceeding via the electromagnetic interaction. BERNARDINI 73 and BARISH 73 are of this type. The second method (BUSHNIN 73) is to look for charged, weakly interacting, long-lived particles.

Several experiments have observed events which could arise from the decay of a heavy lepton. PERL 75 in a SLAC-LBL experiment have observed 64 events of the form

$$e^+ + e^- \to e^\pm + \mu^\mp + \geqslant 2 \text{ undetected particles}$$

at or above 4 GeV c.m. energy. Such events have no conventional explanation, but could arise from the production and decay of heavy lepton pairs or charmed boson pairs.

Dimuon events such as those of the Harvard, Pennsylvania, Wisconsin, Fermilab experiment (see BENVENUTI1-5 75 entries in the charmed hadron searches section) could involve heavy lepton production and decay. However, the characteristics of their events do not favor the heavy lepton interpretation.

The Kolar Gold Mines cosmic ray experiment (KRISHNASWAMY 75) reported 5 events which typically have three observed tracks emerging from a common origin about 70 cm from the rock walls of the mine. The authors suggest that these may be massive, long-lived particles, possibly heavy leptons produced by neutrino interactions in the rock walls. Another hypothesis (see DE RUJULA 75) which was put forth to account for their apparent copious production but slow decay is that the observed particle is a very long-lived neutral heavy lepton which is a decay product of a charged heavy lepton, itself pair-produced by cosmic rays in the upper atmosphere.

An FNAL neutrino experiment (BENVENUTI 75) roughly simulated the Kolar Gold Mines experiment for the most likely case that the new particle is neutral. Their result appears to contradict (at least fails to confirm) the KRISHNASWAMY 75 result.

Intermediate Bosons ($W^{\pm}_{0}$ and Φ^0)

Experimentally, W bosons could be produced by hadrons, muons, or neutrinos. They can decay into leptons or into hadrons. At present, there is no positive evidence for the existence of W bosons, although there have been several searches. We list upper limits on the mass and on production cross section.

All gauge theories postulate, in addition to the vector boson W, at least one scalar boson (Higgs' scalar), Φ^0. The couplings of the Higgs' scalar are model-dependent, and limits on its mass depend on M_W. We list these limits and add in comment cards the assumptions made.

Quarks

Three main techniques have been used in the experimental search for quarks: accelerators, cosmic rays, and searches in stable matter. The most recent limits using each of these techniques are given in the Data Card Listings. Accelerator experiments generally measure quark production cross sections (we quote these in Section C) and differential cross sections (D). Cosmic ray experiments measure quark flux (F), and searches in stable matter measure quark concentration (RHO). Some of the accelerator and cosmic ray experiments have looked for fractionally charged particles, and some have looked for high-mass, low-velocity particles. We give the fractional charge, mass ranges, velocity ranges, and other information in the notes on the right-hand side of the card and below the data cards.

Magnetic Monopoles

Searches have been made for magnetic monopoles using accelerators, cosmic rays, and searches in matter.

In accelerator searches strong magnetic fields

Data Card Listings

For notation, see key at front of Listings.

Stable Particles

PARTICLE SEARCHES

are used to extract magnetic monopoles trapped in beam dumps. Cross-section limits are calculated using the reaction pp → pp MM.

Searches in matter have been made on sediments at the bottom of the Atlantic Ocean (FLEISCHER 69) and at the bottom of the Pacific Ocean (KOLM 71). Both experiments used high magnetic fields in attempting to extract monopoles from the matter. ROSS 73 searched a lunar rock sample using an electromagnetic detector which measures a current change induced in a superconducting circuit when traversed by a magnetically charged object.

PRICE 75, a cosmic ray experiment, reported the observation of a magnetic monopole track in a stack of Lexan sheets and emulsion. They report its mass as $m > 200\ m_p$ and strength $g = 137e$. However, a more conventional interpretation of this event exists. According to ALVAREZ 75, the data can be well fit by the assumption of a fragmenting heavy nucleus. See also EBERHARD 75 for a discussion of the conflict with other experiments.

Charmed Hadrons

The interpretation that the J/ψ and ψ mesons (see the New Heavy Mesons section of the Meson Data Card Listings) are charm-anticharm bound states has encouraged experimenters to search directly for charmed hadrons. Several experiments have obtained results which strongly support the charm hypothesis.

BENVENUTI 75 (see Charmed Particle references) in a Harvard, Pennsylvania, Wisconsin, Fermilab experiment have observed 70 events of the form

$$\nu(\text{or } \bar{\nu}) + N \rightarrow \mu^- + \mu^+ + \text{anything} .$$

The authors state that these events involve the production and decay of one or more new particles. The observed properties of these events indicate that the new particle could be a charmed hadron but it is not likely to be a heavy lepton or intermediate vector boson.

The 64 events of the form

$$e^+ + e^- \rightarrow e^\pm + \mu^\mp + \geqslant 2 \text{ undetected particles}$$

reported by PERL 75 (see note on Heavy Leptons above) could arise from the pair production of charmed bosons or heavy leptons.

Two heavy liquid bubble chamber neutrino experiments have found events of the form

$$\nu + N \rightarrow \mu^- + e^+ + V^0 + \text{anything}$$

where the V^0 is a K^0 or Λ. The appearance of a strange particle with an e^+ is an expected signature of a charmed hadron.[1] The CERN Gargamelle experiment (DEDEN 75 and BLIETSCHAU 75) sees two events in which the V^0 could be K^0 or Λ. An additional four $\mu^- e^+$ events without a V^0 were observed. The FNAL 15' chamber experiment (VON KROGH 76) sees four $\mu^- e^+ K^0$ events and no $\mu^- e^+$ events without a K^0. This is a preliminary result. Their full exposure may yield as many as 50 such events.

A BNL neutrino experiment (CAZZOLI 75) observes a three-constraint event

$$\nu + p \rightarrow \mu^- + \Lambda + 3\pi^+ + \pi^-$$

which they interpret either as a large violation of the $\Delta S = \Delta Q$ rule or as a charmed baryon decaying to $\Lambda + 3\pi^+ + \pi^-$.

See the review of Gaillard et al.[1] for a discussion of charmed particle phenomenology with an eye toward searches for these states.

Other Stable Particle Searches

Searches for stable particles (i.e., particles immune to decay via the strong interaction) which do not fit clearly into the above categories are collected here. They are described in the data cards.

Reference

1. M. K. Gaillard, B. J. Lee, and J. L. Rosner, Rev. Mod. Phys. 47, 277 (1975).

HEAVY LEPTON SEARCHES

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M       HEAVY LEPTON MASS LIMITS (GEV)
M    B   0    0.6   OR MORE            BACCI     73 ELEC    E+E- TO E+E-GAM   1/76*
M    B   0    2.2   OR MORE            BACCI     73 ELEC    E+E- TO E+E-GAM   1/76*
M    C   0    2.0   OR MORE  CL=.90    BARISH    73 ASPK + 50,145GEV NEU,NAL  2/74
M    D   0    1.4   OR MORE  CL=.95    BERNARDIN 73 ASPK    E+E-, FRASCATI    2/74
M    D   0    1.0   OR MORE  CL=.95    BERNARDIN 73 ASPK    E+E-, FRASCATI    2/74
M    N  NONE BETWEEN 0.55 AND 4.5      BUSHNIN   73 CNTR    70GEV P,SERPUKOV  2/74
M    E   0    2.4   OR MORE  CL=.90    EICHTEN   73 HLBC +  1-10 GEV NEU      3/74
M    A        1.8   OR MORE  CL=.90    ASRATYAN  74 HLBC +- CERN NEU EXPT    11/75*
M    C        8.4   OR MORE  CL=.90    BARISH    74 SPEC +  50,135GEV NEU     7/74*
M    O   0    1.15  OR MORE  CL=.95    ORITO     74 ASPK +- E+E- FRASCATI    11/75*
M    P  64 BTWN 1.6 AND 2.0            PERL      75 SPEC                      1/76*
M    B  BACCI 73 LOOKS FOR E GAMMA DECAY MODE OF HEAVY ELECTRON. MASS LIMIT   1/76*
M    B  DEPENDS ON COUPLING CONSTANT LAMBDA FOR THIS DECAY.  FIRST VALUE      1/76*
M    B  ABOVE IS FOR LAMBCA**2 LT 9*10**-5, 2ND IS FOR LAMBDA**2 LT 10**-3.   1/76*
M    C  BARISH LOOKED FOR DECAY TO (MU+ 2NEUTRINOS).  ASSUMES BR.FRAC.=.3    11/75*
M    D  BERNARDINI 73 FIRST VALUE ASSUMES UNIVERSAL COUPLING TO ORDINARY      2/74
M    D  LEPTONS.  SECOND VALUE ALSO ASSUMES COUPLING TO HADRONS.              2/74
M    N  BUSHNIN 73 MASSES ASSUME MEAN LIFE ABOVE 7E-10 AND 3E-8 RESPECTVLY.   2/74
M    N  CALCULATED FROM CROSS SEC(C BELOW) AND 30 GEV MUON PAIR PROD. DATA.   2/74
M    E  EICHTEN 73 LIMIT IS FOR GEORGI-GLASHOW TYPE HVY.LEP. M+ PRODUCED IN   2/76*
M    E  NEU NUCL --> M+ HADRONS ASSUMING 15 PERCENT DECAY TO E+ NEU NEU.      2/76*
M    A  ASRATYAN 74 LIMIT IS FOR HEAVY LEPTON L+ PRODUCED IN THE REACTION     2/76*
M    A  ANTINEU NUCL --> L+ HADRONS.                                          2/76*
M    O  ORITO 74 LOOKED FOR H+H- PAIRS GIVING MU-E PAIRS. MASS LIMIT REFERS   3/74
M    O  TO HEAVY ELECTRON, HEAVY MUON OR HEAVY LEPTON WITH OWN L NUMBER.      3/74
M    O  COUPLING TO HADRON ASSUMED FROM THEORETICAL MODELS.                   3/74
M    P  PERL 75 EVENTS ARE E+ E- TO E+- MU-+ AND TWO OR MORE MISSING          1/76*
M    P  PARTICLES,DONE AT SLAC (SPEAR). AUTHORS CLAIM NO CONVENTIONAL         1/76*
M    P  EXPLANATION FOR THESE EVENTS.  TOTAL CM ENERGY 3-7.5 GEV.             1/76*
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Stable Particles

PARTICLE SEARCHES

Data Card Listings

For notation, see key at front of Listings.

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CE      HEAVY LEPTCN PRODUCTION CROSS SECTION (E+ E-) (UNITS 10**-35 CM**2)
CE    P  64    1.9        0.5              PERL       75 SPEC        M=1.6-2.0 GEV    2/76*
CE    P  PERL 75 IS SLAC(SPEAR) EXPT .  EVENTS ARE E+E- TO E+-MU-+ AND 2 OR     2/76*
CE    P  MORE MISSING PARTICLES.  CS IS FOR ECM=4.8 GEV AND THETA=50-130DEG.     2/76*
CE    P  CROSS SECTION RISES FROM 5X10**-36 AT E=4 TO ABOVE MAX. THEN DROPS      2/76*
CE    P  TO 6E-36  AT E=7.5.   AUTHORS SAY THESE EVENTS HAVE NO CONVENTIONAL     2/76*
CE    P  EXPLANATION.  SUGGEST HEAVY LEPTON OR CHARMED HADRON, M=1.6-2.0GEV.     2/76*

C       HEAVY LEPTON PRODUCTION DIFFERENTIAL CROSS SECTION (CM**2/SR-GEV)
C     G   0  1.6E-37 OR LESS  CL=.90   GOLOVKIN  72 CNTR  70GEV P, SERPUKHOV   1/76*
C   B     0  4. E-38 OR LESS  CL=.90   BUSHNIN   73 CNTR  70GEV P, SERPUKHOV   2/74
C     G  MASS RANGE 1 TO 4.5 GEV,THETA=0,P=25 GEV/C.                            1/76*
C   B    BUSHNIN 73 HEAVY LEPTON PATH TRAVERSES 400 GM/CM**2 ABSORBER.          2/74
C   B    DIFFERENTIAL CROSS-SECTION MEASURED AT P=30 GEV/C THETA= 2 MRAD.       3/74

IC      INVARIANT HEAVY LEPTON PRODUCTION CROSS SECTION (CM**2/GEV**2)
IC    S   0  5.4E-39 OR LESS  CL=.90   CRONIN     74 SPEC -  M=1-6.8 GEV       1/76*
IC    B   0  6.4E-35 OR LESS  CL=.90   BINTINGER 75 SPEC +- M=1-5 GEV          2/76*
IC    S  CRONIN 74 IS AN FNAL 300 GEV P CU EXPT.  LOOKED FOR LONG LIVED         2/76*
IC    S  PENETRATING PARTICLES.  ABOVE LIMIT ASSUMES STABLE.  MULTIPLY IT BY    2/76*
IC    S  EXP(1.22E-8*M/TAU) FOR MASS M(GEV) AND LIFETIME TAU(SEC).              2/76*
IC    B  BINTINGER 75 IS A 30-300 GEV P C EXPT.  LOOKED FOR LONG LIVED          2/76*
IC    B  PENETRATING PARTICLES.  ABOVE LIMIT ASSUMES STABLE.  MULTIPLY IT BY    2/76*
IC    B  EXP(3.5E-8*M/TAU/P) FOR MASS M(GEV), LIFETIME TAU(SEC), MOM.P(GEV).    2/76*

CN      HEAVY LEPTON PRODUCTION CROSS SECTION (NEUTRINO NUCLEON) (CM**2)
CN    K   5  1. E-37 OR MORE            KRISHNASW 75 CNTR +0-  M=2-5 GEV       2/76*
CN    B   0                             BENVENUTI 75 SPEC  0                   2/76*
CN    K  KRISHNASWAMY 75 IS KOLAR GOLD MINE COSMIC RAY EXPT.  TYPICAL EVENT     2/76*
CN    K  HAS VERTEX IN AIR 70 CM FROM WALL WITH THREE OBSERVED CHARGED          2/76*
CN    K  TRACKS.  AUTHORS SUGGEST NEU+ROCK GIVES NEW PARTICLE WITH MEAN LIFE    2/76*
CN    K  10E-9 SEC OR LONGER.  DE RUJULA 75 GIVES ANOTHER INTERPRETATION.       2/76*
CN    B  BENVENUTI 75 IS AN FNAL NEUTRINO EXPERIMENT WHICH ROUGHLY SIMULATES    2/76*
CN    B  THE KRISHNASWAMY 75 EXPT. BUT APPARENTLY CONTRADICTS IT, FINDING       2/76*
CN    B  NO EVENTS.                                                             2/76*

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REFERENCES FOR HEAVY LEPTON SEARCHES


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GOLOVKIN 72 PL 42B 136        +GRACHEV,KHODYREV,KUBAROVSKY+         (SERP)
BACCI    73 PL 44B 530        +PARISI,PENSO,SALVINI,STELLA+    (ROMA+FRAS)
BARISH   73 PRL 31 410        +BARTLETT,BUCHHOLZ,HUMPHREY+      (CIT+FNAL)
BERNARDI 73 NC 17A 383        +BOLLINI,BRUNINI+            (CERN+BGNA+FRAS)
   ALSO  70 LNC 4 1156        ALLES-BORELLI,BERNARDINI,BOLLINI+     (CERN)
BUSHNIN  73 NP B58 476        +DUNAYTZEV,GOLOVKIN,KUBAROVSKY +      (SERP)
   ALSO  72 PL 42B 136        GOLOVKIN,GRACHEV,SHODYREV +           (SERP)
EICHTEN  73 PL 46B 281        +DEDEN+(AACH+BELG+CERN+EPOL+MILA+LALO+LOUC)
ASRATYAN 74 PL 49B 488        +GERSHTEIN,KAFTANOV,KUBANTZEV,LAPIN+ (SERP)
BARISH   74 PRL 32 1387       +BARTLETT,BUCHHOLZ,MERRITT +      (CIT+FNAL)
CRONIN   74 PR D10 3093       +FRISCH,SHOCHET,BOYMOND,MERMOD + (EFI+PRIN)
ORITO    74 PL 48B 165        +VISENTIN,CERADINI,CONVERSI +    (FRAS+ROMA)
BENVENUT 75 PRL 35 1486       BENVENUTI,CLINE,FORD+ (HARV+PENN+WISC+FNAL)
BINTINGE 75 PRL 34 982        BINTINGER,CURRY+        (EFI+HARV+PENN+WISC)
KRISHNAS 75 PL 57B 105        KRISHNASWAMY,MENON+          (BOMBAY+OSAKA)
   ALSO  75 PRL 35 628        DE RUJULA,GEORGI,GLASHOW              (HARV)
PERL     75 PRL 35 1489       +ABRAMS,BOYARSKI,BREIDENBACH +    (LBL+SLAC)
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INTERMEDIATE BOSON SEARCHES

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M       W BOSON MASS LIMITS (GEV)
M   B   0    1.7    OR MORE  CL=.99   BERNARDIN 65 HYBR +   NEU N, CERN        2/74
M   B   0    2.0    OR MORE  CL=.90   BURNS     65 OSPK +   NEU N, BNL         2/74
M   C   0    3.8    OR MORE  CL=.90   BARISH    73 ASPK +   W+ TO LEP+NEU=.2   2/74
M   C   0    4.5    OR MORE  CL=.90   BARISH    73 ASPK +   W+ TO LEP+NEU=.5   2/74
M   C   0    4.7    OR MORE  CL=.90   BARISH    73 ASPK +   W+ TO LEP+NEU=.8   2/74
M   E   0    5.0    OR MORE  CL=.95   BERGESON  73 ELEC                         1/76*
M   B   LOOKED FOR (NEU N) TO (W+ MU- N), W+ TO (MU+ NEU, E+ NEU, OR HDRNS)      2/74
M   C   BARISH 73 LOOKED FOR (NEU N) TO (W+ MU- N), W+ TO (MU+ NEU) AT NAL.      2/74
M   C   RESULT GIVEN FOR THREE ASSUMED BR.FRACS. W+ TO (LEPTON NEU)/ALL.         2/74
M   E   BERGESON 73 LOOKED AT ENERGY DISTR OF NEU-INDUCED MUON FLUX UNDER-       1/76*
M   E   GROUND. SCALE INVARIANCE OF THE INELASTIC STRUCT FN ASSUMED.             1/76*

C       W BOSON PRODUCTION CROSS SECTION (10**-36 CM**2)
C   A   0    6.0    OR LESS           ANKENBRAN 71 CNTR +- W TO(MU NEU)=1.0     2/74
C   A   ANKENBRANDT 71 LOOKED FOR (P N)TO(W HADRONS), W TO (MU NEU) AT BNL.      2/74
C   A   THIS ASSUMES BR OF W TO MU NEU IS 1.  IN GENERAL THIS VALUE IS           2/74
C   A   6.0/BR, WHERE BR=(W TO MU NEU)/(W TO ALL).                               2/74

S       SCALAR BOSON MASS LIMITS (GEV)
S   C   0    10.0   OR MORE  CL=.90   CONVERSI  73 ASPK  0 E+E- FRASCATI        3/74
S   C   CONVERSI 73 LOOKED FOR QED VIOLATION IN E+E- SCATTERING AT 2.8 GEV       3/74
S   C   AND ASSUMED W BOSON MASS=10 GEV.  FOR MW=15 GEV, MS LIMIT= 6.5 GEV       3/74

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REFERENCES FOR INTERMEDIATE BOSON SEARCHES


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BERNARDI 65 NC 38 608         +BIENLEIN,BOHM,DARDEL,FAISSNER+       (CERN)
BURNS    65 PRL 15 42         +GOULIANOS,HYMAN,LEDERMAN,LEE +   (COLU+BNL)
ANKENBRA 71 PR D3 2582        ANKENBRANDT,LARSEN,LEIPUNER+     (BNL+YALE)
BARISH   73 PRL 31 180        +BARTLETT,BUCHHOLZ,HUMPHREY+      (CIT+FNAL)
BERGESON 73 PRL 31 66         +CASSIDAY,HENDRICKS                   (UTAH)
CONVERSI 73 PL 46B 269        +D'ANGELO,GATTO,PACLUZI               (RCMA)
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QUARK SEARCHES

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C        QUARK PRODUCTION CROSS SECT. FROM ACCELERATOR EXPTS  (CM**2)
C     Y   0  3.2E-39 OR LESS  CL=.90   ALLABY    69 CNTR Q= -1/3  M=2GEV      1/76*
C     Y   0  5.5E-38 OR LESS  CL=.90   ALLABY    69 CNTR Q= -2/3  M=2GEV      1/76*
C     Y   0  1.8E-35 OR LESS  CL=.90   ALLABY    69 CNTR Q= +1/3  M=2GEV      1/76*
C     Y   0  1.0E-35 OR LESS  CL=.90   ALLABY    69 CNTR Q= +2/3  M=2GEV      1/76*
C     A   0  4. E-37 OR LESS  CL=.90   ANTIPOV1  69 CNTR Q= -2/3  M=0-5GEV    2/74
C     A   0  3. E-39 OR LESS  CL=.90   ANTIPOV2  69 CNTR Q= -1/3  M=4.5-5GEV  1/76*
C     A   0  3. E-37 OR LESS  CL=.90   ANTIPOV2  69 CNTR Q= -2/3  M=2-5GEV    1/76*
C     V   0  1. E-36 OR LESS  CL=.90   ANTIPOV   71 CNTR Q= -4/3  M=4GEV      1/76*
C     B   0  3. E-34 OR LESS           BOTT-BODE 72 CNTR Q=+-1/3  M=0-22GEV   2/74
C     B   0  6. E-34 OR LESS           BOTT-BODE 72 CNTR Q=+-2/3  M=0-13GEV   2/74
C     P   0  1. E-32 OR LESS  CL=.90   ALPER     73 SPEC Q=  2/3  M=4-24 GEV  1/76*
C     P   0  1. E-32 OR LESS  CL=.90   ALPER     73 SPEC Q=  4/3  M=4-24 GEV  1/76*
C     L   0  1. E-35 OR LESS           LEIPUNER  73 CNTR Q=  1/3  M=0-12GEV   2/74
C     L   0  1. E-35 OR LESS           LEIPUNER  73 CNTR Q=  2/3  M=0-12GEV   2/74
C     L   0  5. E-31 OR LESS           LEIPUNER  73 CNTR Q=  4/3  M=0-12GEV   2/74
C     Y  ALLABY 69 IS A CERN 27 GEV P+BE EXPT.  STUDYS MASSES 0-2.7GEV          1/76*
C     Y  ASSUMING NN=NNQQ.  CROSS SECTIONS ASSUME ISOTROPIC PROD. IN CM.        1/76*
C     Y  CROSS SECTIONS AT 2GEV ARE GIVEN HERE.  SEE FIG.9 FOR MASS DEPEN.      1/76*
C     A  ANTIPOV1 69 IS A SERPUKHOV 70 GEV P EXPT.  MASS LIMIT FROM NN=NNQQ.    2/74
C     A  ANTIPOV1 69 AND ANTIPOV2 69 ARE SERPUKHOV 70GEV P EXPTS.  ANTIPOV2     1/76*
C     A  GIVES RESULTS FOR M=2-5GEV ASSUMING NN-->NNQQ, HADRONIC OR LEPTONIC    1/76*
C     A  QUARKS.  WE QUOTE TYPICAL VALUES.                                      1/76*
C     V  ANTIPOV 71 IS A SERPUKHOV 70 GEV P+AL EXPT.  STUDIES DIQUARK MASSES    1/76*
C     V  1.9-4.4GEV.  WE SHOW 4GEV VALUE.  SEE THEIR FIG.2 FOR MASS DEPEN.      1/76*
C     B  BOTT-BODENHAUSEN 72 IS A CERN ISR 26+26 GEV P+P EXPERIMENT.            2/74
C     P  ALPER 73 IS CERN ISR 26+26 GEV P+P EXPT. ASSUMES ISOTROPIC C.M.        1/76*
C     P  PRODUCTION.  SENSITIVE TO ANY Q>2/3.                                   1/76*
C     L  LEIPUNER 73 IS AN NAL 300 GEV P EXPERIMENT.                            2/74

D        QUARK PROD. DIFFERENTIAL CROSS SEC, ACCELERATOR EXPTS(CM**2/SR-GEV)  2/74
D     D   0  1.5E-36 OR LESS           DORFAN    65 CNTR BE TARG  M=3-7GEV    2/74
D     D   0  3. E-36 OR LESS           DORFAN    65 CNTR FE TARG  M=3-7GEV    2/74
D     Y   0  7.2E-39 OR LESS  CL=.90   ALLABY    69 CNTR Q=-1/3  THETA= 0 MR  1/76*
D     Y   0  5.2E-38 OR LESS  CL=.90   ALLABY    69 CNTR Q=-2/3  THETA=6.5MR  1/76*
D     Y   0  2.6E-35 OR LESS  CL=.90   ALLABY    69 CNTR Q=+1/3  THETA=44 MR  1/76*
D     Y   0  1.3E-35 OR LESS  CL=.90   ALLABY    69 CNTR Q=+2/3  THETA=44 MR  1/76*
D     A   0  7. E-38 OR LESS  CL=.90   ANTIPOV2  69 CNTR Q= -1/3  M=0-5GEV    1/76*
D     A   0  4. E-38 OR LESS  CL=.90   ANTIPOV2  69 CNTR Q= -2/3  M=0-2.5GEV  1/76*
D     V   0  1.6E-36 OR LESS  CL=.90   ANTIPOV   71 CNTR Q=-4/3  THETA=47 MR  1/76*
D     V   0  3.8E-36 OR LESS  CL=.90   ANTIPOV   71 CNTR Q=-4/3  THETA=47 MR  1/76*
D     J   0  5. E-34 OR LESS  CL=.90   JOVANOVIC 75 CNTR Q=1/3, M=7-15 GEV    2/76*
D     J   0  2. E-34 OR LESS  CL=.90   JOVANOVIC 75 CNTR Q=1/3, M=15-26 GEV  11/75*
D     J   0  1.3E-34 OR LESS  CL=.90   JOVANOVIC 75 CNTR Q=2/3, M=10-26 GEV  11/75*
D     J   0  8. E-35 OR LESS  CL=.90   JOVANOVIC 75 CNTR Q=4/3, M=10-26 GEV  11/75*
D     D  DORFAN 65 IS A 30 GEV/C P EXPERIMENT AT BNL.                           2/74
D     Y  SEE FOOTNOTE Y IN SUBSECTION C ABOVE.                                  2/76*
D     A  SEE FOOTNOTE A IN SUBSECTION C ABOVE.                                  2/76*
D     V  FIRST ANTIPOV 71 VALUE IS FOR M=1.9-2.3,2.7-4.4GEV, SECOND IS FOR      1/76*
D     V  M=2.3-2.7GEV.  SEE ALSO NOTE V IN SECTION C ABOVE.                     1/76*
D     J  JOVANOVICH 75 FIG.4 COVERS RANGES Q=1/3 TO 2 AND M=3 TO 26 GEV.       11/75*
D     J  THIS IS A CERN ISR 26+26, 22+22 GEV P+P EXPERIMENT.                    2/76*

F       QUARK FLUX FROM COSMIC RAY EXPERIMENTS  (NUMBEP/CM**2-SR-SEC)          2/74
F     C   0  3. E-10 OR LESS           BJORNBOE  68 CNTR M=5GEV OR MORE       2/74
F         0  2.2E-8  OR LESS           FRANZINI  68 CNTR V=.5-.9C  M=2GEV UP  2/74
F         0  2.4E-8  OR LESS  CL=.95   KASHA     68 OSPK V=.5-.75C M=5-15GEV  2/74
F         0  5. E-11 OR LESS  CL=.90   FUKUSHIMA 69 CNTR Q=1/3  SEA LEVEL     2/74
F         0  7.5E-10 OR LESS  CL=.90   FUKUSHIMA 69 CNTR Q=2/3  SEA LEVEL     2/74
F     M   1  EVENT CLAIMED             MCCUSKER  69 CC   Q=2/3                2/74
F     B   0  1. E-10 OR LESS  CL=.90   BOHM      72 CNTR Q=1/3                2/74
F     B   0  1. E-10 OR LESS  CL=.90   BOHM      72 CNTR Q=2/3                2/74
F     H   0  1.7E-8  OR LESS  CL=.90   HICKS     73 CNTR Q=  1/3              1/76*
F     H   0  1.7E-8  OR LESS  CL=.90   HICKS     73 CNTR Q=  2/3              1/76*
F     C  BJORNBOE 68 LOOKED FOR DELAYED PARTICLES AFTER AIR SHOWERS.            2/74
F     M  MC CUSKER 69 CLAIMS 1 CANDIDATE.   LATER SIMILAR EXPTS. SEE NONE.      2/74
F     B  BOHM 72 IS FLUX IN 10**14 TO 10**15 EV AIR SHOWERS                     2/74
F     H  HICKS 73 LOOKED AT LARGE ZENITH ANGLES, THUS USING THE ATMOSPHERE      1/76*
F     H  AS AN EXTENDED FILTER FOR HADRONIC QUARKS. THEIR SEARCH PUTS AN        1/76*
F     H  UPPER LIMIT ON LEPTONIC QUARK FLUX IN COSMIC RAYS.                     1/76*

RHO      QUARK CONCENTRATION IN MATTER (QUARKS PER NUCLEON)
RHO       0  3 E-29 OR LESS            CHUPKA     66 CNTR   SEAWATER           2/74
RHO       0  1 E-16 OR LESS            GALLINARO  66 CNTR   GRAPHITE           2/74
RHO       0  4 E-19 OR LESS            STOVER     67 CNTR   IRON               2/74
RHO       0  1 E-20 OR LESS            RANK       68 CNTR   OIL                2/74
RHO       0  1 E-24 OR LESS            COOK       69 CNTR   SEAWATER           2/74
RHO       0  1 E-23 OR LESS            COOK       69 CNTR   ROCK SAMPLES       2/74

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REFERENCES FOR QUARK SEARCHES


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DORFAN   65 PRL 14 999         +EADES,LEDERMAN,LEE,TING               (COLU)
CHUPKA   66 PRL 17 60          +SCHIFFER,STEVENS                       (ANL)
GALLINAR 66 PL 23 609          GALLINARO,MORPURGO                     (GENO)
STOVER   67 PR 164 1599        + MORAN,TRISCHKA                       (SYRA)
BJORNBOE 68 NC B53 241         +DAMGARD,HANSEN,CHATTERJEE+       (BOHR+BERN)
FRANZINI 68 PRL 21 1013        FRANZINI,SHULMAN                       (COLU)
KASHA    68 PR 172 1297        +STEFANSKI                         (BNL+YALE)
RANK     68 PR 176 1635        D.M.RANK                               (MICH)
ALLABY   69 NC 64A 75          +BIANCHINI,DIDDENS,DOBINSON,HARTUNG+  (CERN)
ANTIPOV1 69 PL 29B 245         +KARPOV,KHROMOV,LANDSBERG,LAPSHIN+    (SERP)
ANTIPOV2 69 PL 30B 576         +BOLOTOV,DEVISHEV,DEVISHEVA,ISAKOV+   (SERP)
COOK     69 PR 188 2092        +DEPASQUALI,FRAUENFELDER,PEACOCK +     (ILL)
FUKUSHIM 69 PR 178 2058        FUKUSHIMA,KIFUNE,KONDO,KOSHIBA+        (TOKY)
MCCUSKER 69 PRL 23 658         MCCUSKER,CAIRNS                      (SYDNEY)
ANTIPOV  71 NP B27 374         +KACHANOV,KUTJIN,LANDSBERG,LEBEDEV + (SERP)
BOHM     72 PR 28 326          +DIEMONT,FAISSNER,FASOLD,KRISOR+       (AACH)
BOTT-BOD 72 PL 40B 693         +CALDWELL,FABJAN,GRUHN,PEAK+    (CERN+MPIM)
ALPER    73 PL 46B 265         BRITISH-SCANDINAVIAN COLLABORATION
HICKS    73 NC 14A 65          +FLINT,STANDIL                         (MANI)
LEIPUNER 73 PRL 31 1226        +LARSEN,SESSOMS,SMITH,WILLIAMS+  (BNL+YALE)
JOVANOVI 75 PL 56B 105         JOVANOVICH+ (MANI+AACH+CERN+GENO+HARV+TORI)
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PAPERS NOT REFERRED TO IN DATA CARDS

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ZAITSEV  72 SJNP 15 656        +LANDSBERG  -REVIEW PAPER-             (SERP)
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

PARTICLE SEARCHES

MAGNETIC MONOPOLE SEARCHES

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C        MONOPOLE PROD. CROSS SECTION - ACCELERATOR EXP.      (CM**2)/NUCLEON
C    A    0   1 E-40 OR LESS  CL=.95   AMALDI    63 EMUL   M=0 TO 3 GEV      12/75*
C    A    0   5 E-41 OR LESS  CL=.95   AMALDI    63 EMUL   M=0 TO 3.4 GEV    12/75*
C    P    0   2 E-40 OR LESS           PURCELL   63 CNTR   M=0 TO 3 GEV      12/75*
C    G    0   4 E-43 OR LESS  CL=.95   GUREVICH  72 EMUL   M=0-5 GEV          3/74
C    C    0   6 E-42 OR LESS  CL=.95   CARRIGAN  73 CNTR Q=1/6-24 DIRAC CHAR  3/74
C    M    0   5 E-42 OR LESS  CL=.95   CARRIGAN  74 CNTR   Q=1/30 TO 24      12/75*
C    N    0   1 E-39 OR LESS  CL=.95   CARRIGAN  75 HLBC   NEU ENERGY=1.0     1/76*
C    N    0   4 E-38 OR LESS  CL=.95   CARRIGAN  75 HLBC   NEU ENERGY=5.0     1/76*
C    N    0   1 E-37 OR LESS  CL=.95   CARRIGAN  75 HLBC   NEU ENERGY=8.0     1/76*
C    E    0   5 E-44 OR LESS  CL=.95   EBERHARD  75 CNTR   M=0 TO 12 GEV     11/75*
C    I    0   2 E-36 OR LESS  CL=.95   GIACOMELL 75 EMUL   M=0 TO 20 GEV      2/76*
C    A  AMALDI 63 USES 28 GEV PROT BEAM AT CERN PS. FIRST RESULT IS FOR      12/75*
C    A  PROTON TARGET, SECOND IS FOR NUCLEON TARGET INSIDE NUCLEUS.          12/75*
C    P  PURCELL 63 LOOKS FOR MONOPOLES PRODUCED BY 30 GEV PROT AT THE AGS.   12/75*
C    G  GUREVICH 72 IS A SERPUKHOV 70 GEV/C P EXP. MASS LIMIT FROM PP=PPMM    3/74
C    C  CARRIGAN 73 IS NAL 300 GEV P EXP. MASS LIMIT 0-12 GEV FROM PP=PPMM    3/74
C    M  CARRIGAN 74 IS NAL 400 GEV EXP.  MASS LIMIT 0-13.7 GEV/MONOPOLE.     12/75*
C    N  CARRIGAN 75 REEXAMINES OLD CERN NEUTRINO EXPTS IN HLBC. NEU ENERGY    1/76*
C    N  GIVEN AT RIGHT REPRESENTS NEUTRINO THRESHOLD ENERGY.                  1/76*
C    N  THESE VALUES ARE IN UNITS CM**2/NUCLEUS.                              1/76*
C    E  EBERHARD 75 USED NAL TARGETS - 300 GEV AND 400 GEV P ON ALUMINUM.     2/76*
C    E  Q=1-7 DIRAC CHGS.  USED SAME TYPE OF DETECTOR AS ROSS 73.             2/76*
C    I  GIACOMELLI 75 IS CERN ISR EXP., M=0-30 GEV, Q=0.4-2.5 DIRAC CHGS.     2/76*

CS       MONOPOLE PROD. CROSS SECTION - SEARCH IN MATTER      (CM**2)/NUCLEON
CS   G    0   5 E-38 OR LESS           GOTO      63 EMUL   M=1 GEV           12/75*
CS   G    0   5 E-36 OR LESS           GOTO      63 EMUL   M=10 GEV          12/75*
CS   G    0   5 E-33 OR LESS           GOTO      63 EMUL   M=100 GEV         12/75*
CS        0   3 E-40 OR LESS  CL=.95   PETUKHOV  63 CNTR   METEORITE         12/75*
CS   C    0   1 E-38 OR LESS  CL=.90   CARITHERS 66 ELEC   M=2 GEV           12/75*
CS   C    0   7 E-37 OR LESS  CL=.90   CARITHERS 66 ELEC   M=10 GEV          12/75*
CS   C    0   1 E-35 OR LESS  CL=.90   CARITHERS 66 ELEC   M=25 GEV          12/75*
CS   F    0   5 E-43 OR LESS  CL=.90   FLEISCH1  69 CNTR   M=1 GEV            2/76*
CS   F    0   2 E-40 OR LESS  CL=.90   FLEISCH1  69 CNTR   M=10 GEV           2/76*
CS   F    0   3 E-37 OR LESS  CL=.90   FLEISCH1  69 CNTR   M=100 GEV          2/76*
CS   F    0   5 E-34 OR LESS  CL=.90   FLEISCH1  69 CNTR   M=1000 GEV         2/76*
CS   F    0   1 E-29 OR LESS  CL=.90   FLEISCH1  69 CNTR   M=10000 GEV        2/76*
CS   K    0   1 E-42 OR LESS  CL=.95   KOLM      71 CNTR   M=1.5 GEV          3/74
CS   K    0   1 E-42 OR LESS  CL=.95   KOLM      71 CNTR   M=10 GEV           3/74
CS   K    0   1 E-37 OR LESS  CL=.95   KOLM      71 CNTR   M=100 GEV          3/74
CS   K    0   1 E-34 OR LESS  CL=.95   KOLM      71 CNTR   M=1000 GEV         3/74
CS   K    0   1 E-31 OR LESS  CL=.95   KOLM      71 CNTR   M=1500 GEV         3/74
CS   R    0   1 E-43 OR LESS  CL=.95   ROSS      73 ELEC   M=2 GEV            3/74
CS   R    0   5 E-41 OR LESS  CL=.95   ROSS      73 ELEC   M=10 GEV           3/74
CS   R    0   5 E-38 OR LESS  CL=.95   ROSS      73 ELEC   M=100 GEV          3/74
CS   G  GOTO 63 EXAMINES MAGNETITE ROCK IN THE ADIRONDACK MOUNTAINS.         12/75*
CS   C  CARITHERS 66 LIMITS ABOVE ARE FOR NUCLEON-NUCLEON INTERACTIONS.      12/75*
CS   C  LIMITS FOR PHOTONUCLEON PRODUCTION ARE 10**3 TIMES LARGER.           12/75*
CS   F  FLEISCHER 69 LOOKED FOR MONOPOLES IN SEDIMENTS AT BOTTOM OF OCEAN     3/74
CS   F  DEPOSITED DURING THE LAST 16 MILLION YEARS. Q=60 DIRAC CHAR.OR LESS   3/74
CS   K  KOLM 71 TRIED TO DETECT MONOP. IN DEEP SEAWATER Q=.2-27 DIRAC CHAR.   2/76*
CS   R  ROSS 73 TRIED TO DETECT MONOP. IN LUNAR DUST    Q=.4-36 DIRAC CHAR    2/76*
CS   R  OR LARGER CHARGES EXCEPT FOR G= N*36*G0, WITH N INTEGER.  THEY ALSO   3/74
CS   R  REPORT LIMIT OF DENSITY IN LUNAR MATERIAL AS 1.7*10**-4 MONOP./GM.    2/76*

F        MONOPOLE FLUX IN COSMIC RAYS (NUMBER/CM**2-SEC-SR)
F         0   1 E-13 OR LESS           GOTO      63 EMUL   KE TO 10**4 GEV   12/75*
F         0   5 E-15 OR LESS  CL=.90   CARITHERS 66 ELEC                     12/75*
F    F    0   3 E-19 OR LESS  CL=.90   FLEISCH2  69 SCAN   KE TO 10**10 GEV  12/75*
F         0   2 E-18 OR LESS           KOLM      71 CNTR   KE TO 10**5 GEV   12/75*
F    R    0   5 E-19 OR LESS  CL=.95   ROSS      73 ELEC   KE TO 10**4 GEV   12/75*
F   P     1   1 E-13                   PRICE     75 EMUL   M GT 200 GEV      12/75*
F    F  FLEISCHER 2 69 LOOKED FOR MONOPOLE TRACKS LEFT IN OBSIDIAN AND MICA  12/75*
F    F  OVER GEOLOGICAL TIMES.                                               12/75*
F    R  ROSS 73 INCLUDES DATA OF EBERHARD 71 PAPER.                          12/75*
F    P  SEE ALVAREZ 75 FOR ALTERNATIVE EXPLANATION OF PRICE 75 EVENT.        12/75*
F    P  SEE EBERHARD 75 FOR DISCUSSION OF CONFLICT WITH OTHER EXPERIMENTS.   12/75*
F    P  NOT CONSIDERED CONVINCING EVIDENCE FOR THE EXISTENCE OF MONOPOLES.   12/75*

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REFERENCES FOR MAGNETIC MONOPOLE SEARCHES


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AMALDI    63 NC 28 773         +BARONI,MANFREDINI,BRADNER+(ROMA+UCSD+CERN)
GOTO      63 PR 132 387        +KOLM,FORD                  (TOKY+MIT+BRAN)
PETUKHOV  63 NP 49 87          +YAKIMENKO                           (LEBD)
PURCELL   63 PR 129 2326       +COLLINS,FUJII,HORNBOSTEL,TURKOT (HARV+BNL)
CARITHER  66 PR 149 1070       CARITHERS,STEFANSKI,ADAIR            (YALE)
FLEISCH1  69 PR 184 1393       FLEISCHER,HART,JACOBS+      (GESC+UNCS+GSCO)
    ALSO  70 JAP 41 958        FLEISCHER,HART,JACOBS,PRICE,SCHWARTZ+(GESC)
FLEISCH2  69 PR 184 1398       FLEISCHER,PRICE,WOODS                (GESC)
    ALSO  70 JAP 41 958        FLEISCHER,HART,JACOBS,PRICE,SCHWARTZ+(GESC)
KOLM      71 PR D4 1285        +VILLA,ODIAN                     (MIT+SLAC)
GUREVICH  72 PL 38B 549        +KHAKIMOV,MARTEMIANOV+      (KIAE+NOVO+SERP)
    ALSO  70 PL 31B 394        GUREVICH,KHAKIMOV +         (KIAE+NOVO+SERP)
    ALSO  72 JETP 34 917       BARKOV, GUREVICH,           (KIAE+NOVO+SERP)
CARRIGAN  73 PR D8 3717        +NEZRICK,STRAUSS                     (FNAL)
ROSS      73 PR D8 698         +EBERHARD,ALVAREZ,WATT           (LBL+SLAC)
    ALSO  71 PR D4 3260        EBERHARD,ROSS,ALVAREZ,WATT       (UCB+SLAC)
CARRIGAN  74 PR D10 3867       +NEZRICK,STRAUSS                     (FNAL)
CARRIGAN  75 NP B91 279        +NEZRICK                             (FNAL)
    ALSO  71 PR D3 56          CARRIGAN,NEZRICK                     (FNAL)
EBERHARD  75 PR D11 3099       +ROSS,TAYLOR,ALVAREZ,OBERLACK    (LBL+MPIM)
GIACOMEL  75 NC 28A 21         GIACOMELLI,ROSSI+      (BGNA+CERN+SACL+ROMA)
PRICE     75 PRL 35 487        +SHIRK,OSBORNE,PINSKY        (UCB+HOUSTON)
    ALSO  75 LBL-4260          LUIS ALVAREZ                          (LBL)
    ALSO  75 LBL-4289          PHILIPPE EBERHARD                     (LBL)
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CHARMED HADRON SEARCHES

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CE       CHARMED HADRON PRODUCTION CROSS SECTION(E+ E-) (UNITS 10**-35 CM**2)
CE   B    0   18.     OR LESS  CL=.90   BOYARSKI  75 SPEC K- PI+, K+ PI-      2/76*
CE   B    0   40.     OR LESS  CL=.90   BOYARSKI  75 SPEC KOS PI+ PI-         2/76*
CE   B    0   13.     OR LESS  CL=.90   BOYARSKI  75 SPEC PI+ PI-             2/76*
CE   B    0   12.     OR LESS  CL=.90   BOYARSKI  75 SPEC K+ K-               2/76*
CE   B    0   49.     OR LESS  CL=.90   BOYARSKI  75 SPEC K-PI+PI+, K+PI-PI-  2/76*
CE   B    0   27.     OR LESS  CL=.90   BOYARSKI  75 SPEC KOS PI+, KOS PI-    2/76*
CE   B    0   33.     OR LESS  CL=.90   BOYARSKI  75 SPEC KOS K+, KOS K-      2/76*
CE   B    0   38.     OR LESS  CL=.90   BOYARSKI  75 SPEC PI+PI-PI+,PI+PI-PI- 2/76*
CE   B    0   90.     OR LESS  CL=.90   BOYARSKI  75 SPEC K+PI-,KOPI+PI- + CC 2/76*
CE   B    0   16.     OR LESS  CL=.90   BOYARSKI  75 SPEC K+ K-, PI+ PI-      2/76*
CE   B    0   51.     OR LESS  CL=.90   BOYARSKI  75 SPEC K+PI-PI-,KOPI+ + CC 2/76*
CE   B    0   76.     OR LESS  CL=.90   BOYARSKI  75 SPEC KOK+,PI+PI+PI- + CC 2/76*
CE   P   64    1.9      0.5             PERL      75 SPEC     E(OR MU) NEUTRI. 2/76*
CE   B  BOYARSKI 75 IS SLAC(SPEAR) EXPT.  LOOKED FOR E+E- --> D ANYTHING      2/76*
CE   B  AT ECM=4.8 GEV WHERE CHARMED MESON D DECAYED VIA CHANNELS SHOWN.      2/76*
CE   B  ABOVE VALUES ARE FOR D MASS=1.85-2.40 GEV.   SIMILAR LIMITS ARE       2/76*
CE   B  GIVEN FOR MASS=1.50-1.85, 2.40-4.00 GEV IN THEIR TABLE 1.             2/76*
CE   P  PERL 75 IS SLAC(SPEAR) EXPT .  EVENTS ARE E+E- TO E+-MU-+ AND 2 OR    2/76*
CE   P  MORE MISSING PARTICLES.  CS IS FOR ECM=4.8 GEV AND THETA=50-130DEG.   2/76*
CE   P  CROSS SECTION RISES FROM 5X10**-36 AT E=4 TO ABOVE MAX. THEN DROPS    2/76*
CE   P  TO 6E-36  AT E=7.5.    AUTHORS SAY THESE EVENTS HAVE NO CONVENTIONAL  2/76*
CE   P  EXPLANATION.  SUGGEST HEAVY LEPTON OR CHARMED HADRON, M=1.6-2.0GEV.   2/76*

CPI      CHARMED HADRON PRODUCTION CROSS SECTION (PI NUCLEON)    (CM**2)      2/76*
CPI  H    0  4. E-30 OR LESS  CL=.95    HAGOPIAN  76 DBC  SHORT LIVED 2-5GEV  2/76*
CPI  H    1  7. E-31 OR LESS  CL=.95    HAGOPIAN  76 DBC  LONG LIVED 1.9-2GEV 2/76*
CPI  H    0  3. E-31 OR LESS  CL=.95    HAGOPIAN  76 DBC  LONG LIVED1-1.9,2-5 2/76*
CPI  H  HAGOPIAN 76 IS A SLAC 15GEV PI+ D EXPT.  ALL POSSIBLE TWO AND THREE   2/76*
CPI  H  BODY MASS COMBINATIONS WERE STUDIED FOR NARROW RESONANCES WITH MASS   2/76*
CPI  H  1.5-5GEV FOR MESONS AND 2-5GEV FOR BARYONS.  INDIVIDUAL LIMITS FOR    2/76*
CPI  H  TWO AND THREE BODY DECAY FROM MANY REACTIONS ARE GIVEN.               2/76*
CPI  H  VEES WERE STUDIED FOR THE POSSIBILITY OF A NEW LONG LIVED (MEAN       2/76*
CPI  H  LIFE 1E-11 SEC. OR MORE) NEUTRAL PARTICLE.  ONE CANDIDATE WITH MASS   2/76*
CPI  H  1.9-2 GEV WAS FOUND.  SECOND LONG LIVED LIMIT FOR M=1-1.9, 2-5 GEV.   2/76*

CP       CHARMED HADRON PRODUCTION CROSS SECTION (P NUCLEON)    (CM**2)
CP   A    0  1. E-33 OR LESS                AUBERT    75 SPEC    PI+ K-       2/76*
CP   A    0  4. E-33 OR LESS                AUBERT    75 SPEC    K+ PI-       2/76*
CP   A    0  1. E-33 OR LESS                AUBERT    75 SPEC    K+ K-        2/76*
CP   A    0  8. E-33 OR LESS                AUBERT    75 SPEC    PI+ PI-      2/76*
CP   A    0  7. E-33 OR LESS                AUBERT    75 SPEC    P K-         2/76*
CP   A    0  2. E-33 OR LESS                AUBERT    75 SPEC    K+ PBAR      2/76*
CP   A    0  4. E-32 OR LESS                AUBERT    75 SPEC    P PI-        2/76*
CP   A    0  2. E-33 OR LESS                AUBERT    75 SPEC    PI+ PBAR     2/76*
CP   A  AUBERT 75 IS A BNL 30 GEV EXPT.  LOOKS FOR P BE --> JPRIME ANYTHING   2/76*
CP   A  WHERE JPRIME DECAYED VIA THE CHANNEL SHOWN.  ABOVE VALUES ARE         2/76*
CP   A  FOR M=2.25GEV AND ASSUME A WIDTH SMALL COMPARED TO THE RESOLUTION.    2/76*
CP   A  UPPER LIMITS ARE ALSO GIVEN FOR THE ABOVE CHANNELS AND P PBAR FOR     2/76*
CP   A  M=3.1 AND 3.7 GEV.  THOSE LIMITS RANGE FROM 7E-36 TO 4E-33.           2/76*

Y        CHARMED HADRON (Y) EVIDENCE IN NEUTRINO NUCLEON --> 2 MUONS ANYTHING
Y    B  14MU+MU-  0MU-MU-  0MU+MU+    BENVENU1  75 SPEC    PREDOM. NEU BEAM   2/76*
Y    B  51MU+MU-  7MU-MU-  3MU+MU+    BENVENU3  75 SPEC    6/7 NEU BEAM       2/76*
Y    B   5MU+MU-  0MU-MU-  2MU+MU+    BENVENU5  75 SPEC    9/10ANTINEU BEAM   2/76*
Y    B  BENVENUTI 75 ARE FNAL NEUTRINO NUCLEON EXPERIMENTS WHICH LOOKED FOR   2/76*
Y    B  TWO OR MORE MUONS IN THE FINAL STATE.  NO TRIMUON EVENTS WERE SEEN.   2/76*
Y    B  AUTHORS STATE THAT THESE DIMUON EVENTS REQUIRE THE EXISTENCE OF ONE   2/76*
Y    B  OR MORE NEW PARTICLES WITH M=2-4GEV AND TAU=10**-10SEC. OR LESS.      2/76*
Y    B  BENVENUTI4 75 SHOW THAT THE OBSERVED PROPERTIES OF THESE EVENTS       2/76*
Y    B  DO NOT AGREE WITH HYPOTHESES OF HEAVY LEPTON OR INTERMEDIATE VECTOR   2/76*
Y    B  BOSON.  THEY SUGGEST A HADRON (Y) WITH A NEW QUANTUM NUMBER.          2/76*

VO       CHARMED HADRON EVIDENCE IN NEUTRINO NUCLEON --> MU- E+ VO ANYTHING
VO        WHERE THE VO IS A KOS OR A LAMBDA
VO   B    1 EVENT                     DEDEN     75 HLBC                       2/76*
VO   B    1 EVENT                     BLIETSCHA 75 HLBC                       2/76*
VO   V    4 EVENTS                    VONKROGH  76 HLBC                       2/76*
VO   B  THE DEDEN 75 AND BLIETSCHAU 75 EVENTS ARE FROM CERN                   2/76*
VO   B  GARGAMELLE NEUTRINO EXPOSURES.  THE MASSES OF THE E+ VO SYSTEM FOR    2/76*
VO   B  THE TWO EVENTS ARE 1.24, 1.91 GEV FOR LAMBDA OR 0.65, 1.57 FOR KO.    2/76*
VO   V  THE VON KROGH 76 EVENTS ARE FROM AN FNAL 15 FT NEON BUBBLE CHAMBER    2/76*
VO   V  EXPOSURE.  ALL FOUR E+ EVENTS FOUND HAVE ASSOCIATED KOS.              2/76*

BAR      CHARMED BARYON EVIDENCE IN NEUTRINO P --> MU- LAMBDA 3PI+ PI-
BAR  C    1 EVENT (3 CONSTRAINT FIT)   CAZZOLI   75 HBC     M=2.426+-.012GEV  2/76*
BAR  C  CAZZOLI 75 IS A BNL NEUTRINO EXPT.  AUTHORS INTERPRET THIS ONE        2/76*
BAR  C  EVENT AS EITHER A LARGE VIOLATION OF THE DS=DQ RULE OR AS A CHARMED   2/76*
BAR  C  BARYON DECAYING TO LAMBDA 3PI+ PI-.                                   2/76*

R1       CHARMED HADRON (Y) BRANCHING RATIO INTO (MU NEU ANYTHING)/HADRONS
R1   B    8     A FEW PERCENT         BENVENU2  75 SPEC     FNAL NEUTRINO NU  2/76*
R1   B  BENVENUTI2 75 LOOKS AT ANTINEUTRINO NUCLEON --> MUON HADRONS.  SEES   2/76*
R1   B  EXCESS EVENTS ABOVE INCIDENT ENERGY 30 GEV.  COMPARES BENVENUTI1 75   2/76*
R1   B  DIMUON EVENTS WITH EXCESS EVENTS TO GET BRANCHING RATIO.              2/76*

R2       CHARMED HADRON (ASSOC. VO) BRANCHING RATIO INTO SEMILEPTONICS/ALL
R2   B    2     0.1   OR MORE         BLIETSCHA 75 HLBC     M=2.5-4 GEV       2/76*
R2   B  THIS BR.RATIO AND MASS ARE REQD. BY OBSERVED RATE AND CHARM SCHEME.   2/76*

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REFERENCES FOR CHARMED HADRON SEARCHES


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AUBERT    75 PRL 35 416        +BECKER,BIGGS,BURGER,CHEN+          (MIT+BNL)
BENVENU1  75 PRL 34 419        BENVENUTI,CLINE,FORD+ (HARV,PENN,WISC,FNAL)
BENVENU2  75 PRL 34 597        BENVENUTI,CLINE,FORD+ (HARV,PENN,WISC,FNAL)
    ALSO  74 PRL 33 984        AUBERT,BENVENUTI+     (HARV,PENN,WISC,FNAL)
BENVENU3  75 PRL 35 1199       BENVENUTI,CLINE,FORD+ (HARV,PENN,WISC,FNAL)
BENVENU4  75 PRL 35 1203       BENVENUTI,CLINE,FORD+ (HARV,PENN,WISC,FNAL)
BENVENU5  75 PRL 35 1249       BENVENUTI,CLINE,FORD+ (HARV,PENN,WISC,FNAL)
BOYARSKI  75 PRL 35 196        +BREIDENBACH,BULOS,DAKIN,FELDMAN+(SLAC+LBL)
CAZZOLI   75 PRL 34 1125       +CNOPS,CONNOLLY,LOUTTIT,MURTAGH+       (BNL)
DEDEN     75 PL 58B 361               (AACH+BRUX+CERN+EPOL+MILA+ORSA+LOUC)
PERL      75 PRL 35 1489       +ABRAMS,BOYARSKI,BREIDENBACH +        (SLAC)
BLIETSCH  75 CERN/D.PH.II/PHYS 75-49  (AACH+BRUX+CERN+EPOL+MILA+ORSA+LOUC)
HAGOPIAN  76 PRL 36 296        +WILKINS,WIND,HAGOPIAN,ALBRIGHT+ (FSU+BRAN)
VONKROGH  76 (TO BE PUBL.)     +FRY,CAMERINI,CLINE+    (WISC+LBL+CERN+HAWA)
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Stable Particles

PARTICLE SEARCHES

Data Card Listings

For notation, see key at front of Listings.

OTHER STABLE PARTICLE SEARCHES

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       SEARCHES FOR STABLE PARTICLES (I.E. PARTICLES IMMUNE TO DECAY VIA
       THE STRONG INTERACTION) NOT AMONG ABOVE SEARCHES ARE LISTED HERE.

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D        HEAVY PARTICLE PRODUCTION DIFFERENTIAL CROSS SECTION (CM**2/SR-GEV)
D     A   0  1. E-31 OR LESS  CL=.90   APPEL     74 CNTR +- M=3.2-7.2 GEV    2/76*
D     J   0  8. E-35 OR LESS  CL=.90   JOVANOVIC 75 CNTR +- M=15-26 GEV      2/76*
D     J   0  1.5E-34 OR LESS  CL=.90   JOVANOVIC 75 CNTR Q=+-2, M=3-10 GEV   2/76*
D     J   0  6. E-35 OR LESS  CL=.90   JOVANOVIC 75 CNTR Q=+-2, M=10-26 GEV  2/76*
D     A  APPEL 74 IS NAL 300 GEV P+W EXPERIMENT.  STUDIES FORWARD PRODUCTION 2/76*
D     A  OF HEAVY (UP TO 24 GEV) CHARGED PARTICLES WITH MOMENTA 24-200GEV(-) 2/76*
D     A  AND 40-150GEV (+CHG).  ABOVE TYPICAL VALUE IS FOR 75 GEV.           2/76*
D     J  JOVANOVICH 75 IS A CERN ISR 26+26 AND 15+15 GEV P+P EXPERIMENT.     2/76*
D     J  FIG.4 COVERS RANGES Q=1/3 TO 2 AND M=3 TO 26 GEV.                   2/76*

F        HEAVY PARTICLE FLUX IN COSMIC RAYS (NUMBER/CM**2-SEC-SR)            1/76*
F     Y   5   6 E-9  OR MORE           YOCK      74 CNTR    M GT 6 GEV       1/76*
F     Y  YOCK 74 EVENTS COULD BE TRITONS.                                    1/76*

C        LIGHT (BETWEEN MU AND E MASSES) PARTICLE MASS(UNITS-ELECTRON MASSES)
C         0   NONE BETWEEN 2 AND 13    BLAGOV    75 CNTR SPINOR,TAU=2E-10SEC 2/76*
C         0   NONE BETWEEN 2 AND 10.6  BLAGOV    75 CNTR SCALAR,TAU=2E-10SEC 2/76*

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REFERENCES FOR OTHER STABLE PARTICLE SEARCHES


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APPEL    74 PRL 32 428         +BOURQUIN,GAINES,LEDERMAN,PAAR+  (COLU+NAL)
YOCK     74 NP B76 175         P.C.M.YOCK                (UNIV OF AUCKLAND)
BLAGOV   75 YAD.FIZ. 21,300    +KOMAR,MURASHOVA,SYREISHCHIKOVA+      (LEBD)
JOVANOVI 75 PL 56B 105         JOVANOVICH+ (MANI+AACH+CERN+GENO+HARV+TORI)

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Data Card Listings

For notation, see key at front of Listings.

Mesons

$\pi^{\pm}$, π^0, η, $\rho(770)$

S=0 MESON STATES

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π±

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8  CHARGED PION(140,JPG=0--) I=1
SEE STABLE PARTICLE DATA CARD LISTINGS
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π0

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9  NEUTRAL PION(135,JPG=0--) I=1
SEE STABLE PARTICLE DATA CARD LISTINGS
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η

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14  ETA(549,JPG=0-+) I=0
SEE STABLE PARTICLE DATA CARD LISTINGS
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ρ(770)

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9  RHO(770, JPG = 1-+) I=1
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                         9  RHC MASS (MEV)

M       WE NO LONGER LIST S-WAVE BREIT-WIGNER FITS, PBAR P DATA WITH HIGH
M       COMBINATORIAL BACKGROUND, AND INSIGNIFICANT OR DOUBTFUL DATA.

M    MIXED CHARGES
M       240 (752.0)                        ALITTI    63 HBC   -0 1.6 PI-P
M       290 (755.0)                        CHADWICK  63 HBC  +-0 0.0 PBAR P

M       CHARGED ONLY
M           (748.0)                        KENNEY    62 HBC   -  1.2 PI-P
M       130 (775.0)                        GUIRAGOSS 63 HBC   -  3.3 PI-P
M    R      (760.0)   (9.0)                CARMCNY   64 HBC   +  3.5 PI+P,TCUT 4
M    R      (768.0)   (5.0)                BLIEDEN   65 MMSP  -  3-5 PI- P        6/66
M    R      (765.0)   (5.0)                ALFF-STEI 66 HBC   +  2-3 PI+ P        6/66
M    R      (760.0)   (5.0)                HAGOPIAN1 66 HBC   -  3.0 PI- P        6/66
M    R      (765.0)   (5.0)                HAGOPIAN2 66 HBC   -  2.14 PI-,TCUT12  9/67
M    R 2775 (753.5)  (10.5)                JACOBS    66 HBC   -  2-3PI-,T CUT 20  6/68
M    R      (758.0)  (10.0)                JAMES     66 HBC   +  2.1 PI+,TCUT2.5  8/66
M    R      (749.0)   (3.0)                WEST      66 HBC   -  2.1 PI- P       10/66
M   Z   900  767.      6.                  EISNER    67 HBC   -  4.2 PI-,T CUT10  1/73
M    R      (768.0)   (5.0)                MILLER    67 HBC   -  2.7 PI-,T CUT20  9/66
M    R      (773.0)   (2.0)                BATCN     68 HBC   -  2.8 PI-,T CUT13  7/69
M      1700 (782.)    (5.)                 FOSTER    68 HBC  +-  PBAR P AT REST   1/73
M      9650  764.3     1.9       1.8       PISUT     68 RVUE  -  1.7-3.2PI-,CT10  6/68
M    A 9650 (764.3)  (19.2)     (3.3)      PISUT     68 RVUE  -  1.7-3.2PI-,CT10  6/68
M    A    ERRORS ARE 2 STD AND INCLUDE SYSTEMATIC UNCERTAINTIES FRCM THEORY
M   X  1300  777.0     5.0                 REYNOLDS  69 HBC   -  2.26 PI- P       1/73
M   X  6500  766.      7.                  BYERLY    73 OSPK  -  5. PI- P         2/74
M   X     SYSTEMATIC ERRORS ADDED CORRESP. TO SPREAD OF DIFFERENT FITS.
M           . . . . . . . . . .
M    AVG     765.9     2.2      AVERAGE (ERRCR INCLUDES SCALE FACTOR OF 1.4)
M    STUDENT 765.6     1.9      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

MO   NEUTRAL ONLY
MO      190 (750.0)  (20.0)                SAMIOS    62 HBC    0 4.7 PI-P
MO   R  300 (760.0)  (10.0)                ABOLINS   63 HBC    0 3.5 PI+P
MO      160 (775.0)                        GUIRAGOSS 63 HBC    0 3.3 PI-P
MO   R  500 (770.0)  (10.0)                GOLDHABER 64 HBC    0 3.7 PI+P
MO   R      (750.0)   (5.0)                ALFF-STEI 66 HBC    0 2-3 PI+ P        6/66
MO   R      (775.0)   (5.0)                HAGOPIAN1 66 HBC    0 3.0 PI- P        6/66
MO   R      (770.)    (5.)                 HAGOPIAN2 66 HBC    0 2.1 PI-,TCUT 12  2/67
MO   R 4207 (758.0)   (7.5)                JACOBS    66 HBC    0 2-3PI-,T CUT 20  6/68
MO   R      (765.0)   (8.0)                JAMES     66 HBC    0 2.1 PI+ P        6/66
MO   R      (760.0)   (3.0)                WEST      66 HBC    0 2.1 PI- P       10/66
MO   P 4000 (765.)    (5.0)                ASBURY 2  67 CNTR   0 GAMMA + PB       1/73
MO   R      (768.0)   (2.0)                BACON     67 HBC    0 1.7 PI-P         9/67
MO   R      (761.)    (3.)                 HUWE      67 HBC    0 2.4 PI- P        7/67
MO   R      (770.0)   (4.0)                MILLER    67 HBC    0 2.7 PI-,T CUT20  9/66
MO   R      (775.0)   (2.0)                ARMENISE  68 DBC    0 5.1 PI+D         6/68
MO     1900 (776.)    (5.)                 FOSTER    68 HBC    0 PBAR P AT REST   1/73
MO     2250  775.0     3.0                 HYAMS     68 OSPK   011.2 PI- P      . 9/68
MO    13300  766.7     2.8                 PISUT     68 RVUE   0 1.7-3.2PI-,CT10  1/73
MO   B      (754.0)   (9.0)                AUSLENDER 69 OSPK   0 E+E- COLL.BEAMS  2/74
MO   R      (768.4)   (2.4)                MALAMUD   69 RVUE   0 2-4 PI-P         1/73
MO X  1700   772.0     5.0                 REYNOLDS  69 HBC    0 2.26 PI- P       1/73
MO X     SYSTEMATIC ERRORS ADDED CORRESP. TO SPREAD OF DIFFERENT FITS.
MO C         759.0     7.0                 SCHAREN   69 HBC    0 2-4 PI- P        1/73
MO  P       (765.0)  (10.0)                ALVENSLEB 70 CNTR   0 GAMMA A,TCUT.01  1/73
MO  C12630  (760.0)                        BATON     70 HBC    0 2.8 PI- P        1/71
MO     140K  767.7     1.9                 BIGGS     70 CNTR   OPHOTOPRODUCTICN   1/73
MO C         761.0     5.0                 BAILLCN   72 ASPK   0 15. PI- P        1/73
MO     1930  767.0     4.0                 BALLAM    72 HBC    0 2.8 GAMMA P      1/73
MO     2430  770.0     4.0                 BALLAM    72 HBC    0 4.7 GAMMA P      1/73
MO  B       (775.4)   (7.3)                BENAKSAS  72 OSPK   0 E+E- COLL.BEAMS  2/74
MO           772.3     5.9                 BENAKSAS  72 RVUE  0 E+E- COLL.BEAMS   2/74
MO Z 11200   773.5     1.7                 JACOBS    72 HBC    0 2.8 PI- P      . 1/73
MO     6800  764.0     3.0                 RATCLIFF  72 ASPK   0 15. PI-P,TCUT.3. 2/74
MO  P       (775.)    (5.)                 GLADDING  73 CNTR  0 2.9-4.7 GAMMA P   2/74
MO  H       (778.)    (2.)                 HYAMS     73 ASPK  0 17 PI-P,N PI+PI-  1/74
MO C 32000   775.0     4.0                 PROTOPOPE 73 HBC    0 7.1 PI+P,TCUT.4  2/74
MO     4100  767.      4.                  ENGLER    74 DBC    0 6. PI+N,PI+PI-P 12/75*
MO  H       (770.)    (9.)                 ESTABROOK 74 RVUE   0 17 PI-P,PI+PI-N 12/75*
MO           771.      1.                  GRAYER    74 ASPK  0 17 PI-P,N PI+PI-  2/74
MO  H    FRCM PHASE SHIFT ANALYSIS OF GRAYER 74 DATA.
MO  D       (776.3)   (0.4)                ROOS      75 RVUE   OPHASE SHIFTS     12/75*
MO  D    INCLUDES BATON 70,HYAMS 73,PROTOPOPESCU 73                              12/75*
MO          . . . . . . . . . .
MO   AVG     770.23    0.88     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
MO   STUDENT 770.25    0.82     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                               (SEE IDEOGRAM BELOW )

M          ----------NOTES----------

M    C   FROM POLE EXTRAPOLATICN
M    R   INCLUDED IN PISUT 68 RVUE
M    B   INCLUDED IN BENAKSAS 72 REVUE VALUE
M    P   FROM PHOTOPRODUCTION, MODEL DEPENDENT.
M    Z   MASS ERRORS ENLARGEC BY US TO WIDTH/SQRT(N)
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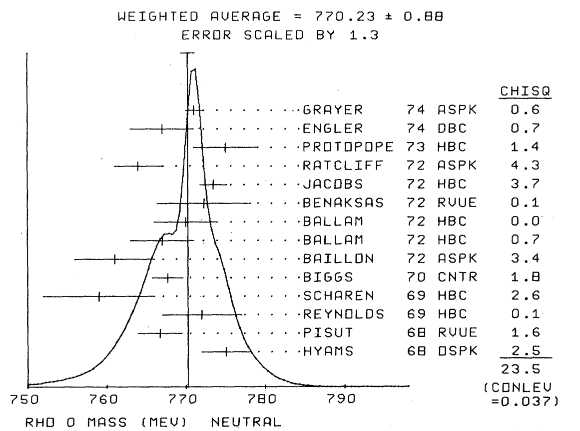


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                9  (RHO0) - (RHO+-) MASS DIFFERENCE (MEV)

D          2.4       2.1                PISUT      68 RVUE     PI N TO RHO N     6/68

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                         9  RHO WIDTH (MEV)

W       SEE NOTE ON RHO MASS ABOVE

W    MIXED CHARGES
W       290 (110.0)                        CHADWICK  63 HBC  +-0 0.0 PBAR P

W       CHARGED ONLY
W       130 (125.0)                        GUIRAGOSS 63 HBC   -  3.3 PI-P
W           (90.0)   (10.0)                SACLAY    63 HBC   +  2.8 PI+P
W        98 (180.0)                        BCNDAR    64 HBC   -  4.1 PI-P
W    R      (77.0)   (20.0)                CARMCNY   64 HBC   +  3.5 PI+P,TCUT 4
W    R      (100.0)                        ALFF-STEI 66 HBC   +  2-3 PI+ P        6/66
W    R      (127.0)   (5.0)                BLIEDEN   66 MMSP  -  3-5 PI- P        6/66
W    R      (150.0)  (20.0)                HAGOPIAN1 66 HBC   -  3.0 PI- P        6/66
W    R      (135.0)  (20.0)                HAGOPIAN2 66 HBC   -  2.14 PI-,TCUT12  9/67
W    R 2775 (137.1)  (20.0)                JACOBS    66 HBC   -  2-3PI-,T CUT 20  6/68
W    R      (147.0)  (19.0)                JAMES     66 HBC   +  2.1 PI+,TCUT2.5  8/66
W    R      (149.0)   (13.0)               WEST      66 HBC   -  2.1 PI- P       10/66
W       900  146.      13.                 EISNER    67 HBC   -  4.2 PI-,T CUT10  9/67
W    R      (153.0)  (13.0)                MILLER    67 HBC   -  2.7 PI-,T CUT20  9/66
W    R      (150.0)   (5.0)                BATON     68 HBC   -  2.8 PI- P        7/69
W      1700 (145.0)  (10.0)                FOSTER    68 HBC  +-  PBAR P AT REST   1/73
W      9650  147.3     4.0       3.9       PISUT     68 RVUE  -  1.7-3.2PI-,CT10  6/68
W   X  1300  154.0    13.0                 REYNOLDS  69 HBC   -  2.26 PI- P       1/73
W   X  6500  146.     12.                  BYERLY    73 OSPK  -  5. PI- P         2/74
W   X     SYSTEMATIC ERRORS ACDED CORRESP. TO SPREAD OF DIFFERENT FITS.
W           . . . . . . . . . .
W    AVG     147.6     3.5      AVERAGE (ERRCR INCLUDES SCALE FACTOR OF 1.0)
W    STUDENT 147.6     3.7      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

WO   NEUTRAL ONLY
WO      190 (150.0)  (20.0)                SAMIOS    62 HBC    0 4.7 PI-P
WO   R  300  (90.0)  (10.0)                ABOLINS   63 HBC    0 3.5 PI+P
WO      160 (175.0)                        GUIRAGOSS 63 HBC    0 3.3 PI-P
WO   R  500 (130.0)                        GOLDHABER 64 HBC    0 3.7 PI+P
WO   R      (100.0)                        ALFF-STEI 66 HBC    0 2-3 PI+ P        6/66
WO   R      (120.0)  (10.0)                HAGOPIAN1 66 HBC    0 3.0 PI- P        6/66
WO   R      (135.0)  (20.0)                HAGOPIAN2 66 HBC    0 2.14 PI-P,LOW T  9/67
WO   R 4207 (122.2)  (15.0)                JACOBS    66 HBC    0 2-3PI-,T CUT 20  6/68
WO   R      (103.0)  (13.0)                JAMES     66 HBC    0 2.1 PI+ P        6/66
WO   R      (173.0)  (13.0)                WEST      66 HBC    0 2.1 PI- P       10/66
WO   P 4000 (130.)    (5.)                 ASBURY 2  67 CNTR   0 GAMMA + PB       1/73
WO   R      (148.0)   (8.0)                BACON     67 HBC    0 1.7 PI-P         9/67
WO   R      (152.)   (15.)                 HUWE      67 HBC    0 2.4 PI- P        7/67
WO   R      (160.0)  (15.0)                MILLER    67 HBC    0 2.7 PI-,T CUT20  9/66
WO   R      (167.0)   (6.0)                ARMENISE  68 DBC    0 5.1 PI+D         6/68
WO     1900 (132.)   (10.)                 FOSTER    68 HBC    0 PBAR P AT REST   1/73
WO Z   2250  145.0    12.0                 HYAMS     68 OSPK   011.2 PI- P      . 1/73
WO  P       (160.0)  (10.0)                LANZEROTT 68 CNTR   0 GAMMA P          1/73
WO  B       (105.0)  (20.0)                AUSLENDER 69 OSPK   0 E+E- COLL.BEAMS  2/74
WO  R       (132.0)  (13.0)                MALAMUD   69 RVUE   0 2-4 PI-P         1/73
WO X  1700   135.0    16.0                 REYNOLDS  69 HBC    0 2.26 PI- P       1/73
WO X     SYSTEMATIC ERRORS ACDEC CORRESP. TO SPREAD OF DIFFERENT FITS.
WO C         119.0    20.0                 SCHAREN   69 HBC    0 2-4 PI- P        1/73
WO  P       (140.0)   (5.0)                ALVENSLEB 70 CNTR   0 GAMMA A,TCUT.01  1/73
WO  C12630  (131.0)                        BATON     70 HBC    0 2.8 PI- P        1/71
WO     140K  146.1     2.9                 BIGGS     70 CNTR   OPHOTOPRODUCTICN   1/73
WO C         108.0    20.0                 BAILLON   72 ASPK   0 15. PI- P        1/73
WO Z  2430   155.0    12.0                 BALLAM    72 HBC    0 4.7 GAMMA P      1/73
WO Z  1930   145.0    13.0                 BALLAM    72 HBC    0 2.8 GAMMA P      1/73
WO  B       (149.6)  (23.2)                BENAKSAS  72 OSPK   0 E+E- COLL.BEAMS  2/74
WO           135.8    15.1                 BENAKSAS  72 RVUE  0 E+E- COLL.BEAMS   2/74
WO    11200 (178.35)  (2.5)                JACOBS    72 HBC    0 2.8 PI- P        1/73
WO     6800  157.0     8.0                 RATCLIFF  72 ASPK   0 15. PI-P,TCUT.3. 2/74
WO  P       (147.)   (11.)                 GLADDING  73 CNTR  0 2.9-4.7 GAMMA P   2/74
WO  H       (152.)    (2.)                 HYAMS     73 ASPK  0 17 PI-P,N PI+PI-  1/74
WO C 32000   160.0    10.0                 PROTOPOPE 73 HBC    0 7.1 PI+P,TCUT.4  2/74
WO     4100  146.     14.                  ENGLER    74 DBC    0 6. PI+N,PI+PI-P 12/75*
WO  H       (143.)   (13.)                 ESTABROOK 74 RVUE   0 17 PI-P,PI+PI-N 12/75*
WO           161.      4.                  GRAYER    74 ASPK  0 17 PI-P,N PI+PI-  2/74
WO  H    FROM PHASE SHIFT ANALYSIS OF GRAYER 74 DATA.
WO  D       (154.5)   (1.0)                ROOS      75 RVUE   OPHASE SHIFTS     12/75*
WO  D    INCLUDES BATON 70,HYAMS 73,PROTOPOPESCU 73                              12/75*
WO          . . . . . . . . . .
WO   AVG     150.3     2.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
WO   STUDENT 149.4     2.8      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                               (SEE IDECGRAM BELOW )

W          ----------NOTES----------

W    C   FROM POLE EXTRAPOLATICN
W    R   INCLUDED IN PISUT 68 RVUE
W    B   INCLUDED IN BENAKSAS 72 REVUE VALUE
W    P   FROM PHCTOPRODUCTION, MODEL DEPENDENT.
W    Z   WIDTH ERRORS ENLARGEC BY US TO 4*WIDTH/SQRT(N)
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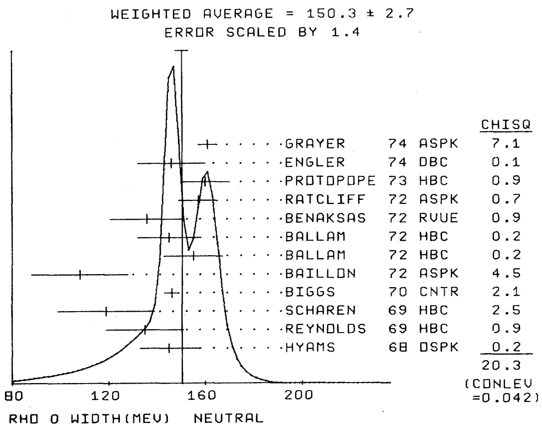
Mesons

$\rho(770)$

Data Card Listings

For notation, see key at front of Listings.

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9  RHO PARTIAL DECAY MODES

                                                         DECAY MASSES
P1       RHO INTO 2PI                                    139+ 139
P2       RHO INTO 4PI                                    139+ 139+ 139+ 139
P3       RHO INTO PI GAMMA                               139+   0
P4       RHO INTO E+ E-                                   .5+  .5
P5       RHO INTO PI ETA (VIOLATES G)                    139+ 548
P6       RHO INTO MU+ MU-                                105+ 105
P7       RHO INTO PI+ PI- PIO (VICLATES G)               139+ 139+ 134
P8       RHO INTO ETA GAMMA                              548+   0
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9  RHO BRANCHING RATIOS

R1       RHO INTO 4PI/2PI                                  (P2)/(P1)

R1       RHO+- INTO (PI+- PI+ PI- PIO) / (PI+- PIO)
R1              (0.026)OR LESS        BLIEDEN    66 MMSP  -  3-5 PI- P           6/66
R1              (0.01) OR LESS        DEUTSCHMA  66 HBC   +  8.0 PI+ P           6/66
R1              (0.002)OR LESS        FERBEL     66 HBC  +- PI+- P ABOVE 2.5 10/66
R1               0.0035    0.004      JAMES      66 HBC   +  2.1 PI+P           11/66

R1       RHO0 INTO (PI+ PI- PI+ PI-) / (PI+ PI-)
R1              (0.008)OR LESS        JAMES      66 HBC    0 2.1 PI+P            6/66
R1              (0.002)OR LESS        CHUNG      68 HBC    0 3.2,4.2 PI-P        7/67
R1              (0.002)OR LESS  CL=.90 HUSCN     68 HLBC   0 16.0 PI- P          1/71
R1              (0.0015)OR LESS CL=.90 GERMAN CO 69 HBC    0 2.5-5.8 GAMMA P 10/67

R2       RHO INTO PI GAMMA/2PI   (UNITS 10**-3)            (P3)/(P1)
R2   M         (20.)    OR LESS         LANZEROTT 65 CNTR     GAMMA P(BREMS)   11/66
R2              (5.)    OR LESS  CL=.97 FIDECARO  66 OSPK  -                   10/66
R2              (7.)    OR LESS         HUSON     66 HLBC  -  15 PI-PB          6/66
R2   M          (2.)    OR LESS  CL=.90 GERMAN CO 69 HBC
R2    C          0.24       0.07        GOBBI     74 OSPK  - 23. PI-A,PI-PIOA 12/75*
R2    C    GOBBI 74 QUOTES THE PARTIAL WIDTH FOR RHO- INTO PI- GAMMA
R2    C    AS (35 +- 10) KEV
R2   M           CNE PION EXCHANGE MODEL USED IN THIS ESTIMATION
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Note on $\rho^0 \rightarrow e^+e^-$

Extraction of a ratio for $\rho^0 \rightarrow e^+e^-$ is complicated by interference with ω decay. In photoproduction, $\gamma A \rightarrow e^+e^- A$, there is substantial interference between the allowed $(\rho^0, \omega) \rightarrow e^+e^-$ decays. The interference in the colliding-beam reaction $e^+e^- \rightarrow \pi^+\pi^-$ is due to G-parity-violating mixing of the overlapping ρ^0 and ω resonances; it alters the results for the rate $\Gamma(\rho^0 \rightarrow e^+e^-)$ only by a small amount. Therefore at present we average only the values from the $e^+e^- \rightarrow \pi^+\pi^-$ experiments.

```
R3       RHO INTO(E+ E-)/(PI+PI-) (UNITS 10**-4)            (P4)/(P1)
R3   P    94   (0.65)   (0.14)          ASBURY 1  67 CNTR    PHOTOPRODUCTION  9/67
R3   P            POSSIBLY LARGE RFO-OMEGA INTERFERENCE
R3   H         (0.65)   (1.1)    (0.5)  HERTZBACH 67 OSPK ASSUME SU(3)+MIXING.10/66
R3   H            NOT SEPARATED FRCM CMEGA DECAY.
R3   A    33   (0.53)   (0.11)          ASTVACATU 68 OSPK ASSUME SU(3)+MIXING  6/68
R3   A            NOT SEPARATED FRCM CMEGA DECAY. ERROR STATISTICAL ONLY.
R3                0.50     0.10         AUSLENDER 69 OSPK    E+E- CGLLID.BEAM  9/68
R3   F         (0.49)   (0.12)   (0.15) BIGGS     70 CNTR   PHOTOPRODUCTICN    6/70
R3   F            ASSUMING RHO WIDTH 140 MEV. ERROR STATISTICAL ONLY.
R3                0.41     0.05         BENAKSAS  72 OSPK    E+E- COLL.BEAMS 12/72
R3             . . . . . . . . .
R3   AVG          0.428    0.045    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3   STUDENT      0.428    0.049    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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R4       RHO INTO (PI ETA)/(2PI)                                (P5)/(P1)
R4            (0.03) OR LESS           DEUTSCHMA 66 HBC  +    8.0 PI+ P        6/66
R4            (0.008)OR LESS           FERBEL    66 HBC  +- PI+- P ABOVE 2.5 11/66

R5       RHO INTO (MU+ MU-)/(PI+ PI-) (UNITS 10**-4)      (P6)/(P1)
R5
R5               SEE NOTE UNDER RHC INTO E+E- ABCVE
R5
R5   H           0.97      0.31      0.33  HYAMS      67 OSPK     11 PI- LI H      6/67
R5   H           HYAMS MASS RESOL. IS 20 MEV. THE OMEGA REGION WAS EXCLUDED.
R5   R           0.82      0.16      0.36  ROTHWELL   69 CNTR    PHOTOPRODUCTICN . 4/70
R5   R           POSSIBLY LARGE RHC-CMEGA INTERFERENCE LEACS US TO INCREASE
R5   R           THE MINUS ERROR
R5               0.56      0.15            WEHMANN    69 OSPK     12 PI- CN C,FE   7/69
R5   W           RESULT CONTAINS (11 +- 11) PER CENT CORRECTION USING SU(3)
R5   W           FOR CENTRAL VALUE. THE ERROR CN THE CORRECTION TAKES ACCOUNT
R5   W           OF POSSIBLE RFO-OMEGA INTERFERENCE AND THE UPPER LIMIT AGREES
R5   W           WITH THE UPPER LIMIT OF (CMEGA INTO MU+ MU-) FROM THIS EXPT.
R5            . . . . . . . . .
R5  AVG          0.67      0.12     AVERAGE (ERROR INCLUDES SCALE FACTOR CF 1.0)
R5  STUDENT      0.67      0.14     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R6       RHO  INTO (PI+ PI- PIO)/(PI+ PI-)                      (P7)/(P1)
R6  G          (0.01) OR LESS  CL=.84   ABRAMS     71 HBC    0 3.7 PI+ P         11/71
R6  G        MODEL DEPENDENT,ASSUMES I = 1,2,OR 3 FOR THE 3PI SYSTEM            11/71

R7       RHO INTO (ETA GAMMA)/TCTAL                            (P8)
R7             (.001)OR LESS  CL=.90    NORDBERG  74 ASPK    7-9 GAMMA+CU       12/75*

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REFERENCES FOR RHO


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ANDERSCN 61 PRL 6 365              ANDERSON,BANG,BURKE,CARMONY,SCHMITZ   (LRL)
ERWIN    61 PRL 6 628              A.R.,R.MARCH,W.C.WALKER,E.WEST       (WISC)
KENNEY   62 PR 126 736             V P KENNEY,W D SHEPHARD,C D GALL (KENTUCKY)
SAMIOS   62 PRL 9 139              SAMIOS,BACHMAN,LEA+     (BNL+CUNY+COLU+KNTY)
XUONG    62 PR 128 1849            NGUYEN HUU XUONG,GERALD R LYNCH         (LRL)

ABOLINS  63 PRL 11 381             ABOLINS,LANDER,MEHLHOP,NGUYEN,YAGER  (UCSD)
ALITTI   63 NC 29 515              ALITTI,BATON,ARMENISE+(SACL+ORSA+BARI+BGNA)
CHADWICK 63 PRL 10 62              CHADWICK,DAVIES,DERRICK,CRESTI + (OXF+PADO)
GUIRAGOS 63 PRL 11 85              ZAVEN GUIRAGOSSIAN                     (LRL)
SACLAY   63 SIENA CONF 1 239       SACLAY+ORSAY+BARI + BOLOGNA- COLLABORATION

BONDAR   64 NC 31 729              BONDAR+    (AACHEN+BIRM+BONN+DESY+LOIC+MPIM)
CARMONY  64 DUBNA CONF 1 486       CARMONY,HOA,LANDER,NG.H.XUCNG,YAGER  (UCSD)
GOLDHABE 64 PRL 12 336             GOLDHABER,BROWN,KADYK,SHEN+        (LRL+UCB)

ALYEA    65 PL 15 82               ALYEA,CRITTENDEN,MARTIN,RHODE +    (INDIANA)
ARMENISE 65 NC 37 361              SACLAY+ORSAY+BARI+BOLOGNA    COLLABORATION
BLIEDEN  65 PL 19 444              CERN MISSING MASS SPECTROMETER GROUP (CERN)
CLARK    65 PR 139 B 1556          A CLARK,CHRISTENSON,CRONIN,TURLAY(PRINCETO)
GUTAY    65 NC 39 381              GUTAY,LANNUTTI,TULI                    (FSU)
LANZEROT 65 PRL 15 210             LANZEROTTI,BLUMENTHAL,EHN,FAISSLER + (HARV)
ZDANIS   65 PRL 14 721             ZDANIS,MADANSKY,KRAEMER +          (JHU+BNL)

ACCENSI  66 PL 20 557              ACCENSI,ALLES-BORELLI,FRENCH,FRISK+  (CERN)
ALFF-STE 66 PR 145 1072            ALFF-STEINBERGER,BERLEY,BRUGGER+(COLU+RUTG)
BALTAY   66 PR 145 1103            +FRANZINI,LUTJENS,SEVERINS,TYCKO+(COLUMBIA)
BLIEDEN  66 NC 43 71               CERN MISSING MASS SPECTROMETER GROUP (CERN)
CAMBRIDG 66 PR  146  994           CAMBRIDGE BUBBLE CHAMBER GROUP  (MIT+HARV+)
CASON    66 PR  148  1282          N M CASON                       (WISCONSIN)
DEUTSCHM 66 PL 20 82               DEUTSCHMANN,STEINBERG + (AACH+BERLIN+ CERN)
FERBEL   66 PL 21 111              FERBEL                          (ROCHESTER)
FIDECARO 66 PL  23  163            G+M FIDECARO,J POIRIER,P SCHIAVON    (CERN)
HAGOPIAN166 PR 145 1128            HAGOPIAN,SELOVE,ALITTI,BATON+ (PENN+SACLAY)
HAGOPIAN266 PR  152  1183          HAGOPIAN,PAN     (PENNSYLVANIA,LRL-BERKELEY)
HUSON    66 PL 20 91               HUSON,ALLARD,DRIJARD,HENNESSY+ (ORSAY+EPOL)
JACOBS   66 UCRL-16877             L.D.JACOBS                             (LRL)
JAMES    66 PR 142 896             F E JAMES,KRAYBILL        (YALE+BROOKHAVEN)
WEST     66 PR 149 1089            WEST,BOYD,ERWIN,WALKER          (WISCONSIN)

ALLES-BO 67 NC 50 A 776            ALLES-BORELLI,FRENCH,FRISK,+    (CERN+BONN)
ASBURY 1 67 PRL 19 869             +BECKER+BERTRAM+JOOS+JORDAN+    (DESY+COLU)
ASBURY 2 67 PRL 19 865             +BECKER+BERTRAM+JOOS+JORDAN+    (DESY+COLU)
BACON    67 PR 157 1263            +FICKINGER,HILL,HOPKINS,ROBINSON+     (BNL)
BANNER   67 PL  25 B  300          +FAYOUX,HAMEL,ZSEMBERY,CHEZE+ (SACLAY+CAEN)
BARLOW   67 NC 50A 701             +LILLESTOL+MONTANET+  (CERN+CDEF+IRAD+LIVP)
BATON    67 PL 25 B 419            J.BATON,G.LAURENS,J.REIGNIER       (SACLAY)
    ALSO 67 NP B 3  349            J.BATON,G.LAURENS,J.REIGNIER       (SACLAY)
CLEAR    67 NC 49A 399             +JOHNSTON+COOPER+MANNER+    (TNTO+ANL+WISC)
DANYSZ   67 NC 51 A 801            DANYSZ+FRENCH+SIMAK                   (CERN)
EISNER   67 PR 164 1699            +JOHNSON+KLEIN+PETERS+SAHNI+YEN+    (PURDUE)
FRENCH   67 NC 52A 442             +KINSON+MCDONALD+RIDDIFORD+     (CERN+BIRM)
HERTZBAC 67 PR 155  1461           HERTZBACH,KRAEMER,MADANSKI,ZDANIS+(JHU+BNL)
    ALSO 65 ZDANIS
HUWE     67 PL 24B 252             +MARQUIT+OPPENHEIMER+SCHULTZ+WILSON  (COLU)
HYAMS    67 PL 24B 634             +KOCH+PELLETT+POTTER+VONLINDERN+(CERN+MPIM)
MILLER   67 PR 153 1423            MILLER,GUTAY,JOHNSON,LOEFFLER +     (PURDUE)
POIRIER  67 PR 163 1462            +BISWAS,CASON,DERADO,KENNEY+     (NDAM+PENN)

ABC COLL 68 NP B4 501                       AACHEN+BERLIN+CERN COLLABORATION*
ARMENISE 68 NC 54A 999             +GHIDINI,FORINO+        (BARI+BGNA+FIRZ+ORSAY)
ASTVACAT 68 PL 27 B  45            ASTVACATUROV,AZIMOV,BALDIN+   (JINR+MOSCOW)
BATCN    68 PR 176 1574            J.P. BATON, G. LAURENS             (SACLAY)
BLECHSCH 68 NC  53 A  1045         BLECHSCHMIDT,DOWD,ELSNER,+      (DESY+MCHS)
    ALSO 67 NC  52 A  1348
CHUNG    68 PR 165 1491            S.U.CHUNG,O.I.DAHL,J.KIRZ,D.H.MILLER  (LRL)
DONALD   68 NP B 6 174             +EDWARDS,FRODESEN,BETTINI+ (LIVP+OSLO+PADO)
FOSTER   68 NP B 6 107             +GAVILLET+LABROSSE+MONTANET+    (CERN+CDEF)
HUSON    68 PL 28B 208             +LUBATTI,SIX,VEILLET,+      (ORSA+MILA+UCLA)
HYAMS    68 NP B 7 1               +KOCH,POTTER,WILSON,VON LINDERN+(CERN+MPIM)
JONES    68 PR 166 1405            +BLEULER,CALDWELL,ELSNER,HARTING+     (CERN)
JOHNSON  68 PR 176 1651            +POIRIER,BISWAS,GUTAY+      (NDAM+PURD+SLAC)
KEY      68 PR 166 1430            +PRENTICE+COOPER+MANNER+     (TNTO+ANL+WISC)
LAMSA    68 PR 166 1395            +CASON+BISWAS+DERADO+GROVES+    (NOTREDAME)
LANZEROT 68 PR 166 1365            LANZEROTTI,BLUMENTHAL,EHN,FAISSLER + (HARV)
MARATECK 68 PRL 21 1613            +HAGOPIAN,+  (PENN+LRL+COLO+PURD+TNTO+WISC)
PISUT    68 NP B 6 325             J.PISUT,M.ROOS                        (CERN)

AUGUSTI1 69 PL 28 B 508            +BIZOT+BUON+HAISSINSKI+LALANNE+      (ORSAY)
AUGUSTI2 69 LNC 2 214              +LEFRANCOIS,LEHMANN,MARIN,+          (ORSAY)
AUSLENDE 69 SJNP 9  69             AUSLENDER,BUDKER,PANTUSCVA,PESTOV+    (NOVO)
GERMAN C 69 PR 188  2060           GERMAN BUBBLE CHAMBER COLL.           (DESY)
HAISSINS 69 ARGONNE CONF. 373      J.HAISSINSKI                         (ORSAY)
JUHALA   69 PR 184  1461           +LEACOCK,RHODE,KOPELMAN,LIBBY,+  (ISU+COLO)
MALAMUD  69 ARGONNE CONF.P.93      E.MALAMUD, P.SCHLEIN                  (UCLA)
MILLER   69 PR 178 2061            R.MILLER,LICHTMAN,WILLMANN          (PURDUE)
MOTT     69 PR 177 1966            +AMMAR,DAVIS,KROPAC,SLATE,DAGAN+ (NWES+ANL)
REYNOLDS 69 PR 184 1424            +ALBRIGHT,BRADLEY,BRUCKER,HARMS+       (FSU)
ROOS     69 NP B 10 563            M.ROOS,J.PISUT             (CERN+BRATISLAVA)
ROTHWELL 69 PRL 23 1521            +CHASE,EARLES,GETTNER,GLASS,WEINSTEI+(NEAS)
SCHAREN  69 ARGONNE CONF.306       SCHARENGUIVEL                       (PURDUE)
WEHMANN  69 PR 178  2095           +ENGELS,WILSCN,+ (HARV+CASE+SLAC+CORN+MCGI)
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Data Card Listings

For notation, see key at front of Listings.

Mesons
ρ(770), ω(783)


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ALVENSLE 70 PRL 24 786          ALVENSLEBEN,BECKER,BERTRAM,CHEN,COHEN(DESY)
BATON    70 PL 33 B 528         +LAURENS,REIGNIER                  (SACLAY)
BIGGS    70 PRL 24 1197         +BRABEN,CLIFFT,GABATHULER,KITCHING+  (CARE)
BINGHAM  70 PRL 24 955          +FRETTER,MOFFEIT,BALLAM+    (LRL+SLAC+TUFT)
GALLOWAY 70 PR D 1 3077         +MOTT,ALYA,LEE,MARTIN,PRICKETT        (IND)

ABRAMS   71 PR D 4 653          +BARNHAM,BUTLER,COYNE,GOLDHABER,HALL,+(LBL)
BLOODWOR 71 NP B 35 133         BLOODWORTH,JACKSON,PRENTICE,YOON (TORONTO)
DEERY    71 PR D 3 635          +BISWAS,CASON,GROVES,JOHNSCN,+ (NOTRE CAME)

BAILLON  72 PL 38 B 555         +CARNEGIE,KLUGE,LEITH,LYNCH,RATCLIFF+(SLAC)
BALLAM   72 PR D 5 545          +CHADWICK,BINGHAM,MILBURN,+ (SLAC+LBL+TUFT)
BASDEVAN 72 PL 41 B 178         BASDEVANT,FROGGATT,PETERSEN          (CERN)
BENAKSAS 72 PL 39 B 289         +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE,+(ORSA)
DRIVER   72 NP B 38 1           +HEINLOTH,HOHNE,HOFMANN,RATHJE,+(DESY+HAMB)
EISENBER 72 PR D 5 15           EISENBERG,BALLAM,DAGAN,+    (REHO+SLAC+TELA)
GRAYER   72 PHIL.CCNF.PROC. 5 +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
GRAYER   72 NP B 50 29          +HYAMS,JONES,WEILHAMMER,BLUM,+  (CERN+MPIM)
JACOBS   72 PR D 6 1291         L.D.JACOBS                         (SACLAY)
RATCLIFF 72 PL 38 B 345         +BULOS,CARNEGIE,KLUGE,LEITH,LYNCH,+  (SLAC)
TAKAHASH 72 PR D 6 1266         TAKAHASHI,BARISH,+      (TCHO+PENN+NCAM+ANL)

BYERLY   73 PR D 7 637          +ANTHONY,COFFIN,MEANLEY,MEYER,RICE,+ (MICH)
CHARLESW 73 NP B 65 253         CHARLESWORTH,EMMS,BELL,+    (RHEL+BIRM+DURH)
GLADDING 73 PR D 8 3721         +RUSSEL,TANNENBAUM,WEISS,THOMSON     (HARV)
HYAMS    73 NP B 64 134         +JONES,WEILHAMMER,BLUM,DIETL,+  (CERN+MPIM)
PROTOPOP 73 PR D 7 1280         PROTOPOPESCU,GARNJOST,GALTIERI,FLATTE+(LBL)

CARROLL  74 PR D 10 1430        +MATTHEWS,WALKER+        (SLAC+DUKE+WISC+TNTO)
ENGLER   74 PR D 10 2070        +KRAEMER,TOAFF,WEISSER,DIAZ+     (CARN+CASE)
ESTABROO 74 NP B 79 301         P.ESTABROCKS,A.D.MARTIN              (DURH)
GOBBI    74 PRL 33 1450         +ROSEN,SCOTT,SHAPIRO+       (NWES+ROCH+CARN)
GRAYER   74 NP B 75 189         G.GRAYER,HYAMS,BLUM,DIETL,+     (CERN+MPIM)
HABER    74 PR D10 1387         +HODOUS,HULSIZER,KISTIAKCWSKY,LEVY+   (MIT)
NORDBERG 74 PL 51 B 106         +ABRAMSON,ANDREWS,HARVEY,+      (CORN+ROCH)
SPITAL   74 PR D 9 126          R.SPITAL,D.R.YENNIE                  (CORN)

ROOS     75 NP B 97 165         M.ROOS                               (HELS)
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ω(783)

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                    1  CMEGA(783,JPG=1--) I=0

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                    1  OMEGA MASS (MEV)

M        64 (779.4)     (1.4)        ARMENTERO 62 HBC     0.0 PBAR P K1K1. 2/74
M       800 (782.0)     (1.0)        ALFF      62 HBC     2.3-2.9 PI+P   . 2/74
M        34 (784.0)     (1.0)        ARMENTERO 63 HBC     0.0 PBAR P     . 2/74
M       220 (781.0)     (2.0)        KRAEMER   64 DBC     1.2 PI+D       . 2/74
M       170 (785.6)     (1.2)        MILLER D  65 HBC    SEEN WITH K+K-  . 2/74
M       666 (786.0)     (1.0)        JAMES     66 HBC     2.1 PI+P       . 2/74
M      2198  783.4       0.7         BALTAY    67 HBC    0.0 PBAR P        2/74
M       155 (779.5)     (1.5)        BARASH    67 HBC     0.0 PBAR P K1K1. 2/74
M           (784.8)     (1.1)        KEY       68 HBC     3 PI-P         . 2/74
M      2400  782.4       0.5         BIZZARRI  69 HBC     0 PBAR P         9/69
M       750  784.1       1.2         ABRAMOVIC 70 HBC     3.9 PI- P        2/74
M            784.0       0.7         ATHERTON  70 HBC    3.6 PBAR P, 7 PI. 2/74
M   F       (783.2)     (1.6)        BIGGS     70 CNTR   PHOTOPRODUCTICN   2/74
M   F   FROM CMEGA-RHO INTERFERENCE IN THE PI+PI- MASS SPECTRUM
M   F   ASSUMING OMEGA WIDTH 12.6 MEV.
M       260 (781.0)     (2.0)        CASCN     70 HBC     8.0 PI-P,4PI   . 2/74
M       250 (784.)      (1.)         DANBURG   70 DBC     1.2 PI+ D      . 2/74
M       500 (786.)      (1.)         DANBURG   70 CBC     1.4 PI+ D      . 2/74
M       600 (784.)      (1.)         DANBURG   70 DBC     1.7 PI+ D      . 2/74
M       500 (786.)      (1.)         DANBURG   70 DBC     1.9 PI+ D      . 2/74
M       400 (785.)      (1.)         DANBURG   70 CBC     2.1 PI+ D      . 2/74
M       200 (785.)      (2.)         DANBURG   70 DBC     2.3 PI+ D      . 2/74
M       248  783.4       1.0         BIZZARRI  71 HBC     0.0 P PBAR K+K- 11/71
M       510  781.0       0.6         BIZZARRI  71 HBC     0.0 P PBAR K1K1 11/71
M   C 4270 (784.1)      (0.3)        COYNE     71 HBC    3.7 PI+ P        11/71
M   C   FROM TOTAL SAMPLE OF COYNE 71.  THEY CBSERVE AN IMPORTANT
M   C   CORRELATICN BETWEEN SIGMA OF EXP. RESOLUTION AND THE MEAS. MASS.
M  D         783.7       1.0         COYNE     71 HBC    3.7 PI+ P        11/71
M  D         FROM BEST-RESOLUTICN SAMPLE OF COYNE 71                      11/71
M       369 (784.0)     (1.4)        MATTHEWS  71 DBC     6.95 PI+ D     . 2/74
M       418  782.5       0.8         AGUILAR   72 HBC    3.9,4.6 K- P     12/72
M  BN10000 (782.4)      (0.5)        BINNIE    73 CNTR   PI-P, CMEGA N    12/75*
M   N   BINNIE 73 SUPERSEDED BY KEYNE 76
M  S  4800  782.0        0.8         OREN      74 HBC    2.3 PBAR P,5PI   12/75*
M  S    ERROR INCLUDES 0.5 MEV MASS SCALE ERROR
M     29200 (782.9)     (0.3)        ROOS      74 RVUE   0-3.6 PBAR P     12/75*
M  B 10000  782.4        C.5         KEYNE     76 CNTR   PI-P, OMEGA N    12/75*
M  B    OBSERVED BY THRESHOLD-CROSSING TECHNIQUE. MASS RESOL.=4.8 MEV FWHM
M           . . . . . . . . . . .
M   AVG      782.61      0.30    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
M   STUDENT  782.66      0.27    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                         (SEE IDEOGRAM BELOW )
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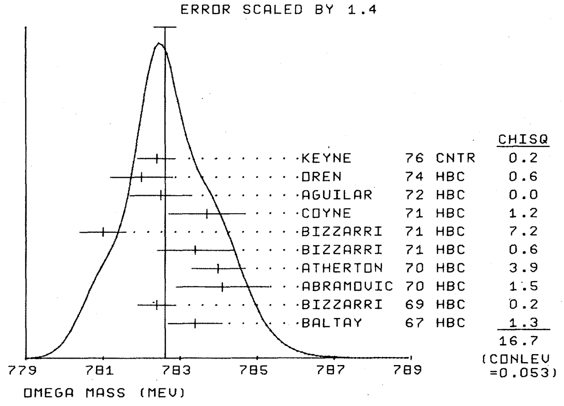
WEIGHTED AVERAGE = 782.61 ± 0.30
ERROR SCALED BY 1.4

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                    1  OMEGA FULL WIDTH (MEV)

W       34     9.0       3.C         ARMENTERO 63 HBC      0.0 PBAR P
W             13.4       2.0         MILLER D  65 HBC    SEEN WITH K+ K-
W      155   (12.3)     (2.0)        BARASH    67 HBC     SEEN WITH K1 K1 . 6/66
W    B 171    (5.8)     (2.8)        BARASH    67 HBC     0.0 PBAR P,K1 K1 11/71
W    B        UNFOLDED BY COYNE 71                                        11/71
W      750     8.8       3.0         ABRAMOVIC 70 HBC      3.9 PI- P        6/70
W             11.2       2.7         ATHERTON  70 HBC     3.6 PBAR P, 7 PI  5/70
W      510    10.3       1.4         BIZZARRI  71 HBC      0.0 P PBAR K1K1 11/71
W      248    12.8       3.0         BIZZARRI  71 HBC      0.0 P PBAR K+K- 11/71
W     4270     9.5       1.0         COYNE     71 HBC     3.7 PI+ P        11/71
W      418    13.3       2.          AGUILAR   72 HBC     3.9,4.6 K- P     12/72
W              9.1       0.8         BENAKSAS1 72 OSPK    E+E- COLL.BEAMS   2/73
W   E  940     7.70      1.65        BROWN     72 MMS     2.5 PI- P,N MMS  12/72
W   E   ERROR TAKES ACCCUNT OF SYSTEMATICS ADDED LINEARLY
W   BN10000  (10.2)     (0.6)        BINNIE    73 CNTR    PI-P, OMEGA N     1/74
W    N  BINNIE 73 SUPERSEDEC BY KEYNE 76
W   B 10000   10.22      0.43        KEYNE     76 CNTR    PI-P, OMEGA N    12/75*
W   B   OBSERVED BY THRESHOLD-CROSSING TECHNIQUE. MASS RESOL.=4.8 MEV FWHM
W          . . . . . . . . . . .
W    AVG      10.05      0.33    AVERAGE (ERRCR INCLUDES SCALE FACTOR OF 1.0)
W    STUDENT  10.05      0.36    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    1  CMEGA PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      OMEGA INTO PI+ PI- PIO                           139+ 139+ 134
P2      OMEGA INTO PI+ PI- (VICLATES G)                  139+ 139
P3      OMEGA INTO PIO GAMMA                             134+   0
P4      CMEGA INTO PI+ PI- GAMMA                         139+ 139+   0
P5      OMEGA INTO 2PIO GAMMA                            134+ 134+   0
P6      OMEGA INTO ETA GAMMA                             548+   0
P7      OMEGA INTO E+ E-                                  .5+  .5
P8      OMEGA INTO MU+ MU-                               105+ 105
P9      OMEGA INTO ETA PIO (VIOLATES C)                  548+ 134
P10     CMEGA INTO 3 GAMMA                                 0+   0+   0
P11     CMEGA INTO PIO MU+ ML-                           134+ 105+ 105

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

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        P 1        P 2       P 3
P 1  .8987+-.0056
P 2   -.5582   .0130+-.0027
P 3   -.8728      .0824   .0884+-.0046


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                    1  OMEGA BRANCHING RATIOS

R1      OMEGA INTO NEUTRAL/(PI+ PI- PIO)                      (P3+...)/(P1)
R1             0.17      0.04             ARMENTERO 63 HBC      0.0 PBAR P
R1       20    0.11      0.02             BUSCHBECK 63 HBC      1.5 K-P
R1       35    0.08      0.03             KRAEMER   64 DBC      1.2 PI+D
R1       65    0.10      0.04             ALFF-STEI 66 HBC CORR.BY SCHULTZ(COL)  9/66
R1      850    0.134     0.026            DIGIUGNO  66 CNTR     1.4 PI-P         9/66
R1      348    0.097     0.016            FLATTE    66 HBC      1.8 K-P          9/66
R1             0.06      0.05      0.02   JAMES     66 HBC      2.1 PI+P         6/66
R1       19    0.10      0.03             BARASH    67 HBC      0.0 PBAR P       7/67
R1       46    0.15      0.04             AGUILAR   72 HBC     3.9,4.6 K- P     12/72
R1           . . . . . . . . . .
R1   AVG       0.1065    0.0088  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1   STUDENT   0.106     0.010   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1   FIT       0.0983    0.0057 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      CMEGA INTO (PI+ PI-)/(PI+ PI- PIO). SEE ALSO R15 (P2)/(P1)
R2 R        (0.011)OR MORE  CL=.95   ABRAMOVIC 70 HBC      3.9 PI- P      . 6/70
R2 R        (0.035)OR LESS  CL=.95   BIZZARRI  70 DBC      PBAR N AT REST  11/71
R2          (0.019)OR MORE  CL=.95   CHAFMAN   70 HBC     1.6-2.2 P PBAR    6/70
R2   F       (.002)OR MORE  CL=.90   FLATTE    70 HBC      1.5     K- P     8/69
R2   F      FLATTE 70 SEES NO SIGNAL AT 1.7, 2.1, 2.6 GEV/C.
R2          (0.0026)OR MORE CL=.84   HAGOPIAN  70 HBC      2.3 PI- P        1/71
R2          (0.040)OR LESS  CL=.84   HAGOPIAN  70 HBC      2.3 PI- P        1/71
R2 R         0.022     0.009     0.01  ROOS      70 RVUE                    6/70
R2 R        ROOS 70 COMBINES ABRAMOVICH 70 AND BIZZARRI 70
R2           0.028     0.006           BEHREND   71 ASPK    PHOTOPRODUCTICN 11/71
R2 S         0.021     0.028     0.009 RATCLIFF  72 ASPK    15.PI- P,N 2PI  12/72
R2 S    SIGNIFICANT INTERFERENCE EFFECT OBSERVED.NB OF OMEGA INTO 3PI       12/72
R2 S    COMES FROM AN EXTRAPOLATION.                                        12/72
R2          (0.0115)OR MORE            BURNS     73 HBC     .6-1.1 PBAR P   12/75*
R2           . . . . . . . . . .
R2   AVG       0.0259    0.0049  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2   STUDENT   0.0259    0.0053  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2   FIT       0.0144    0.0031 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)

R3      OMEGA INTO (PIO GAMMA) / (PI+ PI- PIO)              (P3)/(P1)
R3          (0.125)   (0.025)OR GRTR. BARMIN    64 PXBC     2.8 PI-P
R3           0.13      0.04             JACQUET   69 HLBC                   10/67
R3           0.081     0.020            BALDIN    71 HLBC   2.9 PI+ P       11/71
R3           0.109     0.025            BENAKSAS2 72 OSPK   E+E- COLL.BEAMS  2/73
R3   N      (0.079)   (0.012)           BINNIE    73 CNTR   PI-P, CMEGA N    1/74
R3   N    BINNIE 73 SUPERSECEC BY KEYNE 76
R3           0.084     0.013            KEYNE     76 CNTR   PI-P, OMEGA N   12/75*
R3           . . . . . . . . . .
R3   AVG       0.0898    0.0097  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3   STUDENT   0.090     0.011   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R3   FIT       0.0983    0.0057 FROM FIT (ERRCR INCLUDES SCALE FACTOR OF 1.0)

R4      CMEGA INTO (PI+ PI- GAMMA)/(PI+ PI- PIO)            (P4)/(P1)
R4          (0.05) OR LESS  CL=.90   FLATTE    66 HBC      1.8 K-P           9/66
R4           (.066)OR LESS  CL=.90   KALBFLEI  75 HBC      2.2 K- P,GAMMA + 12/75*

R6      OMEGA INTO (MU+ MU-)/(PI+ PI- PIO)(UNITS 10**-3) (P8)/(P1)
R6          (1.2)  OR LESS            GALTIERI  65 HBC      2.7 K-P
R6          (1.7)  OR LESS  CL=.74    FLATTE    66 HBC      1.8 K-P          9/66
R6          (0.2)  OR LESS            WILSON    69 OSPK     12 PI- ON C,FE   9/69
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Mesons

ω(783), M(940)


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R7      OMEGA INTO (2PIO GAMM)/(PIO GAMMA)                      (P5)/(P3)
R7             (0.1)  OR LESS             BARMIN     64 PXBC     1.3-2.8 PI-P
R7             (0.45)   (0.33)            STRUGALSK 69 HLBC      2.34 PI+ N        8/69
R7             (0.14) OR LESS             BALDIN     71 HLBC     2.9 PI+ P        11/71
R7             (0.15) OR LESS  CL=.90     BENAKSAS2 72 OSPK    · E+E- COLL. BEAMS  2/73

R8      CMEGA INTO (ETA PIO + ETA GAMMA)/(PI+ PI- PIO)    (P9+P6)/(P1)
R8             (0.017)OR LESS  CL=.90     FLATTE     66 HBC      1.8 K-P            9/66
R8             (0.045)OR LESS  CL=.95     JACQUET    69 HLBC                        4/70

R9      OMEGA INTO (NEUTRALS) / (CHARGED)                       (P3+...)/(P1+P2...)
R9              0.124     0.021           FELDMAN    67 OSPK     1.2 PI- P          3/67
R9              . . . . . . . . .
R9   FIT        0.0969    0.0056 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R10     CMEGA INTO (2PIO GAMMA)/(PI+PI-PIO)                     (P5)/(P1)
R10            (0.08) OR LESS  CL=.95     JACQUET    69 HLBC                        4/70

R11     OMEGA INTO (ETA GAMMA)/(PIO GAMMA)                      (P6)/(P3)
R11            (0.58)   (0.30)            STRUGALSK 69 HLBC      2.34 PI+ N         8/69
R11            (0.40) OR LESS             BALDIN     71 HLBC     2.9 PI+ P         11/71
R11             0.010     0.045           APEL       72 OSPK     4-8 PI- P,N 3GAM  2/73
R11            (0.27) OR LESS  CL=.90     BENAKSAS2 72 OSPK      E+E- COLL. BEAMS  2/73

R12     OMEGA INTO (PIO MU+ MU-) / TOTAL (UNITS 10**-3)  (P11)
R12            (2.)     OR LESS           WEHMANN    68 OSPK     12 PI- FE          6/68

R13     OMEGA INTO (E+ E-)/TOTAL (UNITS 10**-4)                 (P7)
R13       3     2.        1.2             BINNIE     65 OSPK     PI-P NEAR THLD.   6/66
R13 B           MASS RESOLUTICN OF BINNIE 65 IS ABOUT 15 MEV.
R13 H          (1.0)     (1.7)     (0.75) HERTZBACH 67 OSPK ASSUME SU(3)+MIXING.10/66
R13 H           NOT RESOLVED  FRCM RHO DECAY.
R13 A    33    (0.65)    (0.13)           ASTVACATU 68 OSPK ASSUME SU(3)+MIXING  6/68
R13 A           NOT RESOLVED  FROM  RHO  DECAY. ERROR STATISTICAL ONLY.
R13             0.40      0.21            BOLLINI1   68 CNTR     1.7PI-P,NOTE Z     9/68
R13 Z           MASS RESOLUTION OF BOLLINI 1 IS +-10 MEV.HIS ERROR IS +-.15
R13 Z           WITHOUT RHO-OMEGA INTERFERENCE. COMPLETE INTERFERENCE WOULD
R13 Z           CHANGE VALUE BY +-35 PER CENT. THEREFORE WE INCREASED ERROR.
R13 E          (0.76)    (0.14)           AUGUSTI1   69 OSPK     SEE NOTE E         2/72
R13 E   FROM E+ E- COLLIDING BEAMS, ASSUMING OMEGA WIDTH 12.2+-1.3 MEV              4/69
R13             0.83      0.10            BENAKSAS1 72 OSPK      E+E- CCLL.BEAMS    2/73
R13             . . . . . . . . .
R13 AVG         0.76      0.17     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
R13 STUDENT     0.77      0.11     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R14     CMEGA INTO NEUTRALS / TCTAL                             (P3+...)
R14             0.084     0.015           BOLLINI    68 CNTR     2.1 PI- P          6/68
R14             0.079     0.019           DEINET     69 OSPK     1.5 PI- P          9/69
R14             0.075     0.025           BIZZARRI   71 HBC      0.0 P PBAR        11/71
R14      42     0.073     0.018           BASILE     72 CNTR     1.67 PI- P         2/73
R14             . . . . . . . . .
R14 AVG         0.0788    0.0092  AVERAGE (ERROR INCLUDES SCALE FACTCR OF 1.0)
R14 STUDENT     0.0788    0.0098  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R14 FIT         0.0884    0.0046 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R15     OMEGA INTO (PI PI)/(TOTAL). SEE ALSO R2                 (P2)
R15             0.032     0.028     0.019 AUGUSTI2   69 OSPK     E+E- COLL.BEAMS   8/69
R15            (0.003)OR MORE  CL=.95     GOLDHABER 69 HBC       3.7-4.0 PI+P     11/69
R15            (0.014)OR MORE  CL=.95     ALLISON    70 HBC      1.3-1.7 PBAR P  . 6/70
R15             0.0080    0.0028    0.0022BIGGS      70 CNTR     PHOTOPRODUCTICN    6/70
R15             0.0122    0.0030          ALVENSLEB 71 CNTR      PHOTOPRODUCTICN   11/71
R15             0.013     0.012     0.009 MOFFEIT    71 HBC      2.8,4.7 GAMMA P   11/71
R15             0.036     0.024     0.018 BENAKSAS   72 OSPK     E+E- COLL.BEAMS  12/72
R15            (.01)                      KRAMER     74 ASPK     3,4,6 PI+-P,N2PI 12/75*
R15             . . . . . . . . .
R15 AVG         0.0102    0.0019  AVERAGE (ERRCR INCLUDES SCALE FACTOR OF 1.0)
R15 STUDENT     0.0102    0.0022  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R15 FIT         0.0130    0.0027 FRCM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)

R16     CMEGA INTO (ETA GAMMA) / (ALL NEUTRALS)                 (P6)/(P3+...)
R16            (0.24) OR LESS  CL=.90     DEINET     69 OSPK                        9/69
R16            (0.36) OR LESS  CL=.90     DAKIN      72 OSPK     1.4 PI- P,N MMO   12/72

R17     OMEGA INTO (2 PIO GAMMA) / (ALL NEUTRALS)               (P5)/(P3+...)
R17            (0.19) OR LESS  CL=.90     DEINET     69 OSPK                        9/69
R17 D          (0.22)    (0.07)           CAKIN      72 OSPK     1.4 PI- P,N MMO   12/72
R17 D        SEE R18

R18     OMEGA INTO (PIO GAMMA) / (ALL NEUTRALS)                 (P3)/(P3+...)
R18            (0.81) OR MORE  CL=.90     DEINET     69 OSPK                        9/69
R18 D          (0.78)    (0.07)           DAKIN      72 OSPK     1.4 PI- P,N MMO   12/72
R18 D        ERROR STATISTICAL ONLY.AUTHORS OBTAIN GOOD FIT ALSO ASSUMING          11/71
R18 D        PIO GAMMA AS THE ONLY NEUTRAL DECAY.                                  11/71

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REFERENCES FOR CMEGA


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MAGLIC   61 PRL 7 178           B MAGLIC,ALVAREZ,ROSENFELD,STEVENSON  (LRL)
PEVSNER  61 PRL 7 421           PEVSNER,KRAEMER,NUSSBAUM,RICHARD+(JHU+NWES)
XUONG    61 PRL 7 327           NGUYEN HUU XUONG,GERALD R LYNCH       (LRL)

ALFF     62 PRL 9 325           ALFF,BERLEY,COLLEY,GELFAND + (COLU+RUTGERS)
ARMENTER 62 CERN CONF 90        R ARMENTEROS,R BUDDE +     (CERN+CDEF+EPOL)
STEVENSO 62 PR 125 687          STEVENSON,ALVAREZ,MAGLIC,RCSENFELD    (LRL)

ARMENTER 63 SIENA CONF 1 296  ARMENTEROS,EDWARDS,JACOBSEN+     (CERN+CDEF)
BARMIN   63 SIENA CONF 1 207  BARMIN,DOLGOLENKO,KRESTNIKOV+          (ITEP)
BUSCHBEC 63 SIENA CONF 1 166  BUSCHBECK,CZAPP+    (VIENNA+CERN+AMSTERDAM)
GELFAND  63 PRL 11 436          GELFAND,MILLER,NUSSBAUM,RATAU+  (COLU+RUTG)
MURRAY   63 PL 7 358            MURRAY,FERROLUZZI,HUWE,SHAFER,SOLMITZ+(LRL)

BARMIN   64 JETP 18 1289        BARMIN,DOLGCLENKO,KRESTNIKCV +       (ITEP)
KRAEMER  64 PR 136 B 496        KRAEMER,MACANSKY,MEER+      (JHU+NWES+WOOD)

BINNIE   65 PL 18 348           BINNIE,DUANE,JANE,W JCNES+       (LOIC+MCHS)
GALTIERI 65 PRL 14 279          A BARBARO GALTIERI,R D TRIPP          (LRL)
MILLER D 65 CU-237(NEVIS 131) CAVID C MILLER  (THESIS)         (CCLUMBIA)
    INCLUDES CATA OF GELFAND 63 ABOVE
ALFF-STE 66 PR 145 1072         ALFF-STEINBERGER,BERLEY,BRUGGER+(COLU+RUTG)
ZDANIS   65 PRL 14 721          ZDANIS,MADANSKY,KRAEMER,HERTZBACH+(JHU+BNL)

DIGIUGNO 66 NC 44A 1272         DI GIUGNO,PERUZZI,TROISE+  (NAPL+FRAS+TRST)
FLATTE   66 PR  145  1050       +HUWE,MURRAY,BUTTON-SHAFER,SOLMITZ+   (LRL)
JAMES    66 PR 142 896          F E JAMES,KRAYBILL         (YALE+BROOKHAVEN)

BALTAY   67 PRL  18  93         +FRANZINI,SEVERIENS,YEH,ZANELLC  (CCLUMBIA)
BARASH   67 PR  156  1399       BARASH,KIRSCH,MILLER,TAN         (COLUMBIA)
FELDMAN  67 PR 159 1219         +FRATI,GLEESCN,HALPERN,NUSSBAUM+     (PENN)
HERTZBAC 67 PR 155, 1461        HERTZBACH,KRAEMER,MADANSKI,ZDANIS+(JHU+BNL)
    ALSO 65 ZCANIS

ASTVACAT 68 PL 27 B  45         ASTVACATUROV,AZIMOV,BALDIN+   (JINR+MOSCOW)
BOLLINI  68 NC 56 A 531         +BUHLER,DALPIAZ,MASSAM+     (CERN+BGNA+STRB)
BOLLINI1 68 NC 57 A 404         +BUHLER,DALPIAZ,MASSAM+     (CERN+BGNA+STRB)
KEY      68 PR 166 1430         +PRENTICE+COOPER+MANNER      (TNTO+ANL+WISC)
PISUT    68 NP B 6 325          J.PISUT,M.ROOS                       (CERN)
WEHMANN  68 PRL 20 748          +ENGELS+ (HARVARD+CASE+SLAC+CORNELL+MCGILL)

AUGUSTI1 69 PL 28 B 513         +BENAKSAS,BUCN,GRACCO,HAISSINSKI,+  (ORSAY)
AUGUSTI2 69 LNC 2 214           +LEFRANCOIS,LEHMANN,MARIN,+         (ORSAY)
BIZZARRI 69 NP B 14 169         +FOSTER,GAVILLET,MCNTANET,+     (CERN+CDEF)
DANBURG  69 UCRL-19275          JERCME S. CANBURG, THESIS             (LRL)
     ALSO DANBURG 70
DEINET   69 PL 30 B 426         +MENZIONE,MULLER,BUNIATOV+      (KARL+CERN)
ERWIN    69 NP B 9 364          +WALKER,GOSHAW,WEINBERG     (WISC+PRIN+VAND)
GOLDHABE 69 PRL 23,1351         +BUTLER,COYNE,HALL,MACNAUGHTON,TRILING(LRL)
JACQUET  69 NC 63 A 743         +NGUYEN-KHAC,HAATUFT,HALSTEINSLI(EPOL+BERG)
MILLER   69 PR 178 2061         R.MILLER,LICHTMAN,WILLMANN         (PURDUE)
STRUGALS 69 PL 29 B 532         +CHUVILO,FENYVES,+          (WARS+JINR+BUDA)
WILSCN   69 PRIVATE COMM.       RICHARD WILSCN (SEE ALSO PR 178 2095)(HARV)

ABRAMOVI 70 NP B 20 209         ABRAMOVICH,BLUMENFELD,BRUYANT,+      (CERN)
BIZZARRI 70 PRL 25 1385         +CIAPETTI,DORE,GASPERO,GUIDCNI,+(ROMA+SYRA)
ALLISON  70 PRL 24 618          +CCOPER,FIELDS,RHINES                 (ANL)
ATHERTON 70 NP B 18 221         +BLAIR,CELNIKER,DOMINGO,FRENCH+  (CERN+IPN)
BIGGS    70 PRL 24 1201         +CLIFFT,GABATHULER,KITCHING,RAND     (DARE)
CASON    70 PR D 1 851          +ANDREWS,BISWAS,GROVES,HARRINGTON,+  (NDAM)
CHAPMAN  70 NP B 24 445         +CAVIDSCN,GREEN,LYS,ROE,VANDER VELDE (MICH)
DANBURG  70 PR D 2 2564         +ABOLINS,DAHL,DAVIES,HOCH,KIRZ,MILLER+(LRL)
FLATTE   70 PR D 1 1            STANLEY M. FLATTE                     (LRL)
GOLDHABE 70 PHILA.CONF.P.59     GERSON GOLDHABER,REVIEW               (LRL)
HAGOPIAN 70 PRL 25 1050         S. AND V.HAGOPIAN,BOGART,SELOVE  (FSU+PENN)
ROOS     70 DNPL/R7 P.173       PROC. DARESBURY STUDY WEEKEND NO 1.  (CERN)

ABRAMS   71 PR D 4 653          +BARNHAM,BUTLER,COYNE,GOLDHABER,HALL,+(LBL)
ALVENSLE 71 PRL 27 888          ALVENSLEBEN,BECKER,BUSZA,CHEN,COHEN,+(DESY)
ANGELOW  71 SJNP 12 427         +GRAMENITSKY,KANASIRSKY,KERATSCHEW,+ (JINR)
BALDIN   71 SJNP 13 758         +YERGAKOV,TREBUKHOVSKY,SHISHOV       (ITEP)
BARCADIN 71 PR D4 2711          BARDADIN-OTWINOWSKA,HOFMCKL,MICHEJDA+(WARS)
BEHREND  71 PRL 27 61           +LEE,NORDBERG,WEHMAN,+      (ROCH+CORN+FNAL)
BIZZARRI 71 NP B 27 140         +MONTANET,NILSSCN,D-ANDLAU,+    (CERN+CDEF)
BLOODWGR 71 NP B 35 133         BLOCDWORTH,JACKSON,PRENTICE,YOON  (TORCNTO)
CHAPMAN  71 PR D 3 38           +FCRTNEY,FOWLER                      (DUKE)
COYNE    71 NP B 32 333         +BUTLER,FANG-LANDAU,MACNAUGHTON       (LRL)
FIELDS   71 PRL 27 1749         +COOPER,RHINES,ALLISON            (ANL+OXF)
MATTHEWS 71 PRL 26 400          +PRENTICE,YOON,CARROLL,WALKER,+ (TNTO+WISC)
MOFFEIT  71 NP B 29 349         +BINGHAM,FRETTER,BALLAM+(LRL+UCB+SLAC+TUFT)

AGUILAR  72 PR D 6 29           AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS   (BNL)
APEL     72 PL 41 B 234         +AUSLANDER,MULLER,BERTOLUCCI,+  (KARL+PISA)
BASILE   72 PHIL.CCNF.PROC153 +BOLLINI,BROGLIN,DALPIAZ,FRABETTI,+  (CERN)
BENAKSAS 72 PL 39 B 289         +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE,+(ORSA)
BENAKSAS172 PL 42 B 507         +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE+(ORSAY)
BENAKSAS272 PL 42 B 511         +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE+(ORSAY)
BROWN    72 PL 42 B 117         +DOWNING,HOLLOWAY,HULD,BERNSTEIN+(ILL+ILLC)
DAKIN    72 PR D 6 2321         +HAUSER,KREISLER,MISCHKE        (PRINCETON)
EISENBER 72 PR D 5 15           EISENBERG,BALLAM,DAGAN,+   (REHO+SLAC+TELA)
RATCLIFF 72 PL 38 B 345         +BULOS,CARNEGIE,KLUGE,LEITH,LYNCH,+  (SLAC)

BINNIE   73 PR D 8 2789         +CARR,DEBENHAM,DUANE,GARBUTT,+  (LOIC+SHMP)
BURNS    73 PR D 7 1310         +CONDON,KIM,MANDELKERN,PRICE,SCHULTZ  (UCI)

ESTABROO 74 NP B 81 70          ESTABROOKS,HYAMS,JCNES,BLUM,    (CERN+MPIM)
GREGCRIO 74 NC 20 A 437         M.A.GREGORIO                 (ICTP,TRIESTE)
KRAMER   74 PRL 33 505          +AYRES,DIEBOLD,GREENE,PAWLICKI+       (ANL)
OREN     74 NP B 71 189         +CCOPER,FIELDS,RHINES,ALLISCN+    (ANL+OXF)
ROOS     74  PREPRINT 72        M.ROOS,J.ROUSKU                  (HELSINKI)

EMMS     75 NP B98 1            +KINSCN,STACEY,BELL,DALE+  (BIRM+DURH+RHEL)
KALBFLEI 75 PR D 11 987         KALBFLEISCH,STRAND,CHAPMAN       (BNL+MICH)
ROOS     75 NP B 97 165         M.RCOS                               (HELS)

KEYNE    76 PR D                +BINNIE,CARR,DEBENHAM,GARBUTT,+ (LOIC+SHMP)
     ALSO 73 BINNIE
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M(940) →MM

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                    66  M(940)

                    EVIDENCE NOT COMPELLING.OMITTED FROM TABLE.

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                    66  M(940) MASS  (MEV)

M  N    55  940.5      1.7            CHESHIRE  72 MMS   0 2.4 PI- P,N MM   12/72
M  N    NOT SEEN BY BINNIE 72 AT THRESHOLD.
M  N    NOT SEEN BY BINNIE 74 AT 2 GEV/C                                     2/74
M  N    NOT SEEN BY BUTTRAM 75 AT 2.4 GEV/C                                 12/75*

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                    66  M(940) WIDTH  (MEV)

W  N    55  (10.4)  OR LESS  CL=.90   CHESHIRE  72 MMS   0 2.4 PI- P,N MM   12/72

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                    66  M(940) BRANCHING RATICS

R1      M(940) INTO (NEUTRAL)/(TWO-CHARGE)/(FOUR-CHARGE)
R1             0.12      0.86      0.02  CHESHIRE  72 MMS   0 2.4 PI- P,N MM   12/72

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REFERENCES FOR M(940)


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CHESHIRE 72 PRL 28 520          +HOFFMAN,GARFINKEL,+        (IOWA+ANL+PURD)
BINNIE   72 PL 39 B 275         +CAMILLERI,DUANE,GARBUTT,BURTON+(LOIC+SHMP)
BINNIE   74 PRL 32 392          +CAMILLERI,CARR,DEBENHAM,+      (LOIC+SHMP)

BUTTRAM  75 PRL 35 970          +CRAWLEY,DUKE,LAMB,LEEPER,PETERSON    (ISU)
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Data Card Listings

For notation, see key at front of Listings.

Mesons

M(953), η'(958)

M(953) $\to\gamma\pi^+\pi^-$ $\not\to\gamma\rho^0$

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59  M(953,JPG=  +)

WHILE MASS AND WIDTH ARE CONSISTENT WITH
ETA PRIME(958),THE PI+ PI- GAMMA DECAY
SHOWS NO RHO SIGNAL.
POSSIBLY SEEN IN MMS.
OMITTED FROM TABLE.
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                    59   M MASS (MEV)

M       68  953.0      2.0           AGUILAR    70 HBC     3.9-4.6K-P,P K-M  1/71
M   M      (953.4)    (1.5)    (3.8) MAGLICH    71 MMS     3.8 P D,HE3 X0    2/72
M   M   MISSING MASS SPECTRUM SHOWED THIS PEAK AT 953.4 INSTEAD OF
M   M   ETA PRIME (958).  PEAK LISTED UNDER M BECAUSE OF MASS
M   M   COINCIDENCE.  THE 1.5 MEV ERROR MAY BE UNDERESTIMATED BY
M   M   A FACTOR OF 2 (SEE BRODY 72, TABLE III).  OBSERVED PEAK COULD
M   M   THEN WELL CORRESPOND TO ETA PRIME.
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                    59   M WIDTH (MEV)

W       68  (10.0)   OR LESS  CL=.95  AGUILAR   70 HBC     3.9-4.6K-P,P K-M  1/71
W   M       (15.)    OR LESS          MAGLICH   71 MMS     3.8 P D,HE3 X0    2/72
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                    59   M PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      M INTO PI+ PI- GAMMA                             139+ 139+   0
P2      M INTO RHOO GAMMA                                773+   0
P3      M INTO PI+ PI- ETA                               139+ 139+ 548
P4      M INTO PIO ETA                                   134+ 548
P5      M INTO PI+ PI- PIO                               139+ 139+ 134
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                    59   M BRANCHING RATIOS

R1      M INTO (RHOO GAMMA)/(ALL PI+ PI- GAMMA)          (P2)/(P1)
R1        58     0.05       0.1          AGUILAR    70 HBC     3.9-4.6K-P,P K-M  1/71

R2      M INTO (PI+ PI- GAMMA)/(PI+ PI- ETA NEUTR.)      (P1)/(P3N)
R2        58     1.2        0.3          AGUILAR    70 HBC     3.9-4.6K-P,P K-M  1/71

R3      M INTO (PI+ PI- PIO)/TOTAL                       (P5)
R3        58     NOT OBSERVED            AGUILAR    70 HBC     3.9-4.6K-P,P K-M  1/71

R4      M INTO (PIO ETA NEUTR.)/TOTAL                    (P4N)
R4        58     NOT OBSERVED            AGUILAR    70 HBC     3.9-4.6K-P,P K-M  1/71
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REFERENCES FOR M

AGUILAR 70 PRL 25 1635 AGUILAR-BENITEZ,BASSANO,SAMIOS,BARNES+(BNL)

MAGLICH 71 PRL 27 1479 +OCSTENS,BRODY,CVIJANOVICH (RUTG+PENN+UPNJ)
ROSNER 71 PRL 26 933 J.L.ROSNER,E.W.COLGLAZIER (MINN+CIT)

AGUILAR 72 PR D 6 29 AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS (BNL)
BRODY 72 UPR-3E.SUBM.TO PR +GROVES,NOREM,CVIJANOVICH,+(PENN+RUTG+UPNJ)

GRIGORIA 75 NP B91 232 GRIGORIAN,LADAGE,MELLEMA,RUDNICK,+ (UCLA)


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η'(958)

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2  ETA PRIME(958,JPG=0-+) I=0
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Note on the J^P Assignment of η'(958)

From the Dalitz plot analyses of the $\eta' \to \pi\pi\eta$ and $\eta' \to \pi^+\pi^-\gamma$ decays, and from the observation of a $\eta' \to \gamma\gamma$ decay mode, all assignments except $J^{PC} = 0^{-+}$ and 2^{-+} are excluded. The Dalitz plot analyses favor spin 0, but cannot rule out spin 2. The indication of anisotropy in the decay of very forward produced η' (KALBFLEISCH 73) has not been confirmed by BALTAY 74, thus favoring strongly spin 0.

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                    2   ETA PRIME MASS (MEV)

M   O   ONLY EXPERIMENTS GIVING ERROR LESS THAN 2 MEV KEPT FOR AVERAGING      12/75*
M        85 (957.0)                    DAUBER     64 HBC     1.95 K-P
M   K       (958.0)     (1.0)          KALBFLE1   64 HBC     2.7 K-P           6/66
M   K       KALBFLEISCH 64 SUPERSEDED BY RITTENBERG 69
M   O       (957.0)     (3.0)          BADIER     65 HBC     3.0 K-P
M   O     8 (960.0)     (2.0)          TRILLING   65 HBC     3.65 PI+ P       12/75*
M   O     7 (955.0)    (10.0)          COHN       66 DBC     3.3 PI+D          6/66
M   O       (959.0)     (3.0)          LONDON     66 HBC     2.2 K-P           6/66
M   O       (960.0)     (5.0)          MOTT       69 HBC     4.1-5.5 K- P      7/69
M             957.        1.           RITTENBER  69 HBC     1.7-2.7 K- P      9/69
M   O       (956.0)     (2.0)          AGUILAR    70 HBC     3.9-4.6K-P       12/75*
M      3415   956.1       1.1          BASILE1    71 CNTR    1.6 PI- P,N X0   11/71
M       535   957.4       1.4          BASILE1    71 CNTR    1.6 PI- P,N X0   11/71
M      1414   958.2       0.5          DANBURG    73 HBC     2.2 K-P,LAM X0    2/74
M       400   958.        1.           JACOBS     73 HBC     2.9 K-P,LAM X0    1/74
M             957.46      0.33         DUANE      74 MMS     PI- P,N MM        1/74
M             . . . . . . . . . .
M   AVG       957.57      0.25    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT   957.57      0.28    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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                    2   ETA PRIME WIDTH (MEV)

W        85   (4.0)   OR LESS          DAUBER     64 HBC     1.95 K-P
W      3415   (8.)    OR LESS  CL=.90  BASILE1    71 CNTR    1.6 PI- P,N X0   11/71
W       514   (4.7)   OR LESS  CL=.95  DANBURG    73 HBC     2.2 K-P,LAM X0    2/74
W             (0.8)   OR LESS  CL=.95  DUANE      74 MMS     PI- P,N MM        1/74
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                    2   ETA PRIME PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      ETA PRIME INTO PI+ PI- ETA                            139+ 139+ 548
                   P1(N)  ETAS DECAY INTO ALL NEUTRALS
                   P1(C)  ETAS DECAY CHARGED
P2      ETA PRIME INTO PIO PIO ETA                            134+ 134+ 548
                   P2(N)  ETAS DECAY INTO ALL NEUTRALS
                   P2(C)  ETAS DECAY CHARGED
P3      ETA PRIME INTO PI+ PI- GAMMA                          139+ 139+   0
                   (INCLUDING RHO GAMMA)
P4      ETA PRIME INTO GAMMA GAMMA                              0+   0
P6      ETA PRIME INTO RHOO GAMMA                               0+ 773
P10     ETA PRIME INTO PI+ PI- E+ E-                          139+ 139+  .5+  .5
P11     ETA PRIME INTO 2 PI                                   139+ 139
P12     ETA PRIME INTO 3 PI                                   139+ 139+ 134
P13     ETA PRIME INTO 4 PI                                   139+ 139+ 139+ 139
P14     ETA PRIME INTO 5 PI
P15     ETA PRIME INTO 6 PI
P16     ETA PRIME INTO PIO E+ E- (VIOLATES C IN               134+  .5+  .5
                                  BORN APPROX.)
P17     ETA PRIME INTO ETA E+ E- (VIOLATES C IN               548+  .5+  .5
                                  BORN APPROX.)
P18     ETA PRIME INTO PIO RHO O (VIOLATES C)                 134+ 773
P19     ETA PRIME INTO PIO OMEGA (VIOLATES C)                 134+ 783
P20     ETA PRIME INTO GAMMA OMEGA                              0+ 783
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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle\delta P_i \delta P_i\rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle\delta P_i \delta P_j\rangle/(\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
        P 1          P 2          P 3          P 4
P 1  .4352+-.0174
P 2   -.5783   .2407+-.0198
P 3   -.3541      -.5478   .3039+-.0171
P 4    .0314      -.1430      -.0218   .0202+-.0027

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                    2   ETA PRIME BRANCHING RATIOS
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Note on η'(958) Branching Fractions

In our calculation of the branching fractions of the η'(958), we use the decay modes $\eta\pi\pi$ (including $\eta\pi^0\pi^0$), $\rho^0\gamma$, and $\gamma\gamma$. It is assumed that the rate $\eta \to$ neutrals is 71.1%.

In the fit we do not use the constraint

$$R = \Gamma(\eta' \to \eta\pi^+\pi^-)/\Gamma(\eta' \to \eta\pi^0\pi^0) = 2$$

from I-spin conservation. The result of the fit is in agreement with it: R = 1.8 ± 0.2.

```
R1      ETA PRIME INTO (PI+ PI-ETA (NEUTRAL DEC.))/TOTAL (P1N)
R1   K    68    (0.36)    (0.05)          KALBFLE2  64 HBC      2.7 K-P          10/66
R1   K        KALBFLE2 64 SUPERSEDED BY RITTENBERG 69
R1        281    0.314     0.026          RITTENBER 69 HBC      1.7-2.7 K-P       9/69
R1            . . . . . . . . . .
R1   FIT         0.309     0.012   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      ETA PRIME INTO (PI+ PI- NEUTRALS) / TOTAL          (P1N+P2C)
R2         33    0.35      0.06           BADIER    65 HBC      3.0 K-P          10/66
R2         39    0.4       0.1            LONDON    66 HBC      2.2 K-P          10/66
R2            . . . . . . . . . .
R2   AVG         0.363     0.051   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2   STUDENT     0.363     0.056   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2   FIT         0.379     0.010   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
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Mesons
$\eta'(958)$, $\delta(970)$

Data Card Listings
For notation, see key at front of Listings.

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R3      ETA PRIME INTO (PI+ PI- ETA (CHRGD.DECAY))/TOTAL (PIC)
R3  K   44   (0.12)    (0.02)           KALBFLE2  64 HBC      2.7 K-P          10/66
R3  K          KALBFLE2 64 SUPERSEDED BY RITTENBERG 69
R3       7   0.07      0.04             BADIER    65 HBC      3.0 K-P          10/66
R3      10   0.1       0.04             LONDON    66 HBC      2.2 K-P          10/66
R3     107   0.123     0.014            RITTENBER 69 HBC      1.7-2.7 K-P       9/69
R3           . . . . . . . . . .
R3  AVG      0.116     0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  STUDENT  0.116     0.014   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R3  FIT      0.1258    0.0050 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4      ETA PRIME INTO (PI+ PI- NEUTRALS (EXCLUDING         (P2C)
R4         PI+ PI- ETA (NEUTR.DEC.))) / TOTAL
R4  K   10   (0.05)    (0.04)           KALBFLE2  64 HBC      2.7 K-P          10/66
R4  K          KALBFLE2 64 SUPERSEDED BY RITTENBERG 69
R4      42   0.045     0.029            RITTENBER 69 HBC      1.7-2.7 K-P       9/69
R4           . . . . . . . . . .
R4  FIT      0.0696    0.0057 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5      ETA PRIME INTO (NEUTRALS) / TOTAL                   (P2N+P4)
R5  K   54   (0.25)    (0.05)           KALBFLE2  64 HBC      2.7 K-P          10/66
R5  K          KALBFLE2 64 SUPERSEDED BY RITTENBERG 69
R5      16   0.24      0.17             BADIER    65 HBC      3.0 K-P          10/66
R5      32   0.3       0.1              LONDON    66 HBC      2.2 K-P          10/66
R5     123   0.189     0.026            RITTENBER 69 HBC      1.7-2.7 K-P       9/69
R5     535   0.185     0.022            BASILE1   71 CNTR   1.6 PI- P,N X0     11/71
R5           . . . . . . . . . .
R5  AVG      0.190     0.016   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  STUDENT  0.190     0.018   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R5  FIT      0.191     0.014  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6      ETA PRIME INTO (PI+ PI- GAMMA (INCLUDING RHO GAMMA))/TOTAL
R6                                                          (P3)
R6  K   42   (0.22)    (0.04)           KALBFLE2  64 HBC      2.7 K-P          10/66
R6  K          KALBFLE2 64 SUPERSEDED BY RITTENBERG 69
R6      35   (0.34)    (0.09)           BADIER    65 HBC      3.0 K-P         .10/66
R6      20   0.2       0.1              LONDON    66 HBC      2.2 K-P          10/66
R6     298   0.329     0.033            RITTENBER 69 HBC      1.7-2.7 K-P       9/69
R6           . . . . . . . . . .
R6  AVG      0.316     0.038   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R6  STUDENT  0.317     0.035   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R6  FIT      0.304     0.017  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R7      ETA PRIME INTO (PI+ PI- GAMMA (INCLUDING RHO GAMMA))/(PI PI ETA)
R7                                                          (P3)/(P1+P2)
R7           0.25      0.14             DAUBER    64 HBC      1.95 K-P         10/66
R7           . . . . . . . . . .
R7  FIT      0.450     0.037  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R8      ETA PRIME INTO (PI0 E+ E-)/TOTAL                    (P16)
R8           (0.013)OR LESS             RITTENBER 65 HBC            2.7 K-P    10/66

R9      ETA PRIME INTO (ETA E+ E-)/TOTAL                    (P17)
R9           (0.011)OR LESS             RITTENBER 65 HBC            2.7 K-P    10/66

R10     ETA PRIME INTO (PI0 RHO0)/TOTAL                     (P18)
R10          (0.04) OR LESS             RITTENBER 65 HBC            2.7 K-P    10/66

R11     ETA PRIME INTO(GAMMA OMEGA)/TOTAL                   (P20)
R11 R        (0.08) OR LESS             RITTENBER 65 HBC            2.7 K-P    10/66
R11 R    INCLUDES PI0 OMEGA
R11          (.05) OR LESS  CL=.90      KALBFLEI  75 HBC      2.2 K- P,GAMMA + 12/75*

R12     ETA PRIME INTO (PI+ PI- E+ E-)/TOTAL                (P10)
R12          (0.006)OR LESS             RITTENBER 65 HBC            2.7 K-P    10/66

R13     ETA PRIME INTO (2 PI)/TOTAL                         (P11)
R13          (0.07) OR LESS             LONDON    66 HBC      COMPILATION      10/66

R14     ETA PRIME INTO (3 PI)/TOTAL                         (P12)
R14          (0.07) OR LESS             LONDON    66 HBC      COMPILATION      10/66

R15     ETA PRIME INTO (4 PI)/TOTAL                         (P13)
R15          (0.01) OR LESS             LONDON    66 HBC      COMPILATION      10/66

R16     ETA PRIME INTO (6 PI)/TOTAL                         (P15)
R16          (0.01) OR LESS             LONDON    66 HBC      COMPILATION      10/66

R18     ETA PRIME INTO (RHO0 GAMMA)/(PI PI ETA)             (P6)/(P1+P2)
R18          0.31      0.15             DAVIS     68 HBC      5.5 K- P          9/68
R18          . . . . . . . . . .
R18 FIT      0.450     0.037  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R19     ETA PRIME INTO (2 GAMMA)/TOTAL                      (P4)
R19      5   0.055     0.036     0.030 BOLLINI    68 CNTR     1.9 PI- P        12/72
R19      7   0.126     0.075           BENSINGER 70 DBC      2.2 PI+ D        12/72
R19     31   0.020     0.008     0.006 HARVEY     71 OSPK     3.65 PI- P,N X0  11/71
R19     68   0.0171    0.0033          DALPIAZ    72 CNTR     1.6 PI- P,N X0   12/72
R19           .025      .007           DUANE      74 MMS      PI-P,N MM        12/75*
R19          . . . . . . . . . .
R19 AVG      0.0192    0.0027  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R19 STUDENT  0.0191    0.0031  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R19 FIT      0.0202    0.0027 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R20     ETA PRIME INTO (PI+PI-)/TOTAL                       (P11)
R20          (0.02) OR LESS             RITTENBER 69 HBC      1.7-2.7 K-P       9/69
R20          (0.08) OR LESS  CL=.95     DANBURG   73 HBC      2.2 K-P,LAM X0    2/74

R21     ETA PRIME INTO (PI+PI-PI0)/TOTAL                    (P12)
R21          (0.05) OR LESS             RITTENBER 69 HBC      1.7-2.7 K-P       9/69
R21          (0.09) OR LESS  CL=.95     DANBURG   73 HBC      2.2 K-P,LAM X0    2/74

R22     ETA PRIME INTO (PI+PI+PI-PI-)/TOTAL                 (P13)
R22          (0.01) OR LESS             RITTENBER 69 HBC      1.7-2.7 K-P       9/69
R22          (0.01) OR LESS  CL=.95     DANBURG   73 HBC      2.2 K-P,LAM X0    2/74

R23     ETA PRIME INTO (PI+PI+PI-PI-PI0)/TOTAL              (P14)
R23          (0.01) OR LESS             RITTENBER 69 HBC      1.7-2.7 K-P

R24     ETA PRIME INTO (PI+PI+PI-PI- NEUTRALS)/TOTAL        (P16+...)
R24          (0.01) OR LESS             RITTENBER 69 HBC      1.7-2.7 K-P       9/69

R25     ETA PRIME INTO (RHO0 GAMMA)/(ALL PI+ PI- GAMMA)     (P6)/(P3)
R25          0.94      0.20             AGUILAR   70 HBC      3.9-4.6K-P        1/71
R25  E 473   1.15      0.10             DANBURG   73 HBC      2.2 K-P,LAM X0    2/74
R25  E 473   (0.95) OR MORE  CL=.95     DANBURG   73 HBC      2.2 K-P,LAM X0    2/74
R25  E  EQUIVALENT STATEMENTS
R25    137   1.01      0.15             JACOBS    73 HBC      2.9 K-P,LAM X0    1/74
R25          . . . . . . . . . .
R25 AVG      1.082     0.077   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R25 STUDENT  1.082     0.086   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R26     ETA PRIME INTO (PI0 PI0 ETA INTO 3 PI0)/TOTAL       (P2N(3PI0))
R26      4   0.11      0.06             BENSINGER 70 DBC      2.2 PI+ D         1/71
R26          . . . . . . . . . .
R26 FIT      0.0722    0.0060 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R27     ETA PRIME INTO (PI+ PI- GAMMA)/(PI+ PI- ETA(NEUTRAL DEC.))
R27                                                         (P3)/(P1N)
R27 K        (0.54)    (0.10)           AGUILAR   72 HBC      3.9,4.6 K- P     12/72
R27 K    NOT AVERAGED DUE TO COMPLICATION WITH M(953).SEE KALBFLEI 74.
R27    473   0.92      0.14             DANBURG   73 HBC      2.2 K-P,LAM X0    2/74
R27    192   1.11      0.18             JACOBS    73 HBC      2.9 K-P,LAM X0    1/74
R27          . . . . . . . . . .
R27 AVG      0.99      0.11    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R27 STUDENT  0.99      0.12    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R27 FIT      0.982     0.078  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R28     ETA PRIME INTO (2 GAMMA)/(PI0 PI0 ETA(NEUTRAL DEC.))
R28                                                         (P4)/(P2(N))
R28     16   0.188     0.058            APEL      72 OSPK     3.8 PI- P,N X0    1/73
R28          . . . . . . . . . .
R28 FIT      0.118     0.019  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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               2  ETA PRIME C-NONCONSERVING DECAY PARAMETER

        RELATED TEXT SECTION  VI C

A   DECAY ASYMMETRY PARAMETER FOR PI+ PI- GAMMA
A       152    .07       .08            RITTENBE  65 HBC      2.1-2.7 K-P      12/75*
A       103    .00       .10            KALBFLEI  75 HBC      2.2 K-P          12/75*
A       295   -.069      .078           GRIGORIA  75 STRC     2.1 PI-P         12/75*
A            . . . . . . . . . .
A   AVG      -0.001    0.049   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A   STUDENT  -0.001    0.056   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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REFERENCES FOR ETA PRIME


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DAUBER   64 PRL 13 449         DAUBER,SLATER,SMITH,STORK,TICHO        (UCLA)JP
    ALSO 64 DUBNA CONF 1 418   DAUBER,SLATER,L T SMITH,STORK,TICHO   (UCLA)
GOLDBERG 64 PRL 12 546         +GUNDZIK,LICHTMAN,CONNOLLY,HART,+(SYRA+BNL)
GOLDBERG 64 PRL 13 249         +GUNDZIK,LEITNER,CONNOLLY,HART,+ (SYRA+BNL)
KALBFLE1 64 PRL 12 527         KALBFLEISCH,ALVAREZ,BARBARO-GALTIERI,+(LRL)JP
KALBFLE2 64 PRL 13 349         G.R.KALBFLEISCH,O.DAHL,A.RITTENBERG    (LRL)JP

BADIER   65 PL 17 337          BADIER,DEMOULIN,BARLOUTAUD+(EPOL+SACL+ZEEM)
KIENZLE  65 PL 19 438          KIENZLE,MAGLIC,LEVRAT,LEFEBVRES +      (CERN)
RITTENBE 65 PRL 15 556         RITTENBERG,KALBFLEISCH              (LRL+BNL)
TRILLING 65 PL 19 427          +BROWN,GOLDHABERS,KADYK,SCANIO          (LRL)

COHN     66 PL 21 347          COHN,MCCULLOCH,BUGG,CONDO  (ORNL+TENN+UCND)
LONDON   66 PR 143 1034        LONDON,RAU,SAMIOS,GOLDBERG + (BNL+SYRACUSE)IJP
MARTIN   66 PL 22,352          MARTIN,CRITTENDEN,SCHROEDER     (INDIANA U)I

BARBARO- 68 PRL 20 349         BARBARO-GALTIERI,MATISON,RITTENBERG+  (LRL)I=0
BARLOUTA 68 PL 26 B  674       BARLOUTAUD+    (SACLAY+AMST+BGNA+REHO+EPOL)I=0
BOLLINI  68 NC 58 A  289       +BUHLER,DALPIAZ,MASSAM+     (CERN+BGNA+STRB)
DAVIS    68 PL 27 B 532        +AMMAR,MOTT,DAGAN,DERRICK,FIELDS (NWES+ANL)

DUFEY    69 PL 29 B 605        +GOBBI,POUCHON,CNOPS,+      (ETHZ+CERN+SACL)IJP
MOTT     69 PR 177 1966        +AMMAR,DAVIS,KROPAC,SLATE,DAGAN+ (NWES+ANL)
RITTENBE 69  UCRL-18863        ALAN RITTENBERG (THESIS)              (LRL)I=0

AGUILAR  70 PRL 25 1635        AGUILAR-BENITEZ,BASSANO,SAMIOS,BARNES+(BNL)
BENSINGE 70 PL 33 B 505        BENSINGER,ERWIN,THOMPSON,W.D.WALKER  (WISC)

BARDADIN 71 PR D4 2711         BARDADIN-OTWINOWSKA,HOFMOKL,MICHEJDA+(WARS)
BASILE1  71 NC 3 A 371         +BOLLINI,DALPIAZ,FRABETTI,+(CERN+BGNA+STRB)
BASILE2  71 NP B 33 29         +BOLLINI,DALPIAZ,FRABETTI,+(CERN+BGNA+STRB)
HARVEY   71 PRL 27 885         +MARQUIT,PETERSON,RHOADES,+       (MINN+MICH)
OGIEVETS 71 PL 25 B 69         OGIEVETSKY,TYBOR,ZASLAVSKY             (DUBNA)

AGUILAR  72 PR D 6 29          AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS    (BNL)
APEL     72 PL 40 B 680        +AUSLANDER,MULLER,BERTOLUCCI,+  (KARL+PISA)
BINNIE   72 PL 39 B 275        +CAMILLERI,DUANE,GARBUTT,BURTON+(LOIC+SHMP)
BLOODWOR 72 NP B 39 525        BLOODWORTH,JACKSON,PRENTICE,YOON  (TORONTO)
DALPIAZ  72 PL 42 B 377        +FRABETTI,MASSAM,NAVARRIA,ZICHICHI    (CERN)
RADER    72 PR D 6 3059        +ABOLINS,DAHL,DANBURG,DAVIES,HOCH,+    (LBL)

DANBURG  73 PR D 8 3744        +KALBFLEISCH,BORENSTEIN,CHAPMAN,+(BNL+MICH)  JP
JACOBS   73 PR D 8 18          +CHANG,GAUTHIER,+        (BRAN+UMD+SYRA+TUFT)  JP
KALBFLEI 73 PRL 31 333         KALBFLEISCH,CHAPMAN,+          (BNL+MICH+LBL)  JP

BALTAY   74 PR D9 2999         +COHEN,CSORNA,HABIBI,KALELKAR,+ (COLU+BING)  JP
DUANE    74 PRL 32 425         +BINNIE,CAMILLERI,CARR,DEBENHAM+(LOIC+SHMP)
GAULT    74 NC 24 A 259        +JONES,SCADRON,THEWS           (DURH+LOIC+ARIZ)
KALBFLEI 74 PR D10 916         G.R.KALBFLEISCH                         (BNL)

GRIGORIA 75 NP B91 232         GRIGORIAN,LADAGE,MELLEMA,RUDNICK,+    (UCLA)
KALBFLEI 75 PR D11 987         KALBFLEISCH,STRAND,CHAPMAN          (BNL+MICH)
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$\delta(970)$ $\rightarrow \eta\pi, \cdots$

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36  DELTA(970,JPG=0+-) I=1
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Under this entry, we list three types of I=1 peaks near $K\bar{K}$ threshold:

1) Missing-mass peaks, mostly controversial.
2) $\eta\pi$ decays, peaking slightly below $K\bar{K}$ threshold. This defines $I^G = 1^-$ and J^P = Normal.
3) Threshold enhancements in the $(K\bar{K})^{\pm}$ system with I=1. The Q value is low and J^P therefore probably 0^+.

Data Card Listings

For notation, see key at front of Listings.

Mesons

δ(970), H(990), S*(993)

In listing these types of peaks together under a common entry we do not imply that they are necessarily all related. However, the $K\bar{K}$ threshold enhancement may be due to a virtual bound state that could also be responsible for the $\eta\pi$ peaks (ASTIER 67). In a coupled-channel analysis of the most significant $\eta\pi$ and $K\bar{K}$ data, MORGAN 75 shows that the δ(970) probably is strongly coupled to both channels. It then constitutes the isovector member of the 0^{+} nonet. MORGAN 75 gets a width much larger than what is observed in the $\eta\pi$ decays because of the strong $K\bar{K}$ coupling.

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                    36  DELTA(970) MASS  (MEV)

M  PEAKS  IN MISSING MASS EXPERIMENTS
M   K  262 (962.0)    (5.0)          KIENZLE   65 MMS   -  3-5 PI- P        9/66
M   K   NOT SEEN BY BANNER1 67 (1.8 PI- P)
M   K   NARROW PEAK NOT SEEN BY KALBFLEI 74 (1.3-1.6 PI-P)
M   O      (966.0)    (8.0)          OOSTENS   66 MMS   +  3.8 PP TO D + MM  9/66
M   O   NOT SEEN BY BANNER2 67 AND ANDERSON 71
M          975.0      6.0            ABOLINS   70 MMS   +  3.8-6.3 PP--D+MM  1/71
M   N  215 (962.9)    (1.7)          CHESHIRE  72 MMS   0 2.4 PI- P,N MM   12/72
M   N   NOT SEEN BY BINNIE 72 AT THRESHOLD.
M   N   NOT SEEN BY BINNIE 74 AT 2 GEV/C
M   N   NOT SEEN BY BUTTRAM 75 AT 2.4 GEV/C                               12/75*

M  ETA PI FINAL STATE CNLY.
M  S    30  980.0     10.0           AMMAR     68 HBC  +-    ,5.5K-,ETA PI  2/73
M  S    SEE ALSO AMMAR 70.
M       10 (960.)     APPROX.        CHUNG S   68 HBC   -  3.2 PI-P         5/70
M       80 (975.0)                   DEFOIX    68 HBC  +-  1.2 PB P,ETA PI  3/69
M       20  970.0     15.0           BARNES    69 HBC   -  4-5 K-P,PI-ETA   9/69
M           980.      10.            CAMPBELL  69 DBC  +- 2.7 PI+ D         1/73
M       15 (980.0)   (10.0)          MILLER    69 HBC   -  4.5 K-N,ETA PI   7/69
M       21  948.0     (7.0)          BARDADIN  71 HBC  +- 8 PI+P,P DO PI    2/72
M      150  972.      10.            DEFOIX    72 HBC  +- 0.7 PBAR P,7 PI   1/73
M       47 (980.)                    CONFORTO  73 OSPK -  4.5 PI-P,P X-     1/74
M           . . . . . . . . . .
M   AVG      976.4     5.4    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT 976.4      5.8    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M  K KBAR ONLY, SEE THE TYPED NOTE ABOVE
M      143(1003.3)     7.0+SYSTEMATIC ROSENFELD 65 RVUE +-                . 8/66
M          SCAT. LENGTH 2 TO 6 FERMIS.BALTAY    66 HBC      3.7 PBAR P      8/66
M   A  100(1016.)     (10.)          ASTIER    67 HBC  +-  0 PBAR P       . 7/67
M   A   SCATT.LENGTH ALSO FITS, SEE BELOW
M       SCATT.LENGTH +2.5 +-1. FERMI ASTIER    67 HBC  +-  0-1.2 PBAR P     7/67
M       OR CMPLX, RE PART=-2.3 F     ......    .. ...  ..  ..... .... .     7/67
M                  IM PART=.5F OR LESS ......  .. ...  ..  ..... .... .     7/67
M   B        (1.8)     (0.4)     (0.3)  DUBOC  72 HBC      1.2 PBAR P,3PI2K 12/72
M   B  ABSOLUTE VALUE OF SCAT.LENGTH                                       12/72

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                    36  DELTA(970) WIDTH  (MEV)

W  PEAKS SEEN IN MISSING MASS EXPERIMENTS
W   S  262    (5.0)  OR LESS             KIENZLE   65 MMS   -  3-5 PI- P        9/66
W   S        (10.0)  OR LESS             OOSTENS   66 MMS   + 3.8 PP TO D + MM  9/66
W             60.0     16.0      10.0    ABOLINS   70 MMS   + 3.8-6.3 PP--D+MM  1/71
W   S  215    (5.9)  OR LESS   CL=.90    CHESHIRE  72 MMS   0 2.4 PI- P,N MM   12/72
W   S   SEE NOTES ON DELTA MASS ABOVE

W  ETA PI  FINAL STATE CNLY
W       30    80.0     30.0              AMMAR     68 HBC  +-    ,5.5K-,ETA PI  2/73
W       80   (25.0)                      DEFOIX    68 HBC  +-  1.2 PB P,ETA PI  3/69
W       20   (50.0)  OR LESS             BARNES    69 HBC   -  4-5 K-P,PI-ETA   9/69
W             40.      15.               CAMPBELL  69 DBC  +- 2.7 PI+ D         1/73
W       15    60.0     30.0              MILLER    69 HBC   -  4.5 K-N,ETA PI   2/74
W       21    31.0     28.0              BARDADIN  71 HBC  +- 8 PI+P,P DO PI  . 2/74
W      150   (30.)     (5.)              DEFOIX    72 HBC  +- 0.7 PBAR P,7 PI . 2/74
W       47   (60.)    (50.)     (30.)    CONFORTO  73 OSPK -  4.5 PI-P,P X-     1/74
W            . . . . . . . . . .
W   AVG      46.9      11.2    AVERAGE (ERRCR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT  46.6      12.5    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W  K KBAR ONLY, SEE THE TYPED NCTE ABCVE
W      143   (57.0)     13.0+SYSTEMATIC ROSENFELD 65 RVUE +-                 8/66
W   A  100   (25.) APPROX.               ASTIER    67 HBC  +- SEE NOTE A ABOVE  9/67
W   M        (120.) APPROX.              MORGAN    75 RVUE    1.2 PBAR P      12/75*
W   M   FROM COUPLED CHANNEL FIT TO DUBOC 72 DATA

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                    36  DELTA(970) PARTIAL DECAY MCDES

                                                          DECAY MASSES
P1      DELTA(970)    INTO ETA PI                        548+ 134
P2      DELTA(970)    INTO RHO PI                        773+ 134

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                    36  DELTA(970) BRANCHING RATIOS

R1      DELTA(970)    INTO (RHO PI)/(ETA PI)              (P2)/(P1)
R1            (0.25) OR LESS  CL=.70   AMMAR      70 HBC  +- 4.1,5.5K-,ETA PI. 5/70

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                              REFERENCES FOR DELTA(970)

TURKOT    63 SIENNA CONF 1 661 +CCLLINS,FUJII,KEMP+         (BNL+PITTSBURGH)

ARMENTER 65 PL 17 344           ARMENTEROS,EDWARDS, JACOBSEN +  (CERN+CDEF)
BARASH   65 PR  139 B  1659     +FRANZINI,KIRSCH,MILLER,STEINBERGER+ (COLU)
KIENZLE  65 PL   19  438        + MAGLIC,LEVRAT,LEFEBVRES +           (CERN)
ROSENFEL 65 OXFORD CONF 58      A H ROSENFELD                      (LRL--RVUE)

ALLEN D  66 PL  22  543         +GP FISHER,G GODDEN,L MARSHALL,SEARS (COLO)G=+
BALTAY   66 PR  142 B  932      +LACH,SANDWEISS,TAFT,YEH,STONEHILL+  (YALE)
FOCACCI  66 PRL  17  890        + KIENZLE,LEVRAT,MAGLIC,MARTIN       (CERN)
OOSTENS  66 PL   22  708        +CHAVANON,CROZCN,TOCQUEVILLE  (SACLAY,CDEF)I=1

ALLISCN  67 PL 25B 619          +CRUZ+         (OXF+MPIM+BIRM+RHEL+GLAS+LOIC)
ASTIER   67 PL   25 B  294      +MONTANET,BAUBILLIER,DUBOC+(CDEF+CERN+IRAD)
  ASTIER 67 INCLUDES DATA OF BARLOW 67,CONFORTO 67,ARMENTEROS 65.
BAILLON  67 NC 50A 393          +EDWARDS+D.ANDLAU+ASTIER+  (CERN+CDEF+IRAD)
BANNER 1 67 PL   25 B  300      +FAYOUX,HAMEL,ZSEMBERY,CHEZE+ (SACLAY+CAEN)
BANNER 2 67 PL 25 B 569         +CHEZE,HAMEL,MAREL,TEIGER+        (CDEF+SACL)
BARLOW   67 NC   50 A   701     +MONTANET,D,ANDLAU+    (CERN+CDEF+IRAD+LIVP)
CONFORTO 67 NP B3 469           CONFORTO,MARECHAL+     (CERN+CDEF+IPNP+LIVP)

AMMAR    68 PRL 21 1832         +CAVIS,KROPAC,DERRICK,FIELCS,+   (NWES+ANL)
CHUNG S  68 PR 165 1491          +O.DAHL, J. KIRZ, D.H.MILLER          (LRL)
DEFOIX   68 PL 28 B 253         +RIVET,SIAUD,CONFORTO+       (CDEF+IPNP+CERN)
GALTIERI 68 PRL 20 349          BARBARO-GALTIERI,MATISON,RITTENBERG+  (LRL)
JUHALA   68 PL 27 B 257         +LEACOCK,RHODE,KOPELMAN,LIBBY+  (IOWA+COLO)
SABRE CO 68 PL 26 B 674         BARLOUTAUD+        (SACL+AMST+BGNA+REHO+EPOL)

BARNES   69 PRL 23 610          +CHUNG,EISNER,BASSANO,GOLCBERG+  (BNL+SYRA)
CAMPBELL 69 PRL 22 1204         J.H.CAMPBELL,LICHTMAN,LOEFFLER,+   (PURDUE)
CRENNELL 69 PRL 22 1398         +KARSHON,KWAN WU LAI,+            (BNL+NYU)
JUHALA   69 PR 184  1461        +LEACOCK,RHODE,KOPELMAN,LIBBY,+  (ISU+COLO)
KRUSE    69 PR 177 1951         KRUSE,LOOS,GOLDWASSER             (ILLINOIS)
MILLER   69 PL 29 B  255        D.H.MILLER,S.L.KRAMER,D.D.CARMONY,+(PURDUE)
   ALSO  69 PR 188 2011         YEN,AMMANN,CARMONY,ELSNER,+         (PURDUE)
SCHROEDE 69 PR 188  2081        SCHROEDER,KERNAN,FISHER,LIBBY,+  (ISU+COLO)

ABOLINS  70 PRL 25 469          +GRAVEN,MCCARTHY,G.SMITH,L.SMITH+ (LRL+UCD)
AMMAR    70 PR D 2 430          +KROPAC,DAVIS,DERRICK+ (KANS+NWES+ANL+WISC)
COOPER   70 NP B 23 605         +HANNER,MUSGRAVE,POLLARD,VOYVODIC      (ANL)
YIOU     70  THESIS, A 646      TCHIU-PUNG YIOU                      (ORSAY)

ANDERSON 71 PRL 26 108          +DIXIT,+   (CHIC+ANL+CARL+LASL+CNRC+NAGOYA)
BARDADIN 71 PR D4 2711          BARDADIN-OTWINOWSKA,HOFMOKL,MICHEJDA+(WARS)

BINNIE   72 PL 39 B 275         +CAMILLERI,DUANE,GARBUTT,BURTON+(LOIC+SHMP)
CHESHIRE 72 PRL 28 520          +HOFFMAN,GARFINKEL,+         (IOWA+ANL+PURD)
DEFOIX   72 NP B 44 125         +NASCIMENTO,BIZZARRI,+          (CDEF+CERN)
DUBOC    72 NP B 46 429         +GOLDBERG,MAKOWSKI,DCNALD,+     (LPNP+LIVP)
HOLLOWAY 72 PHIL.CONF.PROC.133+HULD,KOETZ,KRUSE,BERNSTEIN,+    (ILL+ILLC)

ATHERTCN 73 PL 43 B 249         +FRANEK,FRENCH,GHIDINI,HILPERT,+     (CERN)
CONFORTO 73  AIX CONF.          BUTTERWORTH RAPPORTEUR TALK C1-195,FIG.39

BINNIE   74 PRL 32 392          +CAMILLERI,CARR,DEBENHAM,+      (LOIC+SHMP)
KALBFLEI 74 NP B69 279          KALBFLEISCH,VANDERBURG,+     (BNL+RUTG+IND)
MORGAN   74 PL 51B 71           D.MCRGAN                              (RHEL)

BUTTRAM  75 PRL 35 970          +CRAWLEY,DUKE,LAMB,LEEPER,PETERSON    (ISU)
MORGAN   75  PREPRINT RL75133 D.MORGAN                                (RHEL)
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H(990) →

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35  H(990,JPG=A -) I=0

THE EVIDENCE OF BENSCN 66 HAS DISAPPEARED AFTER
RE-ANALYSIS (CHAUDHARY 70). NO SIGNIFICANT
OTHER EVIDENCE HAS BEEN PUBLISHED.
OMITTED FRCM TABLE.

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                              REFERENCES FOR H

BARTSCH  64 PL   11  167        AACHEN-ZEUTHEN-BIRM-BONN-HAMB-MUNCHEN CCLL
GOLDHABE 65 CORAL GABLES P.76 G. GOLDHABER                            (LRL)
BENSON   66 PRL 17 1234         +MARQUIT,ROE,SINCLAIR,VANDER VELDE  (MICH)IJP
COHN     67 NP B1 57            +MC CULLOCH,BUGG,CONDO     (ORNL+UNIV.TENN)
ROSENFEL 67 RMP 39 1,APPENDIX   ROSENFELD,BARBARO-GALTIERI+(LRL+CERN+YALE)
ARMENISE 68 PL 26B 336          +GHIDINI,FORINO+       (BARI+BGNA+FIRZ+ORSAY)
BARBARO- 68 PHILAD.CONF.P.137 A.BARBARO-GALTIERI,P.SODING             (LRL)
FUNG     68 PRL 21  47          +JACKSCN+PU+BROWN+GIDAL     (U.C.RIVERS+LRL)
GOLDHABE 69 LUND CONF.P.271     G.GOLDHABER QUOTED BY B.MAGLIC         (LRL)
CHAUDHAR 70 PR D 2 2110         B.CHAUDHARY,E.MARQUIT            (MINNESOTA)
GORDON   70  COO 1195 179       THESIS,ILLINOIS                        (ILL)
MICHAEL  72 PRL 28 1475         W.MICHAEL,G.GIDAL                      (LBL)
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S*(993)

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3  S*(993,JPG=0++) I=0

UNDER THIS ENTRY WE LIST PARAMETERS OF THE POLE IN THE
ISOSCALAR S-WAVE.FOR A MINI-REVIEW SEE UNDER EPSILON.
POSSIBLE EVIDENCE OF D-WAVE PI PI INTERACTIONS IN THIS
REGION IS LISTED SEPARATELY UNDER  ETA N(1080).

FOR EARLY WORK USING BREIT-WIGNER OR SCATTERING
LENGTH PARAMETRIZATION IN FITS TO THE (K KBAR) MASS
SPECTRUM SEE REFERENCE SECTION AND OUR 1972 EDITION.

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                 3  REAL PART OF THE S* POLE POSITION (MEV)

M  H       970.      30.      130.    HOANG     69 OSPK    4. PI-P,KS KS N   1/73
M  H       920.      80.       90.    HOANG     69 OSPK    5. PI-P,KS KS N   1/73
M  H    CALCULATED FROM SCATTERING LENGTH FIT OF HOANG 69.
M  B      (965.)                      BEUSCH    70 OSPK    4,6 PI-P        . 1/73
M  B    CALCULATED FROM SCATTERING LENGTH FIT OF BEUSCH 70.
M          997.      6.               PROTOPOPE 73 HBC     SHEET 2 7. PI+ P  1/74
M  S       987.      7.               BINNIE    73 CNTR    PI- P,S* N        1/74
M  S    OBSERVED BY THRESHOLD-CROSSING TECHNIQUE. POSSIBLY IMPORTANT
M  S    S-CHANNEL EFFECTS.
M         (997.)                      ESTABROOK 73 ASPK    17 PI-P,PI+PI-N  12/75*
M        (1012.)    (6.)              GRAYER    73 ASPK    17 PI-P,PI+PI-N  12/75*
M         1007.     20.               HYAMS     73 ASPK  0 17 PI-P,N PI+PI-  1/74
M   A     (986.)    (5.)              FUJII     75 RVUE    17 PI-P,PI+PI-N  12/75*
M   A   S* AMPLITUDES PARAMETRIZED IN TERMS OF POLE POSITIONS USING
M   A   HYAMS 73 PHASE SHIFTS
M          . . . . . . . . . .
M   AVG     993.2     4.4     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT 993.3     5.1     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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Mesons

S*(993), φ(1020)

Data Card Listings

For notation, see key at front of Listings.

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                3  NEGATIVE IMAG. PART OF THE S* PCLE PCSITICN  (MEV)
               CORRESPONCS TO HALF-WIDTH, NOT FULL WIDTH.

W  H        40.       40.       60.     HOANG      69 OSPK    4. PI-P,KS KS N    1/73
W  H        30.       30.       70.     HOANG      69 OSPK    5. PI-P,KS KS N    1/73
W  B       (13.)                        BEUSCH     70 OSPK    4,6 PI-P           1/73
W  P        27.        8.               PROTOPOPE  73 HBC     7. PI+ P           1/74
W  P    ANOTHER SOLUTION HAS 52 MEV AND NO EPSILON POLE.
W  S        24.        7.               BINNIE     73 CNTR    PI- P,S* N         1/74
W  S    SEE NOTE S ABOVE
W           (5.)                        ESTABROOK  73 ASPK   17 PI-P,PI+PI-N  12/75*
W          (16.)      (5.)              GRAYER     73 ASPK   17 PI-P,PI+PI-N  12/75*
W           15.        5.               HYAMS      73 ASPK  0 17 PI-P,N PI+PI-  1/74
W   A      (19.)      (3.)              FUJII      75 RVUE   17 PI-P,PI+PI-N  12/75*
W   A   S* AMPLITUDES PARAMETRIZED IN TERMS OF POLE POSITIONS USING
W   A   HYAMS 73 PHASE SHIFTS
W          . . . . . . . . .
W   AVG     20.0      3.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT 20.1      4.2     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                3  S* WIDTH (MEV)

      (180.)   APPROX.              MORGAN     75 RVUE                        12/75*

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                        REFERENCES FOR S*
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WANG     61 JETP 13 323          WANG TSU-TSENG,VEKSLER,VRANA,+           (JINR)
BIGI     62 CERN CONF 247        A BIGI,S BRANDT, R CARRARA +             (CERN)
BINGHAM  62 CERN CONF 240        H H BINGHAM,M BLOCH +               (EPOL+CERN)
ERWIN    62 PRL 9 34             ERWIN,HOYER,MARCH,WALKER,WANGLER (WISC+BNL)
BALTAY   64 DUBNA CONF 1 409     BALTAY,LACH,CRENNELL,OREN,STUMP +(YALE+BNL)
BARMIN   64 DUBNA CONF 1 433     BARMIN,DOLGCLENKO,YEROFEEV,KRESTNI+  (ITEP)
CRENNELL 66 PRL 16 1025          CRENNELL,KALBFLEISCH,LAI,SCARR,SCHU+  (BNL)
HESS     66 PRL 17 1109          +CAHL+HARDY+KIRZ+MILLER                 (LRL)

BARLOW   67 NC 50A 701           +LILLESTOL+MONTANET+  (CERN+CDEF+IRAD+LIVP)
BEUSCH   67 PL 25 B 357          +FISCHER,GOBBI,ASTBURY+            (ETHZ+CERN)
DAHL     67 PR 163 1377          +HARDY+HESS+KIRZ+MILLER                 (LRL)
ALITTI   68 PRL 21 1705          +BARNES,CRENNELL,FLAMINIO,GOLDBERG,+  (BNL)
LAI      68 PHILAD.CONF.P.303 KWAN WU LAI                                (BNL)
PHELAN   68  THESIS              JAMES J. PHELAN          (ANL+ST.LOUIS UNIV)
   ALSO  68 PRL 21 316           HOANG,EARTLY,PHELAN,ROBERTS+(ANL+CHIC+NDAM)
AGUILAR- 69 PL 29 B  241         M.AGUILAR-BENITEZ,J.BARLOW,+      (CERN+CDEF)
   ALSO  67 BARLOW
   ALSO  69 NP B 14 195          M.AGUILAR-BENITEZ,J.BARLOW,+      (CERN+CDEF)
HOANG    69 NC 61 A 325          T.F.HOANG                               (ANL)
HOANG    69 PR 184  1363         +EARTLY,PHELAN,ROBERTS,+           (ANL+ILLC)

BADIER   70 NP B 22 512          +BCNNET,DREVILLON,BAUBILLIER,+  (EPOL+IPNP)
BATON    70 PL 33 B 528          +LAURENS,REIGNIER                    (SACLAY)
BEUSCH   70 PHILA.CONF.P.185     W.BEUSCH                          (ETHZ+CERN)
HYAMS    70 PHILA.CONF.P.41      +KOCH,BEUSCH,+    (CERN+MPIM+ETHZ+LOIC+HAWA)
   ALSO  70 NP B 22 189          HYAMS,KOCH,POTTER,VON LINDERN,+ (CERN+MPIM)
OH       70 PR D 1 2494          +GARFINKEL,MORSE,WALKER,PRENTICE(WISC+TNTO)
ALSTON-G 71 PL 36 B 152          ALSTON-GARNJOST,BARBARO-GALTIERI,+    (LBL)

BASDEVAN 72 PL 41 B 178          BASDEVANT,FROGGATT,PETERSEN            (CERN)
DAMERI   72 NC 9 A 1             +BORZATTA,GOUSSU,+          (GENO+MILA+SACL)
DUBOC    72 NP B 46 429          +GOLDBERG,MAKOWSKI,DCNALD,+     (LPNP+LIVP)
FLATTE   72 PL 38 B 232          +ALSTON-GARNJOST,BARBARO-GALTIERI,+   (LBL)
GRAYER   72 PHIL.CONF.PROC. 5 +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
WILLIAMS 72 PR D 6 3178          P.K.WILLIAMS                            (FSU)

BINNIE   73 PRL 31 1534          +CARR,DEBENHAM,DUANE,GARBUTT,+  (LOIC+SHMP)
DIAMOND  73 PR D 7 1977          +BINKLEY,+        (WISC+DUKE+COLO+TNTO+OHIO)
ESTABROO 73  TALLAHASSEE         ESTABROOKS,MARTIN,GRAYER,HYAMS+ (CERN+MPIM)
FUJII    73 NC 13 A 311          Y.FUJII,M.KATO                        (TOKYO)
GRAYER   73  TALLAHASSEE         +HYAMS,JONES,BLUM,DIETL,KOCH+   (CERN+MPIM)
HYAMS    73 NP B 64 134          +JONES,WEILHAMMER,BLUM,DIETL,+  (CERN+MPIM)
OCHS     73 THESIS               W.OCHS                                 (MPIM)
PROTOPOP 73 PR D 7 1280          PROTOPOPESCU,GARNJOST,GALTIERI,FLATTE+(LBL)

GRAYER   74 NP B 76 375          +HYAMS,JONES,BLUM,DIETL         (CERN+MPIM)
GRAYER   74 NP B75 189           +HYAMS,JONES,BLUM,DIETL,KOCH+   (CERN+MPIM)
MORGAN   74 PL 51B 71            D.MORGAN                               (RHEL)

FUJII    75 NP B85 179           Y.FUJII,M.FUKUGITA                     (TOKY)
MORGAN   75  PREPRINT RL75133 D.MORGAN                                  (RHEL)
PAWLICKI 75 PR D12 631           +AYRES,DIEBCLD,GREENE,KRAMER,WICKLUND (ANL)
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φ(1020)

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 4   PHI(1020,JPG=1-- ) I=0

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                4  PHI MASS (MEV)

M   S   18(1019.0)     (2.0)              SCHLEIN    63 HBC    2.0 K- P          .12/75*
M   S   20(1018.6)     (0.5)              MILLER D   65 HBC     0.0 PBAR P        12/75*
M   S   41(1020.0)     (2.0)              LONDON     66 HBC     2.2 K-P           12/75*
M   S   46(1021.5)     (0.8)              ABRAMS     67 HBC    4.2 K- P           12/75*
M   S   15(1019.)      (3.)               BARLOW     67 HBC     1.2 PBAR P        12/75*
M   S   32(1021.0)     (4.0)              DAHL       67 HBC     1-4 PI- P         12/75*
M      165 1022.        1.5               MOSTEK     68 OSPK   1.8 GAMMA + C       6/68
M      136 1018.        0.5        0.35   HYAMS      70 OSPK   11. PI- P           6/70
M      107 1021.0       1.5               ALVENSLE   71 OSPK   GAMMA+C             1/72
M    D  70 1019.9       0.7               DIBIANCA   71 DBC    4.93 K- N          12/75*
M      410(1019.9)     (0.3)              STOTTLEMY  71 HBC    2.9 K-P,Y K KBAR   11/71
M    D 120 1019.6       0.5               AGUILAR    72 HBC    3.9,4.6 K- P       12/75*
M    D 100 1019.9       0.5               AGUILAR    72 HBC    3.9,4.6 K- P       12/75*
M       87 1020.8       0.8               BALAKIN    72 OSPK   E+ E- COLL.BEAMS   12/72
M      131 1020.4       0.5               COLLEY     72 HBC    10.K+ P,K+ P PHI   12/72
M      100 1020.3       0.4               BALLAM     73 HBC    2.8 - 9.3 G P       1/74
M      500 1019.5       0.6               AYRES      74 ASPK   3-6PI/K-P,K+K-     12/75*
M      984 1019.4       0.8               BESCH      74 CNTR   2 GAMMA P,PK+K-    12/75*
M       54 1018.7       0.8               BIZZARRI   74 DBC    0 PBAR N,K+K- PI.12/75*
M       71 1018.6        .7               BIZZARRI   74 DBC    0 PBAR N,KLKS PI 12/75*
M      170 1020.3       0.4               DE GROOT   74 HBC    4.2 K-P,L K+K-     12/75*
M          . . . . . . . . .
M   AVG    1019.70      0.24     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
M   STUDENT1019.84      0.20     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                       (SEE IDEOGRAM BELOW )

M   S   INSIGNIFICANT DATA WITH SMALL STATISTICS NC LONGER AVERAGED
M    D  MASS ERRORS ENLARGED BY US TO WIDTH/SQRT(N)
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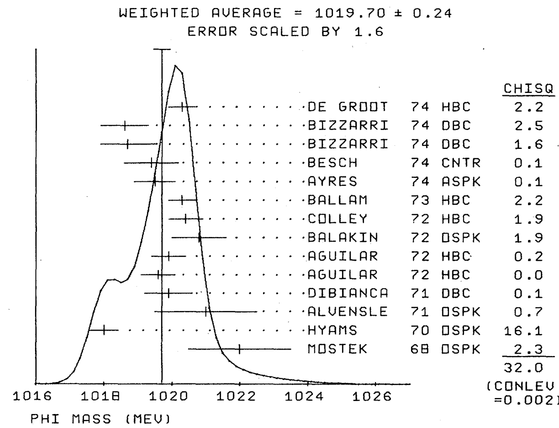


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                4  PHI WICTH (MEV)

W   S   20   (3.5)     (1.0)              MILLER D   65 HBC      0.0 PBAR P      .12/75*
W   S   41   (6.0)     (4.0)              LONDON     66 HBC      2.2 K-P          12/75*
W   S   46   (1.8)     (3.0)     (1.5)    ABRAMS     67 HBC     4.2 K- P          12/75*
W      165   (4.5)     (3.0)     (2.0)    MOSTEK     68 OSPK    1.8 GAMMA + C      6/68
W      150    4.2       0.9               AUGUSTIN   69 OSPK    E+ E- COLL.BEAMS.12/72
W             4.09      0.29              BIZOT      70 OSPK    E+ E- COLL.BEAMS 12/72
W      136    3.3       1.5       0.9     HYAMS      70 OSPK    11. PI- P          6/70
W    D  87    4.67      2.02              BALAKIN    71 OSPK     E+ E- COLL.BEAM 12/75*
W    D  70    5.5       2.6               DIBIANCA   71 DBC     4.93 K- N         12/75*
W      110   (4.5)     (3.0)     (4.0)    STOTTLEMY  71 HBC     2.9 K-P,Y K KBAR 11/71
W    D 120    4.6       1.7               AGUILAR    72 HBC     3.9,4.6 K- P      12/75*
W    D 100    4.7       1.9               AGUILAR    72 HBC     3.9,4.6 K- P      12/75*
W    D 131    5.0       1.8               COLLEY     72 HBC     10.K+ P,K+ P PHI 12/75*
W    D 100    3.8       1.5               BALLAM     73 HBC     2.8 - 9.3 G P     12/75*
W             3.81      0.37              COSME 2    74 OSPK    E+E- COLL.BEAMS    2/74
W    D 500    4.5       0.8               AYRES      74 ASPK    3-6PI/K-P,K+K-    12/75*
W    D 984    4.4       0.6               BESCH      74 CNTR    2 GAMMA P,PK+K-   12/75*
W   S   54   (6.8)     (3.1)     (2.5)    BIZZARRI   74 CBC     0 PBAR N,K+K- PI 12/75*
W   S   71   (4.1)     (3.8)     (3.6)    BIZZARRI   74 CBC     0 PBAR N,KLKS PI 12/75*
W    D 170    4.2       1.3               DE GROOT   74 HBC     4.2 K-P,L K+K-    12/75*
W          . . . . . . . . .
W   AVG       4.09      0.19     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT   4.09      0.21     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W   S   INSIGNIFICANT DATA WITH SMALL STATISTICS NO LONGER AVERAGED
W    D  WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N)

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                4  PHI PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     PHI INTO K+ K-                                   493+ 493
P2     PHI INTO KL KS                                   497+ 497
P3     PHI INTO PI+ PI- PIO (INCLUDING RHO PI)          139+ 139+ 134
P4     PHI INTO ETA GAMMA                               548+   0
P5     PHI INTO E+ E-                                    .5+  .5
P6     PHI INTO MU+ MU-                                 105+ 105
P7     PHI INTO PIO GAMMA                               134+   0
P8     PHI INTO PI+ PI- (VICLATES G)                    139+ 139
P9     PHI INTO PI+PI-GAMMA                             139+ 139+   0
P10    PHI INTO OMEGA GAMMA (VICLATES C)                783+   0
P11    PHI INTO ETA PIO (VICLATES C)                    548+ 134
P12    PHI INTO RHO GAMMA (VIOLATES C)                  773+   0
P13    PHI INTO ETA NEUTRALS
P14    PHI INTO 5PI

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<u>FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS</u>

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The <u>diagonal</u> elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the <u>off-diagonal</u> elements are the <u>normalized</u> correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

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         P 1          P 2          P 3          P 4
P 1 .4661+-.0232
P 2   -.7766   .3503+-.0203
P 3   -.4924     -.1451  .1642+-.0145
P 4   -.0748     -.0598     -.0399  .0195+-.0035

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                4  PHI BRANCHING RATIOS

R1      PHI INTO (K+ K-)/(KKBAR + PI+ PI- PIO)              (P1)/(P1+P2+P3)
R1  B    27    (0.26)    (0.06)             BADIER    65 HBC                      10/66
R1      252     0.48      0.04              LINDSEY   66 HBC       2.7 K-P        10/66
R1  C          (0.493)   (0.044)            BIZOT     70 OSPK    E+ E- COLL.BEAMS 11/71
R1  C SUPERSEDED BY CHATELLS 71                                                   11/71
R1              0.540     0.034             BALAKIN   71 OSPK     E+ E- COLL.BEAM 11/71
R1              0.486     0.044             CHATELUS  71 OSPK    E+ E- COLL.BEAMS 11/71
R1      270     C.49      0.06              DE GROCT  74 HBC     4.2 K-P,L PHI    12/75*
R1         . . . . . . . . .
R1  AVG         0.505     0.021   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  STUDENT     0.504     0.024   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1  FIT         0.475     0.024  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.6)
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Data Card Listings

For notation, see key at front of Listings.

Mesons

$\phi(1020)$, M(1033), $B_1(1040)$

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R2      PHI INTO (KL KS)/(KKBAR + PI+ PI- PIO)              (P2)/(P1+P2+P3)
R2  B   25    (0.23)    (0.06)        BADIER    65 HBC                       10/66
R2     167     0.40      0.04         LINDSEY   66 HBC       2.7 K-P         10/66
R2             0.257     0.038        BALAKIN   71 OSPK    E+ E- COLL.BEAMS. 1/73
R2     270     0.37      0.05         DE GROOT  74 HBC     4.2 K-P,L PHI     12/75*
R2           . . . . . . . . . .
R2  AVG        0.335     0.046   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
R2  STUDENT    0.342     0.034   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2  FIT        0.357     0.021  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.6)

R5      PHI INTO (KL KS)/(K KBAR)                           (P2)/(P1+P2)
R5      10     0.40      0.10         SCHLEIN   63 HBC       2.0 K-P         10/66
R5      52     0.48      0.07         BADIER    65 HBC       3.0 K-P         11/67
R5             0.44      0.07         LONDON    66 HBC       2.2 K-P        .10/66
R5           . . . . . . . . . .
R5  AVG        0.448     0.044   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  STUDENT    0.448     0.048   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R5  FIT        0.429     0.025  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)

R6      PHI INTO (PI+ PI- PIO (INCL.RHO PI))/(K KBAR)       (P3)/(P1+P2)
R6             0.30      0.15         LONDON    66 HBC       2.2 K-P         10/66
R6           . . . . . . . . . .
R6  FIT        0.201     0.021  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R7      PHI INTO (PI+ PI- PIO (INCL.RHO PI))/(KL KS)        (P3)/(P2)
R7          (0.3)   OR LESS           BERLEY    65 HBC       2.9 PI+P        10/66
R7             0.69      0.14         BIZOT1    70 OSPK    E+ E- COLL.BEAM    1/71
R7             0.47      0.06         COSME 1   74 OSPK    E+E- COLL.BEAMS    2/74
R7           . . . . . . . . . .
R7  AVG        0.504     0.080   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R7  STUDENT    0.501     0.063   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R7  FIT        0.469     0.053  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R8      PHI INTO (PI+ PI-)/(K KBAR) (SEE ALSO R18)          (P8)/(P1+P2)
R8          (0.2)   OR LESS           LONDON    66 HBC       2.2 K-P         10/66

R9      PHI INTO (E+ E-)/(K+ K-) (UNITS 10**-4)             (P5)/(P1)
R9       (SEE ALSO R16)
R9      40     6.1       1.7          BECKER    68 CNTR          GAMMA C      9/68

R10     PHI INTO (MU+ MU-)/TOTAL (UNITS 10**-4)             (P6)
R10            3.5       3.5      1.8 WEHMANN   68 OSPK     12 K- C           6/68
R10            2.34      1.01         MOY       69 CNTR      PHOTOPROD.      11/70
R10            2.17      0.60         EARLES    70 CNTR      6.0 BREMSSTR.   11/70
R10            2.69      0.46         HAYES     71 CNTR     PHOTOPROD.      .11/71
R10          . . . . . . . . . .
R10 AVG        2.50      0.34    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R10 STUDENT    2.50      0.37    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R11     PHI INTO (ETA GAMMA)/TOTAL                          (P4)
R11     27     0.073     0.019        BASILE    72 CNTR     1.8 PI- P        12/72
R11     25     0.026     0.007        BENAKSAS  72 OSPK    E+E- COLL.BEAMS .  2/73
R11     54     0.015     0.004        COSME     75 OSPK    E+E- COLL.BEAMS   12/75*
R11          . . . . . . . . . .
R11 AVG        0.0195    0.0050  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
R11 STUDENT    0.0189    0.0042  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R11 FIT        0.0195    0.0035 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R12     PHI INTO (PI+ PI- GAMMA)/TOTAL                      (P9)
R12         (0.04) OR LESS            LINDSEY   65 HBC       2.7 K-P          2/74
R12         (0.007)OR LESS  CL=.90    COSME 1   74 OSPK    E+E- COLL.BEAMS    2/74
R12          (.06) OR LESS  CL=.90    KALBFLEI  75 HBC     2.2 K- P,GAMMA + 12/75*

R13     PHI INTO (ETA NEUTRALS)/(K KBAR)                    (P13)/(P1+P2)
R13         (0.15) OR LESS            LINDSEY   66 HBC       2.7 K-P         10/66

R14     PHI INTO (OMEGA GAMMA) / TOTAL                      (P10)
R14         (0.05) OR LESS            LINDSEY   66 HBC       2.7 K-P         10/66

R15     PHI INTO (RHO GAMMA) / TOTAL                        (P12)
R15         (0.02) OR LESS            LINDSEY   66 HBC       2.7 K-P         10/66

R16     PHI INTO (E+ E-)/TOTAL (UNITS 10**-4)               (P5)
R16      (SEE ALSO R9)
R16 A    5    (6.6)     (4.4)     (2.8) ASTVACATU 68 OSPK    4 PI- P          6/68
R16 A    ERROR OF ASTVACATUROV 68 DOES NOT INCLUDE SIGMA(PHI) UNCERTAINTY.    6/68
R16     27     7.2       3.9          BINNIE    68 OSPK     1.6 PI- P       . 6/68
R16      9     6.1       2.6          BOLLINI   68 CNTR     1.9 PI- P         9/68
R16 C        (3.45)    (0.27)         BIZOT     70 OSPK    E+ E- COLL.BEAMS 11/71
R16 C SUPERSEDED BY CHATELUS 71                                             11/71
R16            2.81      0.25         BALAKIN   71 OSPK     E+ E- COLL.BEAM 11/71
R16            3.50      0.27         CHATELUS  71 OSPK    E+ E- COLL.BEAMS 11/71
R16            3.3       0.3          COSME 1   74 OSPK    E+E- COLL.BEAMS    2/74
R16          . . . . . . . . . .
R16 AVG        3.19      0.21    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R16 STUDENT    3.21      0.19    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R17     PHI INTO (PIO GAMMA)/(TOTAL)                        (P7)
R17      7    (0.0025) (0.0012)       BENAKSAS  72 OSPK    E+E- COLL. BEAMS   2/73
R17     32     0.0014    0.0005       COSME     75 OSPK    E+E- COLL.BEAMS   12/75*

R18     PHI INTO (PI+ PI-)/(TOTAL) (UNITS 10**-4)           (P8)
R18      (SEE ALSO R8)
R18         (50.)   OR LESS  CL=.95   BIZOT2    70 OSPK    E+ E- COLL.BEAMS 11/71
R18         (80.)   OR LESS  CL=.95   BALAKIN   71 OSPK     E+ E- COLL.BEAM   1/71
R18         (2.7)   OR LESS  CL=.95   ALVENSLE  72 OSPK    GAMMA+C            1/72

R19     PHI INTO (KL KS)/(K+ K-)                            (P2)/(P1)
R19    144     0.89      0.10         AGUILAR   72 HBC     3.9,4.6 K- P      12/72
R19    125     1.15      0.15         COLLEY    72 HBC     10.K+ P,K+ P PHI  12/72
R19          . . . . . . . . . .
R19 AVG        0.97      0.12    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R19 STUDENT    0.966     0.099   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R19 FIT        0.752     0.076  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)

R20     PHI INTO (PI+ PI- PIO(INCL.RHO PI)/(K+ K-)          (P3)/(P1)
R20     34     0.28      0.09         AGUILAR   72 HBC     3.9,4.6 K- P      12/72
R20          . . . . . . . . . .
R20 FIT        0.352     0.043  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R21     PHI INTO (2PI+ 2PI- PIO)/(K+ K-)
R21         (0.02) OR LESS  CL=0.95   AGUILAR   72 HBC     3.9,4.6 K- P     .12/72

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REFERENCES FOR PHI


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BERTANZA 62 PRL 9 180         BERTANZA,BRISSON,CONNOLLY,HART + (BNL+SYRA)
GELFAND  63 PRL 11 438        GELFAND,MILLER,NUSSBAUM,KIRSCH+ (COLU+RUTG)
  GELFAND 63 DATA INCLUDED IN MILLER 65 BELOW
SCHLEIN  63 PRL 10 368        SCHLEIN,SLATER,SMITH,STORK,TICHO       (UCLA)

BADIER   65 PL 17 337         BADIER,DEMOULIN,BARLOUTAUD+       (SACL+ZEEM)
BERLEY   65 PR 139 B 1097     D BERLEY,N GELFAND             (BNL+COLUMBIA)
GALTIERI 65 PRL 14 279        A BARBARO GALTIERI,R D TRIPP            (LRL)
LINDSEY  65 PRL 15 221        JAMES S LINDSEY,GERALD A SMITH          (LRL)
  LINDSEY 65 DATA INCLUDED IN LINDSEY 66 BELOW
MILLER D 65 CU-237(NEVIS 131) DAVID C MILLER  (THESIS)           (COLUMBIA)

GRAY, L  66 PRL  17  501      +HAGERTY,BIZZARRI,CIAPETTI +    (SYRA+ROMA)JPG
LINDSEY  66 PR  147  915      JAMES S LINDSEY, GERALD A SMITH         (LRL)
LINDSEY1 66 PL 20 93          J.S.LINDSEY, G.A.SMITH                  (LRL)
  LINDSEY 1 66 DATA INCLUDED  IN LINDSEY 66 ABOVE
LONDON   66 PR 143 1034       LONDON,RAU,SAMIOS,GOLDBERG + (BNL+SYRACUSE)

ABRAMS   67 MD TECH REP 720   GERALD ABRAMS , THESIS             (MARYLAND)
BARLOW   67 NC 50A 701        +LILLESTOL+MONTANET+  (CERN+CDEF+IRAD+LIVP)
CHASE    67 PRL 18 710        R.C.CHASE,P.ROTHWELL,R.WEINSTEIN (CEA+NEAS)
DAHL     67 PR 163 1377       +HARDY+HESS+KIRZ+MILLER                 (LRL)
HERTZBAC 67 PR 155  1461      HERTZBACH,KRAEMER,MADANSKI,ZDANIS+(JHU+BNL)
KHACHATU 67 PL 24B 349        KHACHATURYAN+AZIMOV+BALDIN+BELOUSOV+(DUBNA)

ABRAMS   68 PR 175 1697       +GLASSER,KEHOE,SECHI-ZORN,WOLSKY (MARYLAND)
ASTVACAT 68 PL 27 B  45       ASTVACATUROV,AZIMOV,BALDIN+    (JINR+MOSCOW)
    ALSO 67 PRL 19 869        ASBURY,BECKER,BERTRAM,TING+ (DESY+COLUMBIA)
BECKER   68 PRL 21 1504       +BERTRAM,BINKLEY,JORDAN,KNASEL+  (DESY+MIT)
BINNIE   68 PL 27B 106        +DUANE+FARUQI+HORSEY+           (LOIC+RHEL)
BOLLINI  68 NC 56 A 1171      +BUHLER,DALPIAZ,MASSAM+     (CERN+BGNA+STRB)
MOSTEK   68 PRL 20 1057       +EISENHANDLER,MCCLELLAN,MISTRY+   (CORNELL)
WEHMANN  68 PRL 20 748        +ENGELS+ (HARVARD+CASE+SLAC+CORNELL+MCGILL)

AUGUSTIN 69 PL 28 B 517       +BIZOT,BUON,DELCOURT,HAISSINSKI,+   (ORSAY)
BALAKIN  69  IYAF 327 TRANS   +BUDKER,KORSHUNOV,MISHNEV,SIDOROV+   (NOVO)
    ALSO 69 SIDOROV
MOY      69  THESIS           KEN MIN MOY       (NORTHEASTERN UNIVERSITY)
SCOTTER  69 NC 62 A 1057      +ERSKINE,PALER,+  (BIRM+GLAS+LOIC+MPIM+OXF)
SIDOROV  69 LIVERPOOL SYMP.ON ELECTRONS+PHOTONS,P.227, SIDOROV      (NOVO)

BALAKIN  70  PREPRINT         +BUTLER,PAKHTUSOVA,SIDOROV,SKRINSKY,+(NOVO)
BIZOT    70 PL 32 416         +BUON,CHATELUS,JEANJEAN,LALANNE,+    (ORSA)
    ALSO 69 PEREZ-Y-JORBA, LIVERPOOL SYMP.69
BIZOT1   70  PRIV.COMM.       PEREZ-Y-JORBA                        (ORSA)
BIZOT2   70 LNC 4 1273        +DELCOURT,JEANJEAN,LALANNE,+        (ORSAY)
EARLES   70 PRL 25 1312       +FAISSLER,GETTNER,LUTZ,MOY,TANG,+    (NEAS)
HYAMS    70 NP B 22 189       +KOCH,POTTER,V.LINDERN,LORENZ,LUTJENS(CERN)

ALVENSLE 71 PRL 27 441        ALVENSLEBEN,BECKER,BUSZA,CHEN,+  (MIT+DESY)
BALAKIN  71 PL 34 B 328       +BUDKER,PAKHTUSOVA,SIDOROV,SKRINSKY,+(NOVO)
DIBIANCA 71 NP B 35 13        +EINSCHLAG,ENDORF,ENGLER,FISK,+      (CORN)
CHATELUS 71  LAL 1247(THESIS) Y.CHATELUS                     (STRASBOURG)
HAYES    71 PR D 4 899        +IMLAY,JOSEPH,KEIZER,STEIN           (CORN)
STOTTLEM 71  ORO 2504 170     A.R.STOTTLEMYER,THESIS             (MARYLAND)

AGUILAR  72 PR D 6 29         AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS   (BNL)
ALVENSLE 72 PRL 28 66         ALVENSLEBEN,BECKER,BIGGS,BINKLEY+(MIT+DESY)
BALAKIN  72 PL 40 B 431       +BOKIN,PAKHTUSOVA,SIDOROV,+   (NOVOSIBIRSK)
BASILE   72 NP B 44 605       +DALPIAZ,FRABETTI,ZICHICHI+(CERN+BGNA+STRB)
BENAKSAS 72 PL 42 B 511       +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE+(ORSAY)
COLLEY   72 NP B 50 1         +JOBES,RIDDIFORD,GRIFFITHS,+     (BIRM+GLAS)

BALLAM   73 PR D 7 3150       +CHADWICK,EISENBERG,BINGHAM,+    (SLAC+LBL)

AYRES    74 PRL 32 1463       +DIEBOLD,GREENE,KRAMER,LEVINE,+       (ANL)
BESCH    74 NP B70 257        +HARTMANN,KOSE,KRAUTSCHNEIDER,PAUL,+ (BONN)
BIZZARRI 74 NC 20A 393        +CIAPETTI,DIONISI,DORE,GASPERO+      (ROMA)
COSME 1  74 PL 48 B 155       +JEAN-MARIE,JULLIAN,LAPLANCHE,+     (ORSAY)
COSME 2  74 PL 48 B 159       +JEAN-MARIE,JULLIAN,LAPLANCHE,+     (ORSAY)
DE GROOT 74 NP B74 77         +HOOGLAND,JONGEJANS,METZGER+    (AMST+NIJM)

COSME    75  PREPRINT LAL1279 +COURAU,DUDELZAK,GRELAUD,JEAN-MARIE+(ORSAY)
KALBFLEI 75 PR D11 987        KALBFLEISCH,STRAND,CHAPMAN       (BNL+MICH)
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M(1033)
→MM

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67  M(1033)

EVIDENCE NOT COMPELLING.OMITTED FROM TABLE.

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                    67  M(1033) MASS  (MEV)

M  N   240 1032.6      2.3           GARFINKEL 72 MMS   0 2.4 PI- P,N MM    1/74
M  N    NOT SEEN BY BINNIE 74 AT 2 GEV/C.
M  N    NOT SEEN BY BUTTRAM 75 AT 2.4 GEV/C                                12/75*

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                    67  M(1033) WIDTH  (MEV)

W      240   16.2      4.8      7.5  GARFINKEL 72 MMS   0 2.4 PI- P,N MM   12/72

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REFERENCES FOR M(1033)


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GARFINKE 72 PRL 29 1477       GARFINKEL,HOFFMAN,JACOBEL,+ (PURD+ANL+IOWA)
BINNIE   74 PRL 32 392        +CAMILLERI,CARR,DEBENHAM,+       (LOIC+SHMP)

BUTTRAM  75 PRL 35 970        +CRAWLEY,DUKE,LAMB,LEEPER,PETERSON    (ISU)
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$B_1(1040)$
$\rightarrow\omega\pi$

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48  B1(1040)  IG=1+

EVIDENCE NOT COMPELLING. OMITTED FROM TABLE.

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                    48  B1(1040) MASS (MEV)

M    S    (1040.)                  DEFOIX    73 HBC  +- 0.7 PBAR P,7 PI   1/74
M    S  SEEN IN DECAY OF A2 INTO B1 PI. NOT SEEN BY DIAZ 74.

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                    48  B1(1040) WIDTH (MEV)

W    S      (55.)                  DEFOIX    73 HBC  +- 0.7 PBAR P,7 PI   1/74

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                    48  B1(1040) PARTIAL DECAY MODES

                                                       DECAY MASSES
P1     B1(1040) INTO OMEGA PI                         139+ 783

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Mesons

$B_1(1040)$, $\eta_N(1080)$, $A_1(1100)$

Data Card Listings

For notation, see key at front of Listings.

REFERENCES FOR B1(1040)

DEFOIX 73 PL 43 B 141 +DOBRZYNSKI,ESPIGAT,NASCIMENTO,+ (CDEF)
DIAZ 74 PRL 32 260 +DIBIANCA,FICKINGER,ANDERSCN,+ (CASE+CARN)

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$\eta_N(1080)$ $\to \pi\pi$

30 ETA N(1080, JPG=N +) I=0 J GREATER THAN 1
SOME EXPERIMENTS SUGGEST J=2.

OMITTED FROM TABLE

Note on $\pi^+\pi^-$ Peaks Called $\eta_N(1080)$

The $\eta_N(1080)$ is seen in $\pi^- p \to \pi^+\pi^- n$ predominantly at backward decay angles, $\cos\theta < -0.75$. OH 70 state that this "bump is almost certainly the result of P-D interference."

Note that the selection made in some bubble chamber experiments to reduce the background under the $\eta_N(1080)$ in the reaction $\pi^- p \to \pi^+\pi^- n$ may lead to a sample of events ambiguous with $\pi^- p \to p\pi^-\pi^0\pi^0$ (BATON 70 and private communications from G. Laurens).

30 ETA N MASS (MEV)

M		1060.0	15.0		MILLER	68	HBC	4.0 PI- P	9/68
M	70	1085.0	10.0		WHITEHEAD	68	ASPK	3.1-3.6 PI-P	10/67
M		1120.0	100.0	40.0	OH	69	HBC	7.PI- P,PI+ D	9/69
M		1112.0	16.0		CLAYTON	70	HBC	2.5 PBAR P,4 PI	1/71
M		(1080.0)			DIAZ	70	HBC	0. PBAR P, 4 PI	5/70
M		1070.0	20.0		REYNOLDS	70	HBC	2.26-2.36 PI- P	1/71
M		. . . .							
M	AVG	1083.3	9.8	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)					
M	STUDENT	1083.0	8.3	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT					

30 ETA N WIDTH (MEV)

W		(70.0)	OR LESS		MILLER	68	HBC	4.0 PI- P	9/68
W		(25.0)	OR LESS		WHITEHEAD	68	ASPK	3.1-3.6 PI-P	10/67
W		150.0	100.0	40.0	OH	69	HBC	7.PI- P,PI+ D	9/69
W		(80.0)			CLAYTON	70	HBC	2.5 PBAR P,4 PI	1/71
W		(80.0)			DIAZ	70	HBC	0. PBAR P, 4 PI	5/70
W		85.0	35.0		REYNOLDS	70	HBC	2.26-2.36 PI- P	1/71
W		. . . .							
W	AVG	98.0	31.3	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)					
W	STUDENT	97.7	34.5	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT					

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REFERENCES FOR ETA N

MILLER 68 PRL 21 1489 +GUTAY,JOHNSON,KENNEY+ (PURDUE+NDAM+SLAC)
WHITEHEA 68 NC 53 A 817 C.WHITEHEAD + (AERE+SHMP+LOIC)
OH 69 PRL 23 331 +WALKER,CARROLL,FIREBAUGH,+ (WISC+TNTO)
BATON 70 PL 33 B 528 +LAURENS,ZEIGNIER (SACLAY)
CLAYTON 70 NP B 22 85 +MASON,MUIRHEAD,RIGOPOULOS,+ (LIVP+ATEN)
DIAZ 70 NP B 16 239 +GAVILLET,LABROSSE,MONTANET,+ (CERN+CDEF)
REYNOLDS 70 NP B 21 77 +ALBRIGHT,BRADLEY,+ (OHIO+FSU+MINN+COLO)
WHITEHEA 72 NP B 48 365 WHITEHEAD,AULD,+ (AERE+RHEL+SHMP+LOUC)
DIAMOND 73 PR D 7 1977 +BINKLEY,+ (WISC+DUKE+COLO+TNTO+OHIO)

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$A_1(1100)$

10 A1(1100, JPG=1+-) I=1

The $A_1 \to \rho\pi$ bump has been mainly observed in the diffraction-like process $\pi N \to (\pi\pi\pi)N$ without quantum number exchange and at small momentum transfer. There are also observations of structure in the A_1 mass region in reactions where additional mesons are produced, in backward production (see however ABASHIAN 75), and in $\bar{p}p$ annihilations (see the Data Card Listings).

There is a special category of "diffractive mesons" consisting of statistically significant peaks like A_1, A_3, Q, and L (see the corresponding mini-reviews), which are not far above the respective $\rho\pi$, $f\pi$, $K^*(892)\pi$, and $K^*(1420)\pi$ thresholds. Because the behavior near threshold in these channels may be described by the Deck effect, a resonance interpretation is questionable. These peaks are included in the Meson Table, but we do not mean to imply that they are necessarily genuine resonances.

Other meson systems such as $K\omega$, $K\phi$, $K^*\bar{K}$ also exhibit low mass peaks when produced in reactions which may proceed without quantum number exchange (see for example DAVIS 72, CHUNG 74, THEOCHAROPOULOS 74, CARNEY 75, OTTER 75).

Partial-wave analyses of multi-meson systems in reactions like $\pi N \to (\pi\pi\pi)N$ are becoming available (ASCOLI 70). Several important assumptions are made in such analyses (see HANSEN 74, HERNDON 75 for detailed discussions), amongst which:

(a) for a given t, the 3π vertex is independent of the NN vertex;

(b) the 3π decay proceeds through quasi-two-body states ($\rho\pi$, $\epsilon\pi$,...) in the spirit of the isobar model (a partial-wave analysis with unitarity corrections to the isobar model is applied to the 3π system in ASCOLI 75; see also AARON 75, AITCHISON 75, and references therein).

The dominant effect in the A_1 mass region is a broad $J^P=1^+$ $\rho\pi$ S-wave enhancement, with a maximum intensity at $\sim$1100 MeV and a width $\sim$300 MeV (ANTIPOV1 73, KRUSE 74, OTTER 74, TABAK 74, THOMPSON 74, EMMS1 75). The phase of the $J^P=1^+$ wave shows little variation relative to various other "background" waves (see however the A_3 and Q mini-reviews). In contrast the A_2 peak has been confirmed as a resonance with a Breit-Wigner-like phase change of the $J^P=2^+$ partial wave (ASCOLI 70, ANTIPOV1 73, OTTER 74, TABAK 74, THOMPSON 74).

These results suggest that at most a small part of the A_1 enhancement corresponds to a $J^P=1^+$ resonance. Indeed ASCOLI1 73 and ASCOLI 74 show that the partial-wave structure of the 3π

Data Card Listings

For notation, see key at front of Listings.

Mesons

$A_1(1100)$

system is qualitatively reproduced by a Reggeized pion exchange model.

BOWLER 75 attempt to explain the lack of variation of the 1^+ phase by allowing for a phase difference between the Deck amplitude and a direct "A_1 resonance" production amplitude. Good fits to the data are obtained, but the A_1 is predicted to have $M \sim 1300$ MeV, $\Gamma \sim 250$ MeV.

Recent analyses of the $(3\pi)^0$ system produced by charge exchange find no evidence for A_1 production. WAGNER 75 study the reaction $\pi^+ p \to \pi^+\pi^-\pi^0\Delta^{++}$ at 7 GeV/c and are able to set an upper limit of 2 μb on the A_1 production cross section if $\Gamma < 150$ MeV. Analyzing $\pi^+ n \to \pi^+\pi^-\pi^0 p$ at 4 GeV/c, EMMS2 75 observe no A_1 with $M \sim 1100$ MeV, but cannot rule out resonance production above 1300 MeV.

References Not Included in the Data Card Listings

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- G. Otter et al., Nucl. Phys. B89, 201 (1975).
- G. Otter et al., Nucl. Phys. B96, 365 (1975).
- P. Theocharopoulos et al., Nucl. Phys. B83, 1 (1974).


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                    10   A1 MASS (MEV)

M    PRODUCED BY PI +
M          (1080.0)                     ADERHOLZ  64 HBC       4.0 PI+P
M          (1080.)   APPROX.            BOESEBECK 68 HBC  +    8 PI+ P           6/68
M          (1040.0)                     ARMENISE  70 HBC    0 9 PI+ N -- A1 P   1/71
M  F       (1128.)     (8.)             THOMPSO1  74 HBC  +  13 PI+P,P(3PI)+   12/75*
M
M    PRODUCED BY PI -
M          (1060.)                      ASCOLI    68 HBC   -0 5 PI-P           . 6/68
M          (1089.0)   (12.0)            BALLAM    68 HBC   - 16.0 PI- P          9/68
M          (1090.)   APPROX.            CHUNG     68 HBC   -  3.2,4.2 PI-P       2/67
M          (1055.0)    (6.0)            JUNKMANN  68 HBC   -  16. PI- P, 5PI     9/69
M   S      (1119.)    (30.)             KEY       68 HBC   -  3 PI-P             9/68
M   S        SHOULDER ON A2 ONLY
M          (1069.0)    (7.0)            CASO      70 HBC   - 11.2PI-P            5/70
M          (1120.0)                     CRENNELL  70 HBC   -  6. PI- P,F PI      5/70
M  F T     (1150.)                      ANTIPCV1  73 CNTR -  25.,40. PI- P       1/74
M    T  MASS AND WIDTH SEEN TO DEPEND ON T, UNIQUE DET. IMPOSSIBLE               1/74
M    PRODUCED BY PIONS,BACKWARDS SCATT.
M          (1115.0)   (20.0)            ANDERSON  69 MMS   -  16 PI- P,BACKW9   8/69
M
M    PRODUCED BY PBARS, SEE TYPED NOTE.
M          (1054.)     (7.)             DANYSZ    67 HBC  +-   3,3.6 PBAR P   . 7/67
M          (1042.)    (21.)             FRIDMAN   68 HBC  +-   5.7 PBAR P       6/68
M    A     (1076.)     (5.)             ATHERTON  73 HBC  +- 5.7 PBAR P         1/74
M    A   JP ANALYSIS GIVES SOME EVICENCE FOR RHO PI D-WAVE                      1/73
M
M    PRODUCED BY K-, SEE TYPED NOTE.
M          (1111.)    (10.)             ALLISON   67 HBC  +    6 K-P,LAM +5 PI  1/68
M          (1117.)    (3C.)             ALLISCN   67 HBC  +    6 K-P,LAM +4 PI  1/68
M          (1060.)    (15.)             JUHALA    67 HBC     0 4.6-5 K-P,5BCDY  1/68
M
M    PRODUCED BY K+, SEE TYPED NOTE.
M    K+    (1060.0)   (20.0)            ALEXANDER 69 HBC  +     9 K+P           9/69
M    K+    (1030.0)   (20.0)            BERLINGHI 69 HBC  + 0 12.7 K+ P         9/69
M    K+ FOR CONTRADICTORY EVIDENCE SEE RABIN 70 .
M
M  F    FRCM A FIT TO JP=1+ RHO PI PARTIAL WAVE
M
M    AVERAGING NOT MEANINGFUL

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                    10   A1 WIDTH (MEV)

W    PRODUCED BY PIONS, RESONANCE INTERP. CONFUSED BY DECK EFFECT

W    PRODUCED BY PI +
W          (80.0)                       ADERHOLZ  64 HBC       4.0 PI+P
W         (130.)    APPROX.             BOESEBECK 68 HBC  +    8 PI+ P           6/68
W          (50.0)   OR LESS             ARMENISE  70 HBC    0 9 PI+ N -- A1 P   1/71
W  F      (300.)    APPROX.             RINAUDO   71 HBC  +  5. PI+P,P (3PI)+  11/71
W  F      (367.)    (30.)               THOMPSO1  74 HBC  +  13 PI+P,P(3PI)+   12/75*
W
W    PRODUCED BY PI -
W         (140.0)   (31.0)              BALLAM    68 HBC   - 16.0 PI- P          9/68
W         (125.)    APPROX.             CHUNG     68 HBC   -  3.2,4.2 PI-P       2/67
W          (77.0)   (17.0)              JUNKMANN  68 HBC   -  16. PI- P, 5PI     9/69
W   K      (76.)    (46.)               KEY       68 HBC   - 3.0 PI- P          11/67
W   K       SHOULDER ON A2 ONLY
W          (99.0)   (15.0)              CASO      70 HBC   - 11.2PI-P            5/70
W  F T    (300.)                        ANTIPOV1  73 CNTR -  25.,40. PI- P       1/74
W    T  MASS AND WIDTH SEEN TO DEPEND ON T, UNIQUE DET. IMPOSSIBLE               1/74
W
W    PRODUCED BY PIONS,BACKWARDS SCATT.
W          (98.0)   (45.0)   (20.0)     ANDERSON  69 MMS   -  16 PI- P,BACKW9   8/69
W
W    PRODUCED BY PBARS, SEE TYPED NOTE.
W          (33.)    (19.)               DANYSZ    67 HBC  +-   3,3.6 PBAR P     7/67
W         (130.)    APPROX.             FRIDMAN   68 HBC  +-   5.7 PBAR P       6/68
W   A      (36.)    (20.)    (15.)      ATHERTON  73 HBC  +- 5.7 PBAR P         1/74
W   A    JP ANALYSIS GIVES SOME EVIDENCE FOR RHO PI D-WAVE                      1/73
W
W    PRODUCED BY K-, SEE TYPED NOTE.
W          (50.)    (50.)               ALLISON   67 HBC  +    6 K-P,LAM +4 PI  1/68
W          (50.)    (25.)               ALLISON   67 HBC  +    6 K-P,LAM +5 PI  1/68
W         (120.)    (15.)               JUHALA    67 HBC     0 4.6-5 K-P,5BCDY  1/68
W
W    PRODUCED BY K+, SEE TYPED NOTE.
W         (160.0)   (20.0)              ALEXANDER 69 HBC  +     9 K+P           9/69
W   B     (120.0)   (30.0)              BERLINGHI 69 HBC       12.7 K+ P         8/69
W    K+ FOR CONTRADICTORY EVIDENCE SEE RABIN 70 .
W         (130.0)   (20.0)              BERLINGHI 69 HBC  + 0 12.7 K+ P         9/69
W
W  F    FROM A FIT TO JP=1+ RHO PI PARTIAL WAVE
W
W    AVERAGING NOT MEANINGFUL

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                    10   A1 PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      A1 INTO RHO PI                                      773+ 139
P2      A1 INTO KBAR K                                      493+ 497

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                    10   A1 BRANCHING RATIOS

R1      A1 INTO (KBAR K)/(RHO PI)                           (P2)/(P1)
R1          (0.0025)OR LESS        DAHL      67 HBC   -  4.0 PI- P        .10/66

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REFERENCES FOR A1


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BELLINI   63 NC 29 896           BELLINI,FIORINI,HERZ,NEGRI,RATTI     (MILAN)

ADERHOLZ  64 PL 10 226           AACH+BERL+BIRM+BONN+DESY+HAMBURG+LOIC+MPIM
GOLDHABE  64 PRL 12 336          GOLDHABER,BROWN,KADYK,SHEN+        (LRL+UCB)
LANDER    64 PRL 13 346 A        LANDER,ABOLINS,CARMONY,HENDRICKS +    (UCSD)  JP

ABOLINS   65 ATHENS(OHIO)CONF.   +CARMONY,LANDER,XUONG,YAGER       (LA JOLLA)I=1
ALITTI    65 PL 15 69            ALITTI,BATON,DELER,CRUSSARD+      (SACL+BGNA)

ALLARD    66 NC 46A 737          +DRIJARD+HENNESSY+    (ORSAY+MILAN+SACL+UCB)
DEUTSCHM  66 PL 20 82            DEUTSCHMANN,STEINBERG +  (AACH+BERLIN+CERN)
HESS      66 UCRL-16832          R I HESS (THESIS, BERKELEY)              (LRL)

ALLISCN   67 PL 25B 619          +CRUZ+        (OXF+MPIM+BIRM+RHEL+GLAS+LOIC)
DAHL      67 PR 163 1377         +HARDY+HESS+KIRZ+MILLER                  (LRL)
DANYSZ    67 NC 51 A 801         DANYSZ+FRENCH+SIMAK                     (CERN)
JUHALA    67 PRL 19 1355         +LEACOCK+RHODE+KOPELMAN+           (IOWA+COLO)
SLATTERY  67 NC 50A 377          +KRAYBILL+FORMAN+FERBEL            (YALE+ROCH)  JP

ARMENISE  68 PL 26 B  336        +FORINO+CARTACCI+      (BARI+BGNA+FIRZ+ORSAY)
ASCOLI    68 PRL 21 113          +CRAWLEY,KRUSE,MORTARA,SCHAFER,+ (ILLINOIS)
BALLAM    68 PRL 21 934          +BRODY,CHADWICK,FRIES,GUIRAGOSSIAN+   (SLAC)JP
BOESEBEC  68 NP B 4 501          BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CASO      68 NC 54 A 983         +CONTE+CORDS+DIAZ+  (GENOVA+HAMB+MILA+SACL)
CHUNG     68 PR 165 1491         S.U.CHUNG,O.DAHL,J.KIRZ,D.H.MILLER       (LRL)
CNOPS     68 PRL 21 1609         +HOUGH,COHN,BUGG+ (BNL+ORNL+UCND+TENN+PENN)
FRIDMAN   68 PR 167 1268         +MAURER,MICHALON,OUDET+     (HEID+STRASBOURG)
JUNKMANN  68 NP B8 471           +COCCONI+           (AACH+BERL+BONN+CERN+WARS)
KEY       68 PR 166 1430         +PRENTICE+COOPER+MANNER+       (TNTO+ANL+WISC)

ALEXANDE  69 PR 183 1168         G.ALEXANDER,A.FIRESTONE,G.GOLDHABER      (LRL)
ALLABY    69 PL 29B 198          +BINON+DIDDENS+DUTEIL+KLOVNING+...      (CERN)
ANDERSCN  69 PRL 22 1390         +COLLINS,+                          (BNL+CARN)
BERLINGH  69 PRL 23 42           BERLINGHIERI,FARBER,+                   (ROCH)
DONALD    69 NP B 11 551         +EDWARDS,BURAN,BETTINI,+     (LIVP+OSLO+PADO)
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Mesons

$A_1(1100)$, M(1150), $A_{1.5}(1170)$, ε(1200)

Data Card Listings

For notation, see key at front of Listings.

FAYOLLE 69 NP B 13 40 +DE MONTAIGNAC,MORAND,STRACHMAN+ (PARIS)
JUHALA 69 PR 184 1461 +LEACOCK,RHODE,KOPELMAN,LIBBY,+ (ISU+COLO)
KENYON 69 PRL 23 146 +KINSON,SCARR,+ (BNL+UCND+ORNL)

ARMENISE 70 LNC 4 199 +GHIDINI,FORING,CARTACCI,+ (BARI+BGNA+FIRZ)
ASCOLI 70 PRL 25 962 +BROCKWAY,CRAWLEY,EISENSTEIN,HANFT,+ (ILL) JP
BRANDENB 70 NP B16 369 +BRENNER,IOFFREDO,JOHNSON,KIM+ (HARVARD)
CASO 70 LNC 3 707 +CORDS,COSTA+ (GENO+DESY+HAMB+MILA+SACL)
ALSO 68 CASO
CRENNELL 70 PRL 24 781 +KARSHON,LAI,SCARR,SIMS (BNL)
CHIEN1 70 TORONTO PREPRINT +CHAO,JOHNSTON,PRENTICE,WALKER (TNTO+WISC)
CHIEN2 70 JHU 7011 C.Y.CHIEN (JOHNS HOPKINS)
GARELICK 70 PHILAD.CONF.P.205 C.A.GARELICK,REVIEW (NORTHEASTERN)
RABIN 70 PRL 24 925 +GALTIERI,DERENZO,FLATTE,FRIEDMAN+ (LRL)
SHIH 70 BNL 14059-REV +YOUNG (BNL)

ASCOLI 71 PRL 26 929 ILLINOIS+GENO+HAMB+MIL+SACL+HARV+TNTO+WISC
BEMPORAD 71 NP B 33 397 +BEUSCH,MELISSINOS,+ (CERN+ETHZ+LOIC+MILA)
BERGER 71 PHENOMENOLOGY IN PARTICLE PHYSICS, CALTECH 1971 (LRL)
RINAUDO 71 NC 5 A 239 +BOECKMANN,MAJOR+(TORI+BONN+DURH+NIJM+EPOL) JP .

BERENYI 72 NP B 37 621 +PRENTICE,STEENBERG,YOON,WALKER (TNTO+WISC)
BLOODWOR 72 NP B 46 402 BLOODWORTH,JACKSON,PRENTICE,YOON (TORONTO)
DIEBOLD 72 BATAV.CONF. R.DIEBOLD RAPPORTEUR TALK (ANL)
LAMSA 72 NP B 41 388 +EZELL,GAIDOS,WILLMANN (PURDUE)
MORSE 72 NP B 43 77 +OH,WALKER,JOHNSTON,YOON (WISC+TNTO)

ANTIPOV1 73 NP B 63 153 +ASCOLI,BUSNELLO,FOCACCI,+ (CERN+SERP) JP
ANTIPOV2 73 NP B 63 141 +ASCOLI,BUSNELLO,FOCACCI,+ (CERN+SERP) JP
ARNOLD 73 NC 17 A 393 +ENGEL,ESCOUBES,GEMESY,JANCSSY,+(STRB+BUDA)
ASCOLI 1 73 PR D 8 3894 +JONES,WEINSTEIN,WYLD (ILL)
ASCOLI 2 73 PRL 31 795 +CHAPIN,CUTLER,HOLLOWAY,KOESTER,KRUSE+(ILL) JP
ATHERTON 73 PL 43 B 249 +FRANEK,FRENCH,GHIDINI,HILPERT,+ (CERN)
READ 73 NP B 64 511 B.J.READ (DESY)

BOWLER 74 NP B74 493 +DAINTON,KADDOURA,AITCHISON (OXF)
ASCOLI 74 PR D9 1963 +CUTLER,JONES,KRUSE,ROBERTS,WEINSTEIN+(ILL)
KRUSE 74 PRL 32 1328 +ROBERTS,EDELSTEIN+ (ILL+CARN+NWES+ROCH) JP
LICHTMAN 74 NP B81 31 +BISWAS,CASON,KENNEY,MCGAHAN,+ (NDAM) JP
OTTER 74 NP B80 1 +RUDOLPH+ (AACH+BERL+BONN+CERN+HEID) JP
TABAK 74 BOSTON +RONAT,ROSENFELD,LASINSKI+ (LBL+SLAC) JP
THOMPSO1 74 PR D9 560 THOMPSON,GAIDOS,MCILWAIN,WILLMANN (PURD) JP
THOMPSO2 74 NP B69 381 THOMPSON,BADEWITZ,GAIDOS,MCILWAIN+ (PURD) JP

ABASHIAN 75 PRL 34 691 +BEAMER,BROSS,EISENSTEIN,+ (ILL+ANL+ISU)
BEUSCH 75 PL 55B 97 +POLGAR,FREUDENREICH+ (CERN+ETHZ+LOIC+MILA)
BOWLER 75 NP B97 227 +GAME,AITCHISON,DAINTON (OXF+CARE)
DIAZ 75 PR 12 D 1272 +DIBIANCA,FICKINGER,DADO,ENGLER+(CASE+CARN) JP
EMMS 1 75 NP B93 1 +JONES,KINSON,BELL,DALE+ (BIRM+DURH+RHEL) JP
EMMS 2 75 PL 60 B 109 +JONES,KINSON,BELL,DALE+ (BIRM+DURH+RHEL) JP
HORNE 75 PR D11 996 +S.HAGOPIAN,V.HAGOPIAN,BENSINGER+(FSU+BRAN)
KANE 75 TENTH RENCONTRE DE MORIOND (MICH)
WAGNER 75 PL 58B 201 +TABAK,CHEW (LBL) JP

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M(1150) →MM

68 M(1150)

EVIDENCE NOT COMPELLING.OMITTED FROM TABLE.

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68 M(1150) MASS (MEV)

M N 65 1148.3 3.3 JACOBEL 72 MMS 0 2.4 PI- P,N MM 12/72
M N NOT SEEN BY BUTTRAM 75 AT 2.4 GEV/C 12/75*

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68 M(1150) WIDTH (MEV)

W 65 15.0 9.0 11.7 JACOBEL 72 MMS 0 2.4 PI- P,N MM 12/72

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REFERENCES FOR M(1150)

JACOBEL 72 PRL 29 671 +GARFINKEL,HOFFMAN,+ (IOWA+PURD+ANL)

BUTTRAM 75 PRL 35 970 +CRAWLEY,DUKE,LAMB,LEEPER,PETERSON (ISU)

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$A_{1.5}(1170)$ →3π

44 A 1.5(1170, JPG= -) I=1

THIS ENTRY LISTS REFERENCES TO PEAKS OF LOW STATISTICAL SIGNIFICANCE IN THE 3 PI SYSTEM BETWEEN THE A1 AND THE A2. CMITTED FROM TABLE.

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REFERENCES FOR A 1.5

BUTTERWO 67 HEIDELB.CONF.P.28 REVIEW TALK ON MESONS AT HEIDELBERG CONF.
CASON 67 PRL 18 880 +LAMSA,BISWAS,DERADO,GROVES,+ (NOTREDAME)
ASCOLI 68 PRL 21 113 +CRAWLEY,KRUSE,MORTARA,SCHAFER,+ (ILLINOIS)
DONALD 68 PL 26 B 327 +FRODESEN,BETTINI,+ (LIVERPOOL,OSLO,PADUA)
VON KROG 68 PL 27B 253 +MIYASHITA,KOPELMAN,MARSHALL LIBBY (COLO)
JUNKMANN 68 NP B8 471 +COCCONI+ (AACH+BERL+BONN+CERN+WARS)
ARMENISE 69 LNC 2 501 +GHIDINI,FORINO,CARTACCI+ (BARI+BGNA+FIRZ)
GALLOWAY 70 PR D 1 3077 +MOTT,ALYEA,LEE,MARTIN,PRICKETT (IND)
MORSE 72 NP B 43 77 +OH,WALKER,JOHNSTON,YOON (WISC+TNTO)

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ε(1200)

14 PI PI S WAVE, CALLED EPSILON

S-Wave ππ Interactions in the Region 280-1800 MeV

In this note, we discuss information on the isoscalar ππ S-wave in terms of its phase shift δ_0^0, from threshold to 1800 MeV.

The threshold behavior of elastic ππ scattering involves S and P waves which can be sufficiently well described by the scattering lengths a_0^0, a_1^1, and a_0^2. In spite of many attempts (see PILKUHN 73, BONNIER 74, PASCUAL 74, RIESTER 75, SRINIVASAN 75), the determination of these parameters still meets with great difficulties (BASDEVANT 73, 75). The parameters a_0^0 and a_0^2 are strongly correlated and must lie in a narrow band in the (a_0^0, a_0^2)-plane (MORGAN2 70). Thus if a_0^0 is fixed, a_0^2 and a_1^1 are determined within small uncertainties (BASDEVANT 72, 75). However, all one knows is a region of finite extent within which a_0^0 must lie. It is therefore not established whether, e.g., the Weinberg predictions are supported by experiment.

Near threshold the S wave shows no resonant behavior. The so-called ABC and DEF effects (BOOTH 63, HALL 69, BRODY 70, 72, BANAIGS 71, 73) occur only on nuclear targets (d, H^3, He^3) and move when kinematical conditions change. Thus they must be kinematical effects (DUBAL 71, BRODY2 72, RISSER 73, BAR-NIR 75, BARRY 75).

The region of elastic ππ scattering is known to extend from threshold to about 990 MeV, near the $K\bar{K}$ threshold (BATON 70, CARROLL 72, PROTOPOPESCU 73, HYAMS 73, OCHS 73).

Up to the ρ meson mass region, δ_0^0 is (qualitatively) uniquely determined; it rises monotonically and reaches a value of 60° to 70° near 700 MeV (SONDEREGGER 69, BATON 70, BAILLON 72, CARROLL 72, FRENKIEL 72, GAIDOS 72, PROTOPOPESCU 73, HYAMS 73, OCHS 73, ENGLER 74, ESTABROOKS 74, 75, GRAYER 74); see Fig. 1.

In the mass region of 700 to 900 MeV, all energy-independent phase-shift analyses using the constraint $\eta_0^0 = 1$ find two solutions ("up-down ambiguity"). This ambiguity was resolved in favor of the "down" solution by the observation of a very rapid decrease in the S-wave amplitude

Data Card Listings

For notation, see key at front of Listings.

Mesons

$\epsilon(1200)$

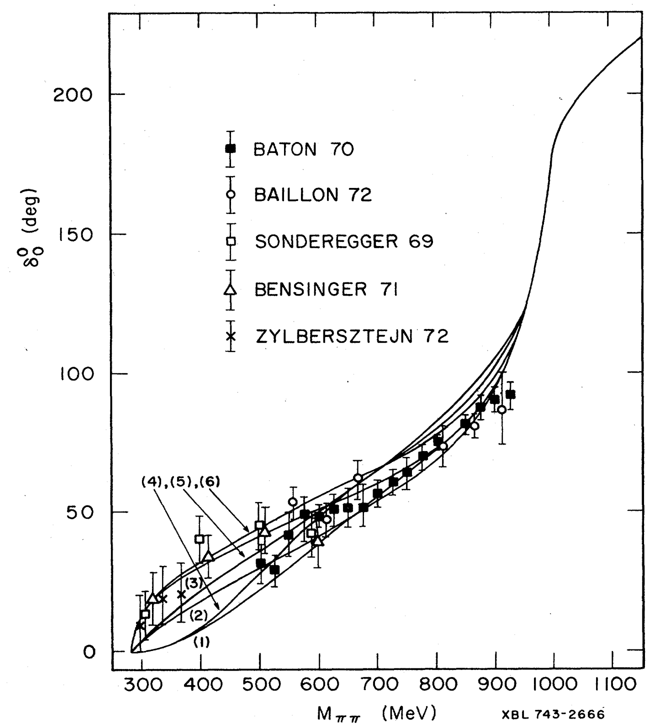


Fig. 1. The S-wave, I=0 ππ phase shift, as determined by several experiments. The curves are from BASDEVANT 73; solutions (1 - 3) were obtained by fitting the data of BATON 70, while (4 - 6) are from fits to the data of PROTOPOPESCU 73.

between 950 and 980 MeV (FLATTE 72, GAIDOS 72, HYAMS 73, BINNIE 73, ENGLER 74). The size of the observed drop corresponds to a change from nearly the unitarity limit to zero; see Fig. 2.

Independent evidence for the correctness of this "down" solution comes from studies of the $\pi^0\pi^0$ system (APEL 72, BRAUN 73, SKUJA 73, RIESTER 75). They observe a wide $\pi^0\pi^0$ enhancement of ∿800 MeV which is much better described by the "down" solution than the "up" solution. Furthermore, indirect information from elastic ππ scattering in the crossed channel (ELVEKJAER 72, NIELSEN 70, 72) is compatible with the "down", but not with the "up", solution.

The ambiguities of the phase-shift solutions stem from the fact that there are more helicity amplitudes than observables. Thus in the absence of polarization measurements one is obliged to make some supplementary assumptions (see, e.g., DONOHUE 75). Analyzing the same data (GRAYER 74) by different methods, HYAMS 75 find four solutions in the region 1.0-1.8 GeV, ESTABROOKS 74 find eight solutions above 1.2 GeV and four solutions below, whereas FROGGATT 75 find arguments to favor one of these solutions [solution B of ESTABROOKS 74 (see Fig. 3), essentially the same as HYAMS 75 solution +--].

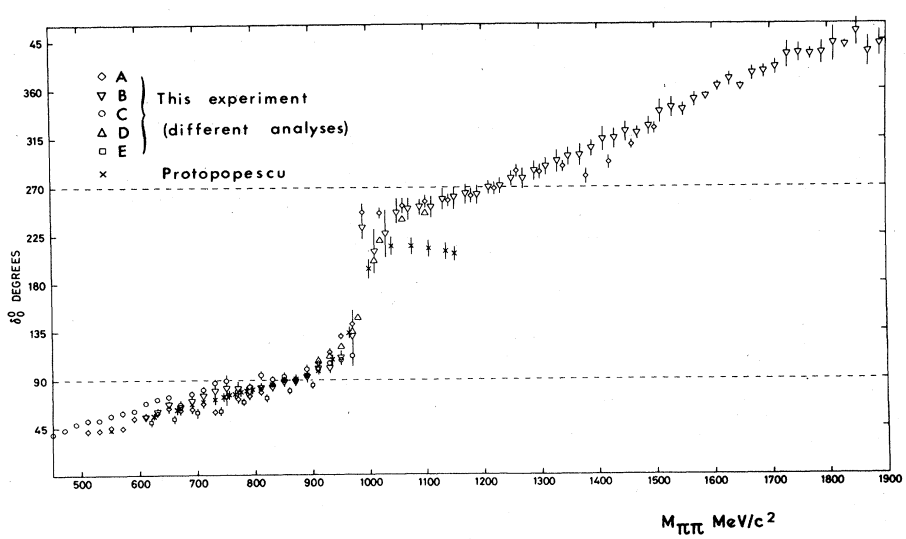


Fig. 2. The S-wave, I=0 ππ phase shift, as determined by various analyses of the data of GRAYER 74, compared with the previous results of PROTOPOPESCU 73. (Figure from GRAYER 74.)

Mesons
ε(1200)

Data Card Listings
For notation, see key at front of Listings.

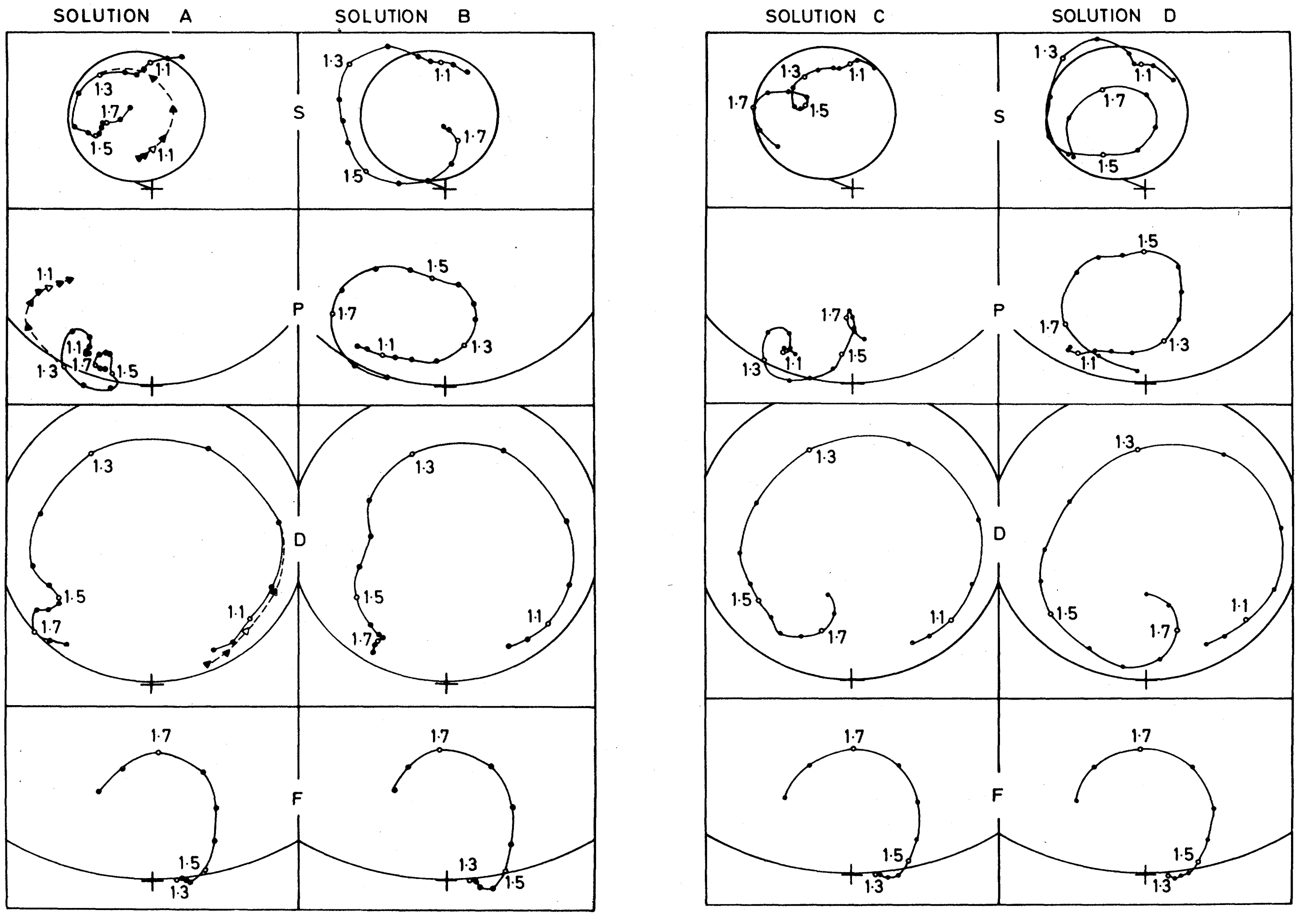


Fig. 3. Argand plots for ππ S, P, D, and F partial-wave amplitudes. Shown are solutions A-D of ESTABROOKS 75, obtained with the data of GRAYER 74. The points on the curves are at 50 MeV intervals. The diameters of the S-, P-, D-, and F-wave unitarity circles shown are given by 2/3, $\sqrt{3}$, $(2/3)\sqrt{5}$, and $\sqrt{7}$, respectively. An elastic I = 2 S-wave phase shift of 25° independent of $M_{\pi\pi}$ has been assumed. (Figure from ESTABROOKS 75.)

Near 1.2 GeV all δ_0^0 solutions based on the GRAYER 74 data, as well as independent analyses of other experiments (CARROLL 72, 74, ENGLER 75), exhibit $\delta_0^0 = 270°$.

It has now been made plausible (MORGAN 75) that all available data are compatible with the existence of just two poles: the $S^*(993)$ connected with the rapid variation of δ_0^0 near the $K\bar{K}$ threshold, and the ε(1200). The $S^*(993)$ is also responsible for the large $K\bar{K}$ I=0 S-wave scattering length.

The ε(1200) "replaces" the pole previously listed below 600 MeV. Note that although many analyses in the past found solutions with an ε(600) pole, they also found solutions without such a pole (PROTOPOPESCU 73, HYAMS 73).

Thus we have just the right number of isoscalar S-wave resonances to make up an SU(3) nonet, presumably together with the δ(970) and the κ(1250) mesons (MORGAN 75).

Note that, although there is general consensus about the position of the S^* pole on the second sheet, it is not clear whether it is accompanied by a companion pole on the third sheet or not (FUJII 75, MORGAN 75). The contrast between the width of 180 MeV of MORGAN 75, and the value of 40 MeV obtained as twice the imaginary part, reflects just this uncertainty.

Data Card Listings

For notation, see key at front of Listings.

Mesons

ε(1200), B(1235)

14 EPSILON MASS (MEV)

M	1100 TO 1300	MORGAN	75 RVUE	12/75*

14 EPSILON WIDTH (MEV)

W	(640.)	MORGAN	75 RVUE	12/75*

REFERENCES FOR EPSILON

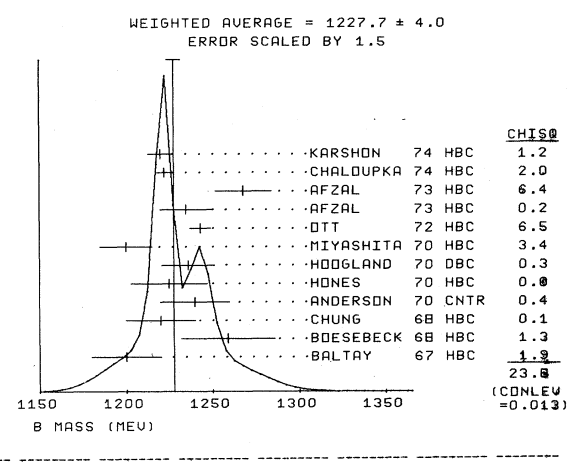
SAMIOS 62 PRL 9 139	+BACHMAN,LEA+	(BNL+CUNY+COLU+KNTY)
BLOKHINT 63 JETP 17 80	BLOKHINTSEVA,GREIBINNIK,ZHUKOV +	(DUBNA)
BOOTH 63 PR 132 2314	+ ABASHIAN	(LRL)
KIRZ 63 PR 130 2481	+SCHWARTZ + TRIPP	(LRL)
BARISH 64 PR 135 B 416	BARISH,KURZ,PEREZ-MENDEZ,SOLOMON	(LRL)
CRAWFORD 64 PRL 13 421	+GROSSMAN,LLOYD,PRICE,FOWLER	(LRL)
DEL FABR 64 PRL 12 674	DEL FABRO,DE PRETIS,JONES+	(FRASCATI)
KALMUS 64 PRL 13 99	+KERNAN,PU,POWELL,DOWD	(LRL+WISCONSIN)
BATON 65 NC 36 1149	J.P.BATON, J.REGNIER	(SACLAY)
BIRGE 65 PR 139 B 1600	+ELY+GIDAL+KALMUS+CAMERINI+	(LRL+WISC)
BROWN 65 CORAL GABLES 219	BROWN+FAIER	(NORTHWESTERN)
DURAND 65 PRL 14 329	L. DURAND AND Y.T. CHIU	(YALE)
JACOBS 66 PRL 16 669	+SELOVE	(LPL)
KOPELMAN 66 PL 22 118	+ALLEN,GODDEN,MARSHALL +	(COLORADO+IOWA)
LOVELACE 66 PL 22 332	LOVELACE,HEINZ,DONNACHIE	(CERN)
ANDERSON 67 PRL 18 89	+FUKUI+KESSLER+ (CHIC+ANL+CNRC+MCGILL+LOQM)	
CLEGG 67 PR 163 1664	A.B.CLEGG	(LANCASTER)
CORBETT 67 PR 156 1451	+DAMERELL+MIDDLEMAS+NEWTON	(OXF+RHEL)
GUTAY 67 PRL 18 142	+JOHNSON+LOEFFLER+MCILWAIN+	(PURDUE+LRL)
JOHNSON 67 PR 163 1497	+GUTAY,EISNER,KLEIN,PETERS,SAHNI,YEN+	(PURD)
MALAMUD 67 PRL 19 1056	E.MALAMUD + P.E.SCHLEIN	(UCLA)
WALKER 67 RMP 39 695	W.D.WALKER	(WISCONSIN)
WALKER 67 PRL 18 630	+CARROLL,GARFINKEL,OH	(WISCONSIN)
BANDER 68 PR 168 1679	+SHAW,FULCO	(UC IRVINE+S.BARBARA)
BISWAS 68 PL 27 B 513	+CASON,JOHNSON,KENNEY,POIRIER+	(NDAM)
BRAUN 68 PRL 21 1275	BRAUN,CLINE,SCHERER	(WISCONSIN)
DUTTA-RO 68 PR 169 1357	B. DUTTA-ROY, I.R. LAPIDUS	(STEV)
EISENHAN 68 PRL 20 758	EISENHANDLER,MISTRY,MOSTEK +	(CORNELL)
FOSTER 68 NP B 6 107	+GAVILLET+LABROSSE+MONTANET+	(CERN+CDEF)
HYAMS 68 NP 87 1	+KOCH,POTTER,..VON LINDERN,LOREN(CERN+MPIM)	
JONES 68 PR 166 1405	+CALDWELL+ZACHAROV+HARTING+BLEULER+	(CERN)
JOHNSON 68 PR 176 1651	+POIRIER,BISWAS,GUTAY+	(NDAM+PURD+SLAC)
LOVELACE 68 PL 28 B 264	C.LOVELACE	(CERN)
MARATECK 68 PRL 21 1613	+HAGOPIAN,+ (PENN+LRL+COLC+PURD+TNTO+WISC)	
BIZZARRI 69 NP B14 169(SEE P.190)	+FOSTER,GAVILLET,GHESQUIERE+	(CERN+CDEF)
DAVISON 69 PR 180 1333	+BACASTOW,BARKAS,+	(UCR+UCB)
DEINET 69 PL 30 B 359	+MENZIONE,MULLER,STAUDENMAIER,+	(KARL+CERN)
ELY 69 PR 180 1319	+GIDAL,HAGOPIAN,+	(UCB+LOUC+WISC)
FELDMAN 69 PRL 22 316	+FRATI,GLEESON,HALPERN,NUSSBAUM,+	(PENN)
GUTAY 69 NP B 12 31	+CARMONY,CSONKA,LOEFFLER,MEIERE	(PURDUE)
HALL 69 NP B 12 573	+MURRAY,RIDDIFORD	(BIRMINGHAM)
HOPKINSO 69 NC 59 A 181	J.HOPKINSON,R.G.ROBERTS	(CERN)
MALAMUD 69 ARGONNE CONF.P.93	E.MALAMUD, P.SCHLEIN	(UCLA)
MORGAN 69 NP B 10 261	D.MORGAN,G.SHAW	(RHEL)
ROBERTS 69 PL 29 B 368	R.G. ROBERTS, F. WAGNER	(CERN)
SCHAREN1 69 ARGONNE CONF.306	SCHARENGUIVEL	(PURDUE)
SCHAREN2 69 PR 186 1387	SCHARENGUIVEL(PURD+LRL+CERN+COLO+PENN+TNTO)	
SMITH 69 PRL 23 335	G.A.SMITH, R.J.MANNING	(MSU+LRL)
SONDEREG 69 SEE BASDEVANT 72	SONDEREGGER,BONAMY	(SACL)
STRUGALS 69 PL 29 B 518	+CHUVILO,FENYVES,+	(WARS+JINR+BUDA)
ALSO 70 NP B 24 358	STRUGALSKI,CHUVILO,FENYVES,GEMESY,+	(DUBNA)
WAGNER 69 NC 64 A 189	F.WAGNER	(CERN)
BARTSCH 70 NP B 22 1	+KEPPEL,GENSCH,MORRISON,+	(AACH+BERL+CERN)
BATON 70 PL 33 B 528	+LAURENS,REIGNIER	(SACLAY)
BRODY 70 PRL 24 948	+GROVES,VANBERG,MAGLIC+(PENN+RUTG+UPNJ+ANL)	
DIAZ 70 NP B 16 239	+GAVILLET,LABROSSE,MONTANET+	(CERN+CDEF)
HYAMS 70 PHILAD.CONF.P.41	+SCHLEIN,BEUSCH,+(CERN+MPIM+ETHZ+LOIC+HAWA)	
MAUNG 70 PL 33 B 521	+MASEK,MILLER,RUDERMAN,VERNON,+	(UCSD+LRL)
MORGAN1 70 SPRINGER TRACTS MOD.PHYS.,VOL.55,P.1.	MORGAN,PISUT	(RHEL+CERN)
MORGAN 2 70 PR D 2 520	D.MORGAN,G.SHAW	(RHEL)
NIELSEN 70 NP B 22 525	+LYNG-PETERSEN,PIETARINEN	(NORDITA)
SCHARENG 70 NP B 22 16	SCHARENGUIVEL,GUTAY,MILLER,+	(PURD+PENN)
OH 70 PR D 1 2494	+GARFINKEL,MORSE,WALKER,PRENTICE	(WISC+TNTO)
SHIBATA 70 PRL 25 1227	+FRISCH,WAHLIG	(MIT)
ALSTON-G 71 PL 36 B 152	ALSTON-GARNJOST,BARBARO-GALTIERI,+	(LBL)
BANAIGS 71 NP B 28 509	+BERGER,DUFLO,GOLDZAHL,COTTEREA+	(SACL+CAEN)
BEAUPRE 71 NP B 28 77	+DEUTSCHMANN,GRAESSLER,+	(AACH+BERL+CERN)
BENSINGE 71 PL 36 B 134	BENSINGER,ERWIN,THOMPSON,W.D.WALKER	(WISC)
DUBAL 71 NP B 32 535	L.DUBAL,D.J.BROWN	(CNRC+CARL)
GUILLOU 71 NC 5 A 659	LE GUILLOU,MOREL,NAVELET	(CERN)
GUTAY 71 NP B 27 486	+SCHARENGUIVEL,FUCHS,GAIDOS,MILLER,+	(PURD)
HAMILTON 71 SPRINGER TRACTS MOD.PHYS.,VOL. 57,P.41	J.HAMILTON	(NORDITA)
KIM 71 PR D 4 265	+BANDER	(UCI)
LYNG PET 71 PHYS.REPRTS 2 155	J.LYNG PETERSEN (REVIEW)	(CERN)
APEL 72 PL 41 B 542	+AUSLANDER,MULLER,BERTOLUCCI,+	(KARL+PISA)
BAILLON 72 PL 38 B 555	+CARNEGIE,KLUGE,LEITH,LYNCH,RATCLIFF+	(SLAC)
BASDEVAN 72 PL 41 B 178	BASDEVANT,FROGGATT,PETERSEN	(CERN)
BRODY 1 72 PRL 28 1215	+GROVES,MAGLICH,NOREM,+	(PENN+RUTG+UPNJ)
BRODY 2 72 PRL 28 1217	H.BRODY	(PENNSYLVANIA)
CARROLL 72 PRL 28 318	+DIAMOND,FIREBAUGH,MATTHEWS,+	(WISC+TNTO)
ELVEKJAE 72 NP B 43 445	F.ELVEKJAER	(AARHUS)
FLATTE 72 PL 38 B 232	+ALSTON-GARNJOST,BARBARO-GALTIERI,	(LBL)
FRENKIEL 72 NP B 47 61	+GHESQUIERE,LILLESTOL,CHUNG,+	(CDEF+CERN)
GAIDOS 72 NP B 46 449	+MCILWAIN,THOMPSON,WILLMANN	(PURDUE)
PRASAD 72 PR D 6 3216	+BREHM	(UNIV.OF MASSACHUSETTS)
NIELSEN 72 NP B 49 586	H.NIELSEN,G.OADES	(NORD+AARHUS)
WHITEHEA 72 NP B 48 365	WHITEHEAD,AULD,+	(AERE+RHEL+SHMP+LOUC)
WILLIAMS 72 PR D 6 3178	P.K.WILLIAMS	(FSU)
ZYLBERSZ 72 PL 38 B 457	ZYLBERSZTEJN,BASILE,BOURQUIN,+	(GEVA+SACL)
ANJOS 73 NP B 67 37	+D.LEVY,A.SANTORO	(SACLAY)
BANAIGS1 73 PL 43 B 535	+COTTEREAU,FABBRI,+	(SACL+CAEN+FRAS)
BANAIGS2 73 NP B 67 1	+BERGER,GOLDZAHL,COTTEREAU,+	(SACL+CAEN)
BASDEVAN 73 AIX CONF.P.220	J.L.BASDEVANT RAPPORTEUR TALK	(PARIS VI)
BEIER 73 PRL 30 399	+BUCHHOLZ,MANN,PARKER,ROBERTS	(PENN)
BINNIE 73 PRL 31 1534	+CARR,DEBENHAM,DUANE,GARBUTT,+	(LOIC+SHMP)
BRAUN 73 PR D 8 3794	+D.CLINE	(WISC)
HYAMS 73 NP B 64 134	+JONES,WEILHAMMER,BLUM,DIETL,+	(CERN+MPIM)
FOR OTHER RESULTS ON SAME EXPERIMENT SEE GRAYER 74		
OCHS 73 THESIS	THESIS	(MPIM)
PILKUHN 73 NP B 65 460	+SCHMIDT,MARTIN,+	(KARL+CERN+LOUC+NIJM)
PROTOPOP 73 PR D 7 1280	PROTOPOPESCU,GARNJOST,GALTIERI,FLATTE+	(LBL)
RISSER 73 PL 43 B 68	T.RISSER,M.D.SHUSTER	(SACL)
SKUJA 73 PRL 31 653	+WAHLIG,RISSER,PRIPSTEIN,NELSON,+	(LBL)
VILLET 73 PREPRINT	+DAVID,AYED,BAREYRE,BORGEEAUD,+	(SACL)
BASDEVAN 74 NP B 72 413	BASDEVANT,FROGGATT,PETERSEN	(LPTP+NORD)
BONNIER 74 NP B 83 440	B.BONNIER,N.JOHANNESSON	(CERN)
CARROLL 74 PR D 10 1430	+MATTHEWS,WALKER+	(SLAC+DUKE+WISC+TNTO)
ENGLER 74 PR D 10 2070	+KRAEMER,TOAFF,WEISSER,DIAZ+	(CARN+CASE)
ESTABROO 74 NP B 79 301	P.ESTABROOKS,A.D.MARTIN	(DURH)
GRAYER 74 NP B 76 375	+HYAMS,JONES,BLUM,DIETL	(CERN+MPIM)
JONES 74 NP B 83 93	+ALLISON,SAXON	(OXF)
MORGAN 74 PL 51 B 71	D.MORGAN	(RHEL)
ORITO 74 PL 48 B 380	+FERRER,PAOLUZI,SANTONICO	(FRAS+ROMA)
PASCUAL 74 NP B 83 362	P.PASCUAL,F.J.YNDURAIN	(BARC+MADU)
BAR-NIR 75 NP B 87 109	+RISSER,SHUSTER	(CERN+UCSB+TELA)
BARRY 75 NP B 85 239	G.W.BARRY	(PURD)
BASDEVAN 75 NP B 98 285	BASDEVANT,CHAPELLE,LOPEZ,SIGELLE	(LPTP)
DONOHUE 75 NC 25 A 409	J.T.DONOHUE,Y.LEROYER	(BORD)
ESTABROO 75 NP B 95 322	P.ESTABROOKS,A.D.MARTIN	(DURH)
FROGGATT 75 NP B 91 454	C.D.FROGGATT,J.L.PETERSEN	(GLAS+NORD)
FUJII 75 NP B 85 179	Y.FUJII,M.FUKUGITA	(TOKY)
HYAMS 75 NP B 100 205	+JONES,WEILHAMMER,BLUM,DIETL+	(CERN+MPIM)
MORGAN 75 PREPRINT RL75133	D.MORGAN	(RHEL)
RIESTER 75 NP B 96 407	+ARNOLD,ENGEL,PATY	(STRB)
SHIMADA 75 NP B 100 225	T.SHIMADA	(TOKY)
SRINIVAS 75 PR D 12 681	SRINIVASAN,HELLAND,LENNOX,KLEM+	(NCAM+ANL)

B(1235)

11 B(1235,JPG=1++) I=1

11 B MASS (MEV)

M		60	(1220.0)		ABOLINS	63 HBC	+	3.5 PI+P	
M			(1220.0)		GOLDHABER	65 HBC		3.7 PI+,PI-P	
M		376	1200.	20.	BALTAY	67 HBC	+-	0.0 PBAR P	2/67
M			1259.0	27.0	BOESEBECK	68 HBC	+	8.0 PI+ P	10/67
M			1220.	20.	CHUNG	68 HBC	-	3.2,4.2 PI- P	9/67
M			1240.0	20.0	ANDERSON	70 CNTR	0	5-18 GAMMA P	11/70
M			(1272.0)	(15.0)	CASON	70 HBC	-	8.0 PI-P,4PI	
M			1200.0	(10.0)	EROFEEV	70 HBC	-	3.25 PI- P	1/71
M			1225.0	22.0	HONES	70 HBC	+	18.5 PI+ P	11/70
M			1236.0	15.0	HOOGLAND	70 DBC	-	3.0 K- D	2/71
M			1200.0	15.0	MIYASHITA	70 HBC	-	6.7 PI-P,4PI	
M	P		(1230.)	(10.)	POLS	70 HBC	+	5. PI+ P	11/71
M	P	HANDDRAWN BACKGROUND.ERRORS STATISTICAL ONLY.							11/71
M	W		(1228.)	(5.)	FRENKIEL	72 HBC	+-	0. PBAR PI,5 PI	12/72
M	W	FIT REQUIRES AN ADDITIONAL JP=1- RESONANCE							
M	W	AT 1256 MEV, WIDTH 129 MEV.							
M	O	1163	1243.	6.	OTT	72 HBC	+	7.1 PI+ P,P B+	2/73
M	O	FROM FIT OF THE MASS SPECTRUM							
M	A		(1252.)	(6.)	OTT	72 HBC	+	7.1 PI+ P,P B+	2/73
M	A	FROM FIT OF MASS SPECTRUM AND MOMENTS DISTRIBUTION WITH A STRONG							
M	A	INTERFERENCE WITH THE BACKGROUND.							
M			1235.	15.	AFZAL	73 HBC	+	11.7 PI+ P	2/73
M			1268.	16.	AFZAL	73 HBC	-	11.2 PI- P	2/73
M		1400	1222.	4.	CHALOUPKA	74 HBC	-	3.9 PI-P,P B-	12/75*
M		600	1220.	7.	KARSHON	74 HBC	+	4.9 PI+P,P B+	12/75*
M			. . . .						
M	AVG		1227.7	4.0	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)				
M	STUDENT		1226.4	3.6	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT				
					(SEE IDEOGRAM BELOW)				



Mesons

B(1235), ρ'(1250), f(1270)

Data Card Listings

For notation, see key at front of Listings.

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                        11  B WIDTH (MEV)

W       60  100.0      20.0               ABOLINS    63 HBC  +    3.5 PI+P
W           (80.0)                        GOLDHABER 65 HBC        3.7 PI+,PI-P
W      376  100.       30.                BALTAY     67 HBC  +- 0.0 PBAR P        2/67
W       25 (100.)    ESTIMATED            LEE        67 HBC  -   3.6 PI- P        1/68
W           203.       75.                BOESEBECK 68 HBC  +   8. PI+ P        11/67
W           150.       20.                CHUNG      68 HBC  - 3.2,4.2 PI- P      9/67
W   B  300  (83.)     (12.)               BIZZARRI   69 HBC  +-   0 PBAR P       12/72
W   B   SUPERSEDED BY FRENKIEL 72
W          (100.0)  APPROX.               ANDERSON   70 CNTR   0 5-18+GAMMA P    11/70
W   C      (150.0)                        CASO       70 HBC   - 11.2PI-P          2/73
W   C   SUPERSEDED BY AFZAL 73
W          (122.0)    (38.0)    (28.0)    CASON      70 HBC   -  8.0 PI-P,4PI
W           100.0      20.0               EROFEEV    70 HBC   -  3.25 PI- P       1/71
W            78.0      14.0      46.0     HONES      70 HBC  +  18.5 PI+ P       11/70
W           132.0      20.0               HOOGLAND   70 DBC   -  3.0 K- D         2/71
W           113.0      44.0               MIYASHITA 70 HBC   -  6.7 PI-P,4PI
W   P      (120.)     (20.)               POLS       70 HBC  +  5. PI+ P         11/71
W   P   HANDDRAWN BACKGROUND.ERRORS STATISTICAL ONLY.                            11/71
W   W      (126.)     (10.)               FRENKIEL   72 HBC  +- 0. PBAR PI,5 PI  12/72
W   W   SEE NOTE UNDER THE MASS ABOVE.
W  O 1163  134.       23.       26.       OTT        72 HBC  +  7.1 PI+ P,P B+    2/73
W  O    FROM FIT OF THE MASS SPECTRUM
W   A      (156.)     (21.)     (18.)     OTT        72 HBC  +  7.1 PI+ P,P B+    2/73
W   A   SEE NOTE UNDER THE MASS ABOVE.
W           120.       50.                AFZAL      73 HBC  +  11.7 PI+ P        2/73
W           130.       50.                AFZAL      73 HBC  -  11.2 PI- P        2/73
W     1400  135.       20.                CHALOUPKA 74 HBC   - 3.9 PI-P,P B-    12/75*
W      600  156.       22.                KARSHON    74 HBC  +  4.9 PI+P,P B+    12/75*
W           . . . . . . . . . .
W   AVG      124.3      7.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT 124.6       8.4      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                        11  B PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      B INTO OMEGA+PI                                  783+ 139
P2      B INTO 2PI+ 2PI-                                 139+ 139+ 139+ 139
P3      B INTO K KBAR                                    493+ 493
P4      B INTO PI PI                                     139+ 139
P5      B INTO PI PHI                                    134+1020
P6      B INTO ETA PI (FORBIDDEN BY G)                   548+ 139
P7      B INTO K KBAR PI                                 493+ 493+ 139

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                        11  B BRANCHING RATIOS

R10     D/S RATIO FOR B(1235) INTO OMEGA PI
R10
R10           0.3        0.1              CHALOUPKA 74 HBC  -  3.9-7.5 PI-P       1/74
R10    600    0.35       0.25             KARSHON   74 HBC  +  4.9 PI+P,P B+     12/75*
R10           0.21       0.08             CHUNG     75 HBC  +  7.1 PI+P          12/75*
R10           . . . . . . . . . .
R10 AVG       0.251      0.061     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R10 STUDENT   0.251      0.067     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R1      B INTO (4PI)/(OMEGA PI)                              (P2)/(P1)
R1            (0.5)  OR LESS              ABOLINS   63 HBC  +   3.5 PI+P

R2      B INTO (K KBAR)/(OMEGA PI)                           (P3)/(P1)
R2            (0.02) OR LESS              DAHL      67 HBC  -   1.6-4.2 PI- P    10/66
R2            (0.10) OR LESS  CL=.90      BALTAY    67 HBC  +-  0.0 PBAR P        2/67
R2            (0.08) OR LESS  CL=.95      BIZZARRI  69 HBC  +-  0 PBAR P          9/69

R3      B INTO (PI PI)/(PI OMEGA)                            (P4)/(P1)
R3            (0.3)  OR LESS              ADERHOLZ  64 HBC      4.0 PI+P          7/66
R3            (0.15) OR LESS  CL=.90      OTT       72 HBC  +  7.1 PI+ P         12/72

R4      B INTO (PI PHI) / (PI OMEGA)                         (P5)/(P1)
R4            (0.015)OR LESS              DAHL      67 HBC      1.6-4.2 PI- P    10/66
R4            (0.04) OR LESS  CL=.95      BIZZARRI  69 HBC  +-  0 PBAR P          9/69

R5      B INTO (ETA PI) / (PI OMEGA)                         (P6)/(P1)
R5            (0.25) OR LESS  CL=.90      BALTAY    67 HBC  +-  0.0 PBAR P        2/67

R6      B+- INTO ((K KBAR)+- PI0) / (PI OMEGA)
R6            (0.08) OR LESS  CL=.90      BALTAY    67 HBC  +-  0.0 PBAR P        2/67

R6      B+- INTO (KS KS PI+-) / (PI OMEGA)
R6            (0.02) OR LESS  CL=.90      BALTAY    67 HBC  +-  0.0 PBA- P        2/67

R6      B+- INTO (KS KL PI+-) / (PI OMEGA)
R6            (0.06) OR LESS  CL=.90      BALTAY    67 HBC  +-  0.0 PBAR P        2/67

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REFERENCES FOR B(1235)


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ABOLINS   63 PRL 11 381          ABOLINS,LANDER,MEHLHOP,XUONG,YAGER   (UCSD)
BONDAR    63 PL 5 209            BONDAR,DODD+    (AACHEN+BIRM+HAMB+LOIC+MPIM)
ADERHOLZ 64 PL 10 240            AACHEN+BERLIN+BIRM + BONN+HAMBUR+LOIC+MPIM
CARMONY   64 PRL 12 254          CARMONY,LANDER,RINDFLEISCH,XUONG,YAGER(UCB) JP
GOLDHABE 65 PRL 15 118           G GOLDHABER,S GOLDHABER,KADYK,SHEN    (LRL)

BALTAY    67 PRL 18 93           +SEVERIENS+YEH+ZANELLO            (COLU+BNL)
DAHL      67 PR 163 1377         +HARDY+HESS+KIRZ+MILLER                (LRL)
LEE       67 PR 159 1156         +MOEBS,ROE,SINCLAIR,VANDERVELDE       (MICH)
SLATTERY 67 NC 50A 377           +KRAYBILL+FORMAN+FERBEL          (YALE+ROCH)

ASCOLI    68 PRL 20 1411         +CRAWLEY,MORTARA,SHAPIRO               (ILL)  JP
BOESEBEC 68 NP B 4 501           BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CASO      68 NC 54 A 983         +CONTE+CORDS+DIAZ+   (GENOVA+HAMB+MILA+SACL)
CHUNG     68 PR 165 1491         S.U.CHUNG,O.DAHL,J.KIRZ,D.H.MILLER     (LRL)
BIZZARRI 69 NP B 14 169          +FOSTER,GAVILLET,MONTANET,+      (CERN+CDEF)

ANDERSON 70 PR D 1 27            +GUSTAVSON,JOHNSON,+   (SLAC+CIT+UCSB+NEAS)
CASO      70 LNC 3 707           +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
CASON     70 PR D 1 851          +ANDREWS,BISWAS,GROVES,HARRINGTON,+  (NDAM)
EROFEEV   70 SJNP 11 450         +VETLITSKY,WLADIMIRSKY,GRIGOREV,+    (ITEP)
HONES     70 PR D 2 827          +CASON,BISWAS,HELLAND,KENNEY,MCGAHAN+(NDAM)
HOOGLAND 70 PL 33 B 631          SABRE COLLABOR.  (ZEEM+SACL+BGNA+REHO+EPOL)
MIYASHIT 70 PR D 1 771           MIYASHITA,VON KROGH,KOPELMAN,LIBBY   (COLO)
POLS      70 NP B 25 109         +BOECKMANN,CIRBA,+     (BONN+DURH+EPOL+TORI)
WERBROUC 70 LNC 4 1267           WERBROUCK,RINAUDO,+    (TORI+NIJM+BONN+LBL)JP
DEVONS    71 PRL 27 1614         +KOZLOWSKI,HORWITZ,+              (COLU+SYRA)

FRENKIEL 72 NP B 47 61           +GHESQUIERE,LILLESTOL,CHUNG,+    (CDEF+CERN)JP
OTT       72  LBL-1547           R.L.OTT  THESIS                         (LBL)JP
SISTERSO 72 NP B 48 493          SISTERSON,HARRISON,HEYDA,JOHNSON,+(HARVARD)

AFZAL     73 NCL 15 A 61         +BASSLER,+        (DURH+GENC+DESY+MILA+SACL)  JP
ARMENISE 73 NC 17 A 707          +FORINO,CARTACCI,+             (BARI+BGNA+FIRZ)
ARMENISE 73 LNC 8 425            +FORINO,CARTACCI,+             (BARI+BGNA+FIRZ)
ARNOLD    73 LNC 6 707           +ENGEL,ESCOUBES,KURTZ,LLORET,PATY,+  (STRB)
CASON     73 PR D 7 1971         +BISWAS,KENNEY,MADDEN,SANDER,SHEPHARD(NDAM)
CASON 1   73 NP B 64 14          +MADDEN,BISHOP,BISWAS,KENNEY,+         (NDAM)
COHEN     73 PR D 8 23           +FERBEL,SLATTERY                  (ROCHESTER)

BALLAM    74 NP B76 375          +CHADWICK,BINGHAM,FRETTER+  (SLAC+LBL+MPIM)
CHALOUPK 74 PL 51B 407           CHALOUPKA,FERRANDO,LOSTY,MONTANET    (CERN)  JP
KARSHCN   74 PR D10 3608         +MIKENBERG,EISENBERG,PITLUCK,RONAT+  (REHO)  JP

CHUNG     75 PR D11 2426         +PROTOPOPESCU,LYNCH,FLATTE,+ (BNL+LBL+UCSC)  JP
    ALSO  73 PL 47 B 526         +PROTOPOPESCU,LYNCH,FLATTE,+ (BNL+LBL+UCSC)  JP
DUBOVIKO 75 SJNP 20 229          M.S.DUBOVIKOV,I.A.EROFEEV              (ITEP)  JP
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ρ'(1250) →

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69  RHO PRIME(1250,JPG=1-+) I=1

EVIDENCE NOT COMPELLING. OMITTED FROM TABLE.

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                        69  RHO PRIME(1250) MASS  (MEV)

M          1256.     10.                FRENKIEL  72 HBC  +- 0.PBARP,OMEGA2PI  1/74

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                        69  RHO PRIME(1250) WIDTH  (MEV)

W           130.      20.               FRENKIEL  72 HBC  +- 0.PBARP,OMEGA2PI  1/74

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REFERENCES FOR RHO PRIME(1250)


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ANDERSON 70 PR D 1 27            +GUSTAVSON,JOHNSON,+   (SLAC+CIT+UCSB+NEAS)
PODOLSKY 71  UCRL 20128          W.J.PODOLSKY,PH.D. THESIS               (LBL)
FRENKIEL 72 NP B 47 61           +GHESQUIERE,LILLESTOL,CHUNG,+    (CDEF+CERN)JP
WOLF      72 ITHACA N.Y. CONF.   G.WOLF,P.213                           (SLAC)

CHUNG     73 PL 47 B 526         +PROTOPOPESCU,LYNCH,FLATTE,+ (BNL+LBL+UCSC)
BRAMON    73 LNC 8 659           A.BRAMON                           (FRASCATI)

BALLAM    74 NP B76 375          +CHADWICK,BINGHAM,FRETTER+  (SLAC+LBL+MPIM)
CHALOUPK 74 PL 51B 407           CHALOUPKA,FERRANDO,LOSTY,MONTANET    (CERN)
CONVERSI 74 PL 52B 493           +PAOLUZI,CERADINI,GRILLI+       (ROMA+FRAS)
ESTABROO 74 NP B79 301           P.ESTABROOKS,A.D.MARTIN               (DURH)
KARSHCN   74 PR D10 3608         +MIKENBERG,EISENBERG,PITLUCK,RONAT+  (REHO)  JP

ALLES     75 NC 30A 136          ALLES-BORELLI,BERNARDINI+  (CERN+BGNA+FRAS)
CHUNG     75 PR D11 2426         +PROTOPOPESCU,LYNCH,FLATTE,+ (BNL+LBL+UCSC)
ESTABROO 75 NP B95 322           P.ESTABROOKS,A.C.MARTIN               (DURH)
FROGGATT 75 NP B91 454           C.D.FROGGATT,J.L.PETERSEN        (GLAS+NORD)
HYAMS     75 NP B100 205         +JONES,WEILHAMMER,BLUM,DIETL+    (CERN+MPIM)
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f(1270)

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5  F(1270,JPG=2++) I=0

WE NO LONGER LIST EVERY PUBLISHED VALUE.                                   1/73
WE AVERAGE ONLY THE MOST SIGNIFICANT                                       1/73
DETERMINATIONS OF MASS AND WIDTH.                                          1/73

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                        5  F MASS (MEV)

M          (1250.0)   (25.0)            SELOVE     62 HBC      3.0 PI- P         1/73
M      1416(1267.0)   (10.0)            JACOBS     66 HBC     2-3 PI-P,T CUT20 10/67
M           1276.     11.               RABIN      67 HBC     8.5 PI+ P          9/67
M  T   1960 1261.      5.               ARMENISE   68 DBC     5.1 PI+N,P PI+ -   1/73
M  T    360 1270.     10.               ARMENISE   68 DBC     5.1 PI+N,P PI0 0   1/73
M           1265.      8.               BOESEBECK 68 HBC     8 PI+ P            6/68
M    J      1268.0     6.0              JOHNSON    68 HBC      3.7-4.2 PI- P     7/69
M    J      JOHNSON 68 INCLUDES BONDAR 63, LEE 64, DERADO 65, EISNER 67.
M           1275.0    13.0              ARMENISE   70 HBC      9 PI+ N -- F P    1/71
M           1273.0     7.0              ARMENISE   70 HBC      9 PI+ N -- MM P   1/71
M       600 1275.0    10.0              OH         70 HBC     1.26 PI- P,P F     1/71
M   E      (1273.0)   (6.0)             STUNTEBEC 70 HBC     8.PI-P,5.4 PI+D   11/71
M      5300 1277.0     4.0              FLATTE     71 HBC      7.0 PI+ P         6/71
M  E    300(1272.)                      KEMP       72 DBC     11.7 PI+ N        12/72
M      2000 1261.0    10.0              JACOBS     72 HBC      2.8 PI- P         1/73
M       600 1258.0    10.0              TAKAHASHI 72 HBC     8. PI- P,N 2PI     1/73
M      1200 1274.     12.               WHITEHEAD 72 ASPK    3.1-3.6 PI- P    . 2/73
M      4600 1272.      4.               ENGLER     74 DBC    0 6. PI+N,PI+PI-P 12/75*
M  IH      (1269.)    (4.)              ESTABROOK 75 RVUE     17 PI-P,PI+PI-N  12/75*
M  I        1275.      4.               HYAMS      75 ASPK     17 PI-P,PI+PI-N 12/75*
M  I    ERROR TAKES ACCOUNT OF SPREAD OF DIFFERENT PHASE-SHIFT SOLUTIONS
M
M  E    EVIDENCE FOR A STRUCTURE CLAIMED                                   12/72
M  T    MASS ERRORS ENLARGED BY US TO WIDTH/SQRT(N)
M   H   USES SAME DATA AS HYAMS 75
M           . . . . . . . . . .
M   AVG     1271.1      1.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1271.3       2.0      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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Data Card Listings

For notation, see key at front of Listings.

Mesons

f(1270)

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                        5  F WIDTH (MEV)

W            (100.0)    (25.0)          SELOVE    62 HBC      3.0 PI-P
W      1416  (99.0)     (10.0)          JACOBS    66 HBC     2-3 PI-P,T CUT20 10/67
W             155.       17.            RABIN     67 HBC     8.5 PI+ P          9/67
W  T   1960   216.       20.            ARMENISE  68 DBC     5.1 PI+N,P PI+ -   1/73
W   T   360  (188.)     (40.)           ARMENISE  68 DBC     5.1 PI+N,P PIO 0   1/73
W             128.       23.            BOESEBECK 68 HBC     8 PI+ P            6/68
W    J        176.0      13.0           JOHNSON   68 HBC      3.7-4.2 PI- P     7/69
W    J       JOHNSON 68 INCLUDES BCNDAR 63, LEE 64, DERADO 65, EISNER 67.
W             131.0      25.0           ARMENISE  70 HBC      9 PI+ N -- MM P   1/71
W  T          173.0      25.0           ARMENISE  70 HBC      9 PI+ N -- F P    2/74
W  T    600   120.0      20.0           OH        70 HBC     1.26 PI- P,P F     2/74
W   E        (196.0)    (18.0)          STUNTEBEC 70 HBC     8.PI-P,5.4 PI+D   11/71
W      5300   183.0      15.0           FLATTE    71 HBC     7.PI+P,DELTA++F    1/71
W  E    300  (143.)                     KEMP      72 CBC     11.7 PI+ N        12/72
W      2000   130.0      25.0           JACOBS    72 HBC      2.8 PI- P         1/73
W  T    600   166.0      28.0           TAKAHASHI 72 HBC     8. PI- P,N 2PI     1/73
W      1200  (217.)     (24.)           WHITEHEAD 72 ASPK    3.1-3.6 PI- P    . 2/73
W      4600   192.       16.            ENGLER    74 DBC    0 6. PI+N,PI+PI-P 12/75*
W  IH        (209.)     (10.)           ESTABROOK 75 RVUE    17 PI-P,PI+PI-N   12/75*
W  I          188.       4.             HYAMS     75 ASPK     17 PI-P,PI+PI-N  12/75*
W  I     ERROR TAKES ACCOUNT OF SPREAD OF DIFFERENT PHASE-SHIFT SOLUTIONS
W
W  E     EVIDENCE FOR A STRUCTURE CLAIMED                                      12/72
W  T     WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N)
W   H    USES SAME DATA AS HYAMS 75
W             . . . . . . . . . .
W   AVG       181.1        5.6      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
W   STUDENT   182.0        4.5      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                           (SEE IDEOGRAM BELOW )
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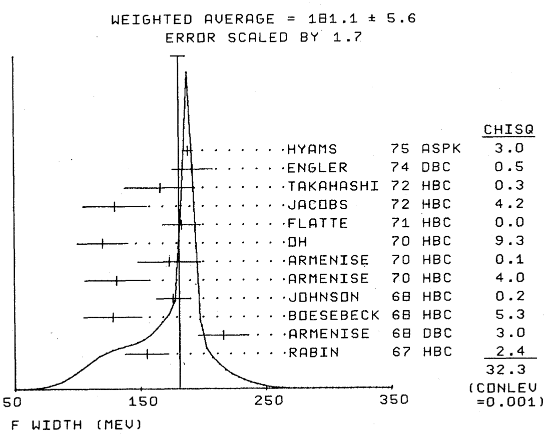


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                        5  F PARTIAL DECAY MODES

                                                      DECAY MASSES
P1     F INTO PI PI                                   139+ 139
P2     F INTO 2PI+ 2PI-                               139+ 139+ 139+ 139
P3     F INTO PI+ PI- 2PIO                            139+ 139+ 134+ 134
P4     F INTO K KBAR                                  497+ 497
P5     F INTO K KBAR PI                               497+ 497+ 139
P6     F INTO ETA PI PI                               548+ 139+ 139
P7     F INTO ETA ETA                                 548+ 548
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                        5  F BRANCHING RATIOS

R10    I=0,JP=2+ PI PI PARTIAL WAVE AMPLITUDE AT F RESONANCE MASS
R10         WE TABULATE X = 1/2 (1 + ETA).  THIS SHOULD BE PI PI FRACTION
R10         FOR PURE BW WITH NO BACKGROUND.
R10    600    0.8      0.04             OH         70 HBC    01.26 PI- P,P F    1/71
R10    250    0.85     0.05             BEAUPRE    71 HBC    08 PI+ P,DELTA++F  1/71
R10IH        (.82)    (.01)             ESTABROOK  75 RVUE    17 PI-P,PI+PI-N  12/75*
R10 H   USES SAME DATA AS HYAMS 75
R10I          .803     .003             HYAMS      75 ASPK    17 PI-P,PI+PI-N 12/75*
R10I    ERROR TAKES ACCOUNT OF SPREAD OF DIFFERENT PHASE-SHIFT SOLUTIONS
R10          . . . . . . . . . .
R10 AVG       0.8032   0.0030  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R10 STUDENT   0.8031   0.0032  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R1     F INTO (2PI+ 2PI-)/(PI PI)                             (P2)/(P1)
R1    ASCOLI 68 SUGGEST DECAY IS MAINLY RHO-RHO, 1/3 OF WHICH YIELD 2PI+ 2PI
R1            0.08     0.06             BCNDAR     63 HBC      4.0 PI-P
R1    D       0.04     0.05             CHUNG      65 HBC      3.2 PI-P         11/71
R1    D   CORRECTED BY O.DAHL                                                   11/71
R1     50     0.07     0.04             ASCOLI     68 HBC     5 PI- P            6/68
R1            0.022    0.045     0.022  BARDADIN   71 HBC     8. PI+ P           2/72
R1            0.047    0.013            OH         70 HBC     1.26 PI- P,P F     2/73
R1    154     0.037    0.007            ANDERSON   73 DBC     6. PI+N,P FO       1/74
R1           (0.033)OR LESS  C.L.=.90   BUGG       73 DBC     8. PI+N,P FO       1/74
R1     70     .051     .025             EISENBERG  74 HBC     4.9 PI+P,DEL++FO 11/75*
R1    285     .043     .007       .011  LOUIE      74 HBC     3.9 PI- P,N FO  .11/75*
R1    160     .024     .006             EMMS       75 CBC     4.  PI+N,P FO    11/75*
R1           . . . . . . . . . .
R1  AVG       0.0344   0.0040  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R1  STUDENT   0.0351   0.0047  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R2     F INTO (PI+ PI- 2PIO)/(PI PI)                          (P3)/(P1)
R2    SHOULD BE TWICE R1 IF DECAY IS RHO-RHO (SEE ASCOLI 68)
R2    600     .15      .06              EISENBERG  74 HBC     4.9 PI+P,DEL++FO 11/75*
R2           (.07)                      EMMS       75 DBC     4.  PI+N,P FO    11/75*

R3     F INTO (K KBAR)/(PI PI)                                (P4)/(P1)
R3         WE CNLY AVERAGE EXPERIMENTS WHICH EITHER TAKE INTO ACCOUNT F-A2
R3         INTERFERENCE EXPLICITLY OR DEMCNSTRATE THAT A2 PRODUCTION IS
R3         NEGLIGIBLE.
R3            (0.047)  (0.012)+ SYST.  BEUSCH     67 OSPK    5,7,12 PI-P         9/67
R3    D        0.05     0.05           DAHL       67 HBC      1.6-4.2 PI- P     10/66
R3    D        CORRECTED BY O.DAHL                                              11/71
R3      20     0.031    0.012          ADERHOLZ   69 HBC      8 PI+ P,K+K-PI-  12/75*
R3 L          (0.07) OR LESS  CL=.95   AGUILAR    72 HBC     3.9,4.6 K- P       12/72
R3 L     LIMIT ABOVE RESTATED FOR AVERAGING BELOW.                              12/72
R3 L           0.0      0.04           AGUILAR    72 HBC     3.9,4.6 K- P       12/72
R3             0.13     0.05           BISWAS     72 HBC     18.5 PI+- P         1/73
R3            (0.02) OR LESS  CL=.85   WHITEHEAD  72 ASPK    3.1-3.6 PI- P      12/72
R3             0.03     0.02           TOET       73 HBC     5 PI+P,P PI+ FO     1/74
R3              .025     .015          EMMS       75 DBC     4.  PI+N,P FO     11/75*
R3              .037     .012          PAWLICKI   75 ASPK    6.  PI-P,N FO     11/75*
R3           . . . . . . . . . .
R3  AVG        0.0328   0.0067  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  STUDENT    0.0325   0.0073  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R4     F INTO (KO K- PI+ AND C.C.)/(PI PI)                    (P5)/(P1)
R4            (0.07) OR LESS  CL=.95   AGUILAR    72 HBC     3.9,4.6 K- P       12/72
R4             (.004)OR LESS  CL=.95   EMMS       75 CBC     4.  PI+N,P FO     11/75*

R5     F  INTO (ETA PI PI)/(PI PI)                            (P6)/(P1)
R5            (0.19) OR LESS  CL=.95   AGUILAR    72 HBC     3.9,4.6 K- P       12/72
R5             (.010)OR LESS  CL=.95   EMMS       75 DBC     4.  PI+N,P FO     11/75*

R6     F INTO (ETA ETA)/(PI PI)                               (P7)/(P1)
R6             (.09) OR LESS  CL=.95   EISENBERG  74 HBC     4.9 PI+P,DEL++FO 11/75*
R6             (.016)OR LESS  CL=.95   EMMS       75 DBC     4.  PI+N,P FO     11/75*

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REFERENCES FOR F


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SELOVE    62 PRL 9 272        SELOVE,HAGOPIAN,BRCDY,BAKER,LEBCY     (PENN)
BONDAR    63 PL 5 153         BONDAR+    (AACHEN+BIRM+BONN+DESY+LOIC+MPIM)
GUIRAGOS  63 PRL 11 85        Z.G.T. GUIRAGOSSIAN                    (LRL)
HAGOPIAN  63 PRL 10 533       V HAGOPIAN,W SELOVE                    (PENN)
VEILLET   63 PRL 10 29        VEILLET,HENNESSY,BINGHAM,BLOCH+(EPOL+MILAN)

ADERHOLZ  64 PL 10 240        AACHEN¬BERLIN¬BERLIN¬BCNN¬HAMBURG¬LOIC¬MPI  IJ
BRUYANT   64 PL 10 232        BRUYANT,GOLDBERG,HOLDER,FLEURY+ (CERN+EPOL) I
LEE       64 PRL 12 342       LEE,ROE,SINCLAIR,VANDERVELDE          (MICH)
SODICKSO  64 PRL 12 485       SODICKSCN,WAHLIG,MANNELLI,FRISCH+      (MIT) I

BARMIN    65 SJNP 1 230       +DOLGOLENKO,ELENSKY,EROFEEV+  (ITEP MOSCOW) JP
BARMIN    65 SJNP 1 623       +DOLGOLENKO+EROFEEV+KRESTNIKOV+ (ITEP MOSC)
CHUNG     65 PRL 15 325       CHUNG,DAHL,HARDY,HESS,JACCBS,KIRZ      (LRL)
DERADO    65 PRL 14 872       DERADO,KENNEY,POIRIER,SHEPHARD (NOTRE DAME)
GUIRAGOS  65 PRL 11 85        Z G T GUIRAGOSSIAN                     (LRL)
WANGLER   65 PR  137 B 414    T P WANGLER,A R ERWIN,W WALKER  (WISCONSIN)

ACCENSI   66 PL 20 557        ACCENSI,ALLES-BORELLI,FRENCH,FRISK+  (CERN)
JACOBS    66 UCRL-16877       L.D.JACOBS,THESIS                      (LRL)
WAHLIG    66 PR  147  941     +SHIBATA,GORDCN,FRISCH,MANNELLI  (MIT+PISA) J

BARLOW    67 NC 50A 701       +LILLESTOL+MONTANET+  (CERN+CDEF+IRAD+LIVP)
BEUSCH    67 PL 25 B 357      +FISCHER,GOBBI,ASTBURY+           (ETHZ+CERN)
DAHL      67 PR 163 1377      +HARDY+HESS+KIRZ+MILLER                (LRL)
EISNER    67 PR 164 1699      +JOHNSON+KLEIN+PETERS+SAHNI+YEN+    (PURDUE)
POIRIER   67 PR 163 1462      +BISWAS,CASON,DERADO,KENNEY+     (NDAM+PENN)
RABIN     67 THESIS           M. RABIN                           (RUTGERS)

ARMENISE  68 NC 54 A 999      +FORINO+CARTACCI+ (BARI+BGNA+FIRENZE+ORSAY)
ASCOLI    68 PRL 21 1712      G.ASCOLI,H.B.CRAWLEY,D.W.MORTARA,+     (ILL)
BOESEBEC  68 NP B 4 501       BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
FOSTER    68 NP B 6 107       +GAVILLET+LABROSSE+MONTANET+     (CERN+CDEF)
JCHNSCN   68 PR 176 1651      +POIRIER,BISWAS,GUTAY+      (NDAM+PURD+SLAC)
LAMSA     68 PR 166 1395      +CASON+BISWAS+DERADO+GROVES+     (NOTREDAME)
WHITEHEA  68 NC 53A 817       +MCEWEN,OTT,AITKEN+         (AERE+SHMP+LOUC)

ADERHOLZ  69 NP B 11 259      +BARTSCH,+          (AACH+BERL+CERN+JAGL+WARS)
AGUILAR-  69 PL 29 B  241     M.AGUILAR-BENITEZ,J.BARLOW,+     (CERN+CDEF)
ARMENISE  69 LNC 2 501        +GHIDINI,FORINO,CARTACCI+  (BARI+BGNA+FIRZ)
CASO      69 NC 62 A 755      +CONTE,BENZ,+    (GENO+DESY+HAMB+MILA+SACL)
DONALC    69 NP B 11 551      +EDWARDS,BURAN,BETTINI,+    (LIVP+OSLO+PADO)

AGUILAR   70 PRL 25 58        AGUILAR-BENITEZ,BARNES,BASSANO,+ (BNL+SYRA)
ARMENISE  70 LNC 4  199       +GHIDINI,FORING,CARTACCI,+ (BARI+BGNA+FIRZ)
BADIER    70 NP B 22 512      +BCNNET,DREVILLON,BAUBILLIER,+  (EPOL+IPNP)
OH        70 PR D 1 2494      +GARFINKEL,MORSE,WALKER,PRENTICE(WISC+TNTOJ)
STUNTEBE  70 PL 32 B 391      STUNTEBECK,KENNEY,DEERY,BISWAS,CASON+(NDAM)

BARDADIN  71 PR D4 2711       BARDANIN-OTWINOWSKA,HOFMCKL,+         (WARS)
BEAUPRE   71 NP B 28 77       +DEUTSCHMANN,GRAESSLER,+    (AACH+BERL+CERN)
FARBER    71 NP B 29 237      +DE PINTO,BISWAS,CASCN,DEERY,KENNEY,+(NDAM)
FLATTE    71 PL 34 B 551      +ALSTON-GARNJOST,BARBARO-GALTIERI,+    (LBL)

AGUILAR   72 PR D 6 29        AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS    (BNL)
BISWAS    72 PR D 5 1564      +CASON,HARRINGTON,KENNEY,SHEPHARD     (NDAM)
FOGLI     72 NC 8 A 670       FOGLI-MUCIACCIA,PICCIARELLI           (BARI)
GRAYER    72 PHIL.CONF.PROC. 5 +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
JACOBS    72 PR D 6 1291      L.D.JACOBS                          (SACLAY)
KEMP      72 NC 8 A 611       +MAJOR,CONTRI,+  (DURH+GENO+MILA+EPOL+LPNP)
SCARROTT  72 LNC 3 271        SCARROTT,KEMP                       (DURHAM)
TAKAHASH  72 PR D 6 1266      TAKAHASHI,BARISH,+     (TOHO+PENN+NDAM+ANL)
WHITEHEA  72 NP B 48 365      WHITEHEAD,AULD,+       (AERE+RHEL+SHMP+LOUC)

ANDERSCN  73 PRL 31 562       +ENGLER,KRAEMER,TOAF,DIAZ,+      (CARN+CASE)
BUGG      73 PR D 7 3264      +CONDO,HART,COHN,ENDORF,+  (TENN+ORNL+CINC)
CHARLESW  73 NP B 65 253      CHARLESWORTH,EMMS,BELL,+    (RHEL+BIRM+DURH)
HYAMS     73 NP B 64 134      +JONES,WEILHAMMER,BLUM,DIETL,+  (CERN+MPIM)
TOET      73 NP B 63 248      +THUAN,MAJOR,RINAUDO,+(NIJM+BONN+DURH+TORI)

EISENBER  74 PL 52B 239       EISENBERG,ENGLER,HABER,KARSHON+       (REHO)
ENGLER    74 PR D10 2070      +KRAEMER,TOAFF,WEISSER,DIAZ+     (CARN+CASE)
GRAYER    74 NP B 75 189      G.GRAYER,HYAMS,BLUM,DIETL,+      (CERN+MPIM)
HOLLOWAY  74 PR D9 1161       +HULD,JORDAN,KOETZ,BERNSTEIN+     (ILL+ILLC)
LOUIE     74 PL 48B 385       +ALITTI,GANDOIS,CHALCUPKA+       (SACL+CERN)

EMMS      75 NP B96 155       +KINSON,STACEY,VOTRUBA+     (BIRM+DURH+RHEL)
ESTABROO  75 NP B95 322       P.ESTABROOKS,A.D.MARTIN               (DURH)
HYAMS     75 NP B100 205      +JONES,WEILHAMMER,BLUM,DIETL+    (CERN+MPIM)
PAWLICKI  75 PR D12 631       +AYRES,DIEBOLD,GREENE,KRAMER,WICKLUND (ANL)
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Mesons

D(1285), A_2(1310)

Data Card Listings

For notation, see key at front of Listings.

D(1285)

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8  C(1285,JPG=  +) I=0
(JP=0-,1+,2- WITH 1+ FAVORED.)

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                8  D MASS (MEV)

M        (1290.)   APPROX.           BARLOW    67 HBC     1.2 PBAR P, 4PFS  5/67
M         1283.0      5.0            DAHL      67 HBC      1.6-4.2 PI- P   10/66
M         1290.       7.             D.ANDLAU  68 HBC   1.2 PBAR P, 5-6 PFS 6/68
M        (1310.0)                    DEFOIX    68 HBC      1.2 PB P,7 PI    3/69
M         1270.0     10.0            CAMPBELL  69 DBC      2.7 PI+ D        8/69
M         1285.       7.             LORSTAD   69 HBC   0.7 PB P, 4,5-BODY  9/69
M         1303.0      8.0            BARDADIN  71 HBC     8 PI+ P, P+6PI    9/69
M         1283.0      6.0            BOESEBECK 71 HBC     16.0 PI P,5 PI    6/71
M     150 1292.      10.             DEFOIX    72 HBC     0.7 PBAR P,7 PI   1/73
M     180 1286.       3.             DUBOC     72 HBC     1.2 PBAR P,2K4PI 12/72
M   S 500(1280.)     (3.)            THUN      72 MMS     13.4 PI- P       12/72
M   S  SEEN IN THE MISSING MASS SPECTRUM                                   12/72
M           . . . . . . . . .
M   AVG     1286.1    2.2      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
M   STUDENT1285.9     2.2      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                8  D WIDTH (MEV)

W   R      (35.0)   (10.0)           DAHL      67 HBC      1.6-4.2 PI- P   11/71
W  U        46.      20.             D.ANDLAU  68 HBC   1.2 PBAR P, 5-6 PFS 2/72
W  U   UNFOLDED BY DOBRZYNSKI 71
W   R      (40.0)                    DEFOIX    68 HBC      1.2 PB P,7 PI   11/71
W           30.0     15.0            CAMPBELL  69 DBC      2.7 PI+ D        8/69
W   R      (60.)    (15.)            LORSTAD   69 HBC   0.7 PB P, 4,5-BODY 11/71
W   R      (44.0)   (24.0)           BARDADIN  71 HBC     8 PI+ P, P+6PI   11/71
W           10.0     10.0            BOESEBECK 71 HBC     16.0 PI P,5 PI    6/71
W   R  150  (28.)    (5.)            DEFOIX    72 HBC     0.7 PBAR P,7 P9   1/73
W   R  180  (46.)    (9.)            DUBOC     72 HBC     1.2 PBAR P,2K4PI 12/72
W   S  500  (37.)    (5.)            THUN      72 MMS     13.4 PI- P       12/72
W   S   SEEN IN THE MISSING MASS SPECTRUM                                  12/72
W   R  RESOLUTION NOT UNFOLDED                                             11/71
W           . . . . . . . . .
W   AVG     20.6      9.6      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
W   STUDENT 20.6      9.2      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                8  D   PARTIAL DECAY MODES

                                                        DECAY MASSES
P1     D INTO K KBAR PI                                 497+ 497+ 134
P2     D INTO PI PI RHO                                 134+ 134+ 773
P3     D INTO ETA PI PI                                 548+ 134+ 134
P4     D INTO DELTA PI                                  976+ 134
P5     D INTO 2PI+ 2PI-                                 139+ 139+ 139+ 139

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                8  D BRANCHING RATIOS

R1     D INTO (PI PI RHO) / (K KBAR PI)                 (P2)/(P1)
R1          (2.0)  OR LESS           DAHL      67 HBC     CHARGED PI ONLY 10/66
R1  D       (4.0)  OR LESS           DONALD    69 HBC     1.2 PBAR P,5P+ .
R1  D        THIS IS FOR (RHOO PI+ PI-)/(K KBAR PIO)

R2     D INTO (K KBAR PI)/(ETA PI PI)                   (P1)/(P3)
R2 K R       0.166    0.055          DEFOIX    68 HBC     1.2 PBAR P        1/73
R2   R  REVISED BY DEFOIX 72
R2           0.16     0.08           CAMPBELL  69 DBC     2.7 PI+ D         1/73
R2 K         0.20     0.08           DEFOIX    72 HBC     0.7 PBAR P,7 PI   1/73
R2 K    K KBAR SYSTEM CHARACTERIZED BY THE I=1 THRESHOLD
R2 K    ENHANCEMENT (SEE UNDER DELTA(970)).
R2          . . . . . . . . .
R2  AVG      0.173    0.039    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  STUDENT  0.173    0.042    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R3     D INTO (DELTA PI)/(ETA PI PI)                    (P4)/(P3)
R3           POSSIBLY SEEN           AMMAR     70 HBC       4.1,5.5K-,ETA   5/70
R3           POSSIBLY SEEN           OTWINOWSK 70 HBC     8 PI+ P, P+6PI    9/69
R3          (0.8)     (0.2)          DEFOIX    72 HBC     0.7 PBAR P,7 PI . 1/73

R4     D INTO (2PI+ 2PI- (INCL. RHO PI PI))/(ETA PI+ PI-)
R4                                                      (P5)/(2/3P3)
R4      50   (0.55) OR MORE          BOESEBECK 71 HBC     16. PI+- P,P 5PI 11/71

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REFERENCES FOR D


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D.ANDLAU 65 PL 17 347          +BARLOW,ADAMSON,+      (CDEF+CERN+IRAD+LIVP)
MILLER   65 PRL 14 1074        +CHUNG,DAHL,HESS,HARDY,KIRZ,+      (LRL+UCB)
BARLOW   67 NC  50 A  701      +MONTANET,D-ANDLAU+    (CERN+CDEF+IRAD+LIVP)
DAHL     67 PR 163 1377        +HARDY+HESS+KIRZ+MILLER                (LRL)I JP
D.ANDLAU 68 NP  B 5  693       +ASTIER,BARLOW+        (CDEF+CERN+IRAD+LIVP)I JP
DEFOIX   68 PL 28 B 353        +RIVET,SIAUD,CONFORTO+      (CDEF+IPNP+CERN)

CAMPBELL 69 PRL 22 1204        +LICHTMAN,+                           (PURD)
DONALD   69 NP B 11 551        +EDWARDS,BURAN,BETTINI,+   (LIVP+OSLO+PADO)
LORSTAD  69 NP B 14 63         B.LORSTAD,D.ANDLAU,ASTIER,+      (CDEF+CERN)  JP
OTWINOWS 69 PL 29 B 529        S.OTWINOWSKI                        (WARSAW)

AMMAR    70 PR D2 430          +KROPAC,DAVIS,DERRICK+ (KANS+NWES+ANL+WISC)

BARDADIN 71 PR D4 2711         BARDADIN-OTWINOWSKA,HOFMOKL,MICHEJDA+(WARS)
BOESEBEC 71 PL 34 B 659               (AACH+BERL+BONN+CERN+CRAC+HEID+WARS)
GOLDBERG 71 LNC 1 627          +MAKOWSKI,TOUCHARD,DONALD,+       (IPN+LIVP)  JP

BERENYI  72 NP B 37 621        +PRENTICE,STEENBERG,YOON,WALKER (TNTO+WISC)
CHAPMAN  72 NP B 42 1          +CHURCH,LYS,MURPHY,RING,VANDER VELDE (MICH)
DEFOIX   72 NP B 44 125        +NASCIMENTO,BIZZARRI,+           (CDEF+CERN)
DUBOC    72 NP B 46 429        +GOLDBERG,MAKOWSKI,DONALD,+      (LPNP+LIVP)
THUN     72 PRL 28 1733        +BLIEDEN,FINOCCHIARO,BOWEN,+     (STON+NEAS)

VUILLEMI 75 LNC 14 165         VUILLEMIN,+       (LALS+NEUC+LPNP+LIVP+GLAS)  JP

HANDLER  76 NP                 +PLANO,BRUCKER,KOLLER+      (RUTG+STEV+SETO)

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A_2(1310)

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12  A2(1310,JPG=2+-) I=1

WE LIST THE A2 AS AN ORDINARY BREIT-WIGNER RESONANCE.
FOR DISCUSSION OF THE REPORTED SPLITTING SEE OUR
APRIL 72 AND APRIL 73 EDITION.

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                12  A2 MASS (MEV),  3PI MODE

M        (1320.0)                  ADERHOLZ  64 HBC      4.0 PI+P
M        (1335.0)   (10.0)         GOLDHABER 64 HBC  +-  3.7 PI+- P      12/75*
M    1425 1290.0     (5.0)         LEFEBVRES 65 MMSP  -  5.6,6.0 PI-P     1/73
M        (1290.0)   (10.0)         BARNES    66 HBC   -  6.0 PI-P         2/73
M        (1310.0)   (10.0)         BENSON    66 DBC   0 3.65 PI+D        12/75*
M    1060 1286.      (8.)          LEVRAT    66 MMS   -   6-7 PI- P       1/73
M  O 4000(1307.)    (16.)          CHIKOVANI 67 MMS   -  7 PI- P         12/75*
M     260 1311.0     6.0           ARMENISE  68 DBC   0 5.1 PI+D          9/67
M     120 1320.      10.           BOESEBECK 68 HBC   0 8 PI+ P           6/68
M  O     (1310.)    (20.)          CHUNG     68 HBC   -  2.7-4.5 PI- P    5/68
M        (1301.0)    (8.0)         VON KROGH 68 HBC   -  6.7 PI- P        9/68
M  A     (1300.0)    (4.0)         JUNKMANN  68 HBC   -  16. PI- P, 5PI   1/73
M  A     (1299.)    (14.)          LAMSA     68 HBC   -  8 PI- P          1/71
M  O     (1295.0)   (20.0)         ANDERSON  69 MMS   -  16 PI- P,BACKW9  8/69
M  A  241(1299.0)   (12.0)         ARMENISE  69 DBC  +   5.1 PI+D,3PI++-  5/70
M         1310.0     14.0          EISENBERG 69 HBC  +  4.3,5.3 GAMMA P  12/69
M         1305.      (3.)          ASCOLI    70 HBC   -  5 - 7.5 PI- P    1/71
M     941 1306.0     4.0           ALSTON-GA 70 HBC  + 7.0 PI+P,3PI P     1/71
M     280 1313.0     7.0           BOCKMANN  70 HBC    05. PI+P           5/70
M  A  581(1288.0)   (10.0)         CASO      70 HBC   - 11.2PI-P,PI RHO   1/73
M  O     (1335.0)   (15.0)         DIAZ      70 HBC  +- 0. PBAR P, 4 PI  12/75*
M  O     (1330.0)   (15.0)         GARFINKEL 70 DBC   -   4.5 K-D,LAMBDA 12/75*
M        (1274.0)   (22.0)         GORDON    70 DBC   0 4.2 PI+ D       . 1/71
M     360 1304.0     4.5           BARNHAM   71 HBC  +  3.7 PI+ P,(3PI)+ 11/71
M   10000 1307.      5.            BINNIE1   71 MMS   - PI-P NEAR A2 THR 11/71
M    5000 1309.      5.            BINNIE1   71 MMS   - PI-P NEAR A2 THR 11/71
M   28000 1299.0     6.0           BOWEN     71 MMS   - 5. PI- P         11/71
M   24000 1300.      6.0           BOWEN     71 MMS  +  5. PI+ P         11/71
M   17000 1309.0     4.0           BOWEN     71 MMS   - 7. PI- P         11/71
M     160 1307.      7.            BLOODWORT 72 HBC  +  5.45 PI+ P,P 3PI  1/73
M  P       1315.     5.            ANTIPOV1  73 CNTR -  25.,40. PI- P     1/74
M    1580 1306.      9.            CHALOUPKA 73 HBC  -  3.9 PI- P,P A2    2/73
M  P 1600 1318.      7.            EMMS      75 DBC    04.  PI+N,P A20   11/75*
M  P 1200 1298.      8.            WAGNER    75 HBC    07.  PI+P,DEL++A2 11/75*
M
M   O   ONLY EXPERIMENTS GIVING ERROR LESS THAN 15 MEV KEPT FOR AVERAGING  12/75*
M  A    ANALYSIS COMPLICATED BY NEARBY PEAK (A1.5) AND/OR A1
M  P    FROM A FIT TO JP=2+ RHO PI PARTIAL WAVE
M          . . . . . . . . .
M   AVG     1307.7    1.4     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1307.7     1.7     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                12  A2 MASS (MEV), K KBAR MODE

MK      80(1317.0)   (3.0)            BARLOW    67 HBC  +-  1.2 PBAR P, KK . 2/72
MK      60 1333.0    13.0             BARLOW    67 HBC  +-  1.2 PBAR P, KK   9/67
MK  N     (1344.0)   (7.)     (6.)    BEUSCH    67 OSPK  0 5-12 PI-P,K1K1  11/71
MK     130 1280.0    12.0             CONFORTO  67 HBC  +-  0. PBAR P IN KK. 9/67
MK         1317.2     4.0             DAHL      67 HBC   -  2.7-4.5 PI- P    8/67
MK  N     (1315.7)  (10.8)            DAHL      67 HBC   0 2.7-4.5 PI- P   11/71
MK  N     (1311.0)   (5.0)            CRENNELL  68 HBC   0 6.0 PI-P,K1K1   11/71
MK     132 1301.0     7.0             ALSTON-GA 70 HBC  +  7.0 PI+P,K+KS P   1/71
MK     190 1313.0     7.0             CRENNEL   71 HBC  - 4.5 PI- P,KSK-P  11/71
MK S  1500 1319.0     3.0             GRAYER    71 ASPK - 17.2 PI-P,K-KS P  2/72
MK     730 1313.0     4.0             FOLEY     72 CNTR - 20.3 PI- P,K- KS 12/72
MK
MK  N   THE NEUTRAL MODE CAN INTERFERE WITH THE F MESON
MK S    SYSTEMATIC ERROR IN MASS SCALE SUBTRACTED
MK         . . . . . . . . .
MK  AVG     1315.0    3.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
MK  STUDENT1315.4     2.2     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                              (SEE IDEOGRAM BELOW )
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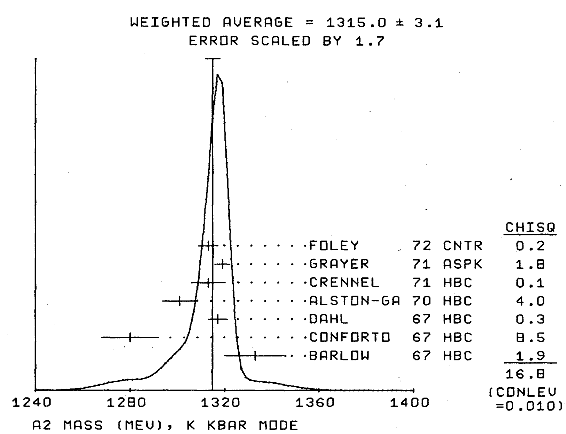

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Data Card Listings

For notation, see key at front of Listings.

Mesons

$A_2(1310)$

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                        12  A2 MASS (MEV),  ETA PI MODE

M       189 1312.0      7.0                 ALSTON-GA 70 HBC  +  7.0 PI+P,PI ETA    1/71
M           1300.0     20.0                 CASO      70 HBC   - 11.2PI-P,PI ETA    5/70
M        32 1300.0      8.                  DZIERBA   70 HBC   -  8. PI- P,PI ETA   1/73
M        30 1288.       7.                  JOHNSTON  70 HBC   -  7.PI-P,PI-ETA P   1/71
M           1320.      20.                  ESPIGAT   72 HBC  +- 0.PBAR P,ETA 2PI  11/71
M  E   1000 1323.       8.                  KEY       73 OSPK -  6.PI-P,P PI-ETA    1/74
M  EM  6200(1324.)     (8.)                 CONFORTO  73 OSPK -  6.PI-P,P MMS-      1/74
M  E    ERROR INCLUDES 5 MEV SYSTEMATIC MASS-SCALE ERROR
M   M   MISSING MASS WITH ENRICHED MMS=ETA PI-, ETA = 2 GAMMA
M            . . . . . . . . .
M   AVG     1305.3      5.8      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
M   STUDENT1306.0       5.0      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                       (SEE IDEOGRAM BELOW )
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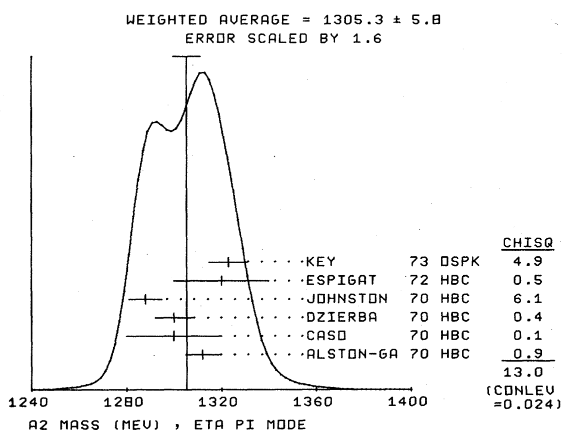


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                        12  A2 WIDTH (MEV), 3PI MODE

W           (100.0)                          ADERHOLZ  64 HBC       4.0 PI+P
W            (90.0)   (10.0)                 GOLDHABER 64 HBC  +-   3.7 PI+- P        12/75*
W     1425   99.0     (15.0)                 LEFEBVRES 65 MMSP  -   6.0 PI-P           1/73
W            (70.0)   (10.0)                 BARNES    66 HBC   -   6.0 PI-P           2/73
W           (100.)    (15.)                  BENSON    66 DBC   0 3.65 PI+D           12/75*
W     1060   98.       (5.)                  LEVRAT    66 MMS   -   6,7 PI- P      .   1/73
W   O 4000  (90.)     (15.)                  CHIKOVANI 67 MMS   -   7 PI- P           12/75*
W      260   96.0      16.0                  ARMENISE  68 DBC   0 5.1 PI+D             9/67
W   O  120  (56.)     (21.)                  BOESEBECK 68 HBC   0 8 PI+ P              1/73
W   O       (80.)     (20.)                  CHUNG     68 HBC   -   2.7-4.5 PI- P      5/68
W           (40.0)    (25.0)                 VON KROGH 68 HBC   -   6.7 PI- P          9/68
W   A       (52.0)    (16.0)                 JUNKMANN  68 HBC   -   16. PI- P, 5PI     1/73
W   O       (90.0)    (10.0)      (50.0)     ANDERSON  69 MMS   -   16 PI- P,BACKW9   12/75*
W   AE 241 (164.0)    (20.0)                 ARMENISE  69 DBC  +    5.1 PI+D,3PI++-    5/70
W   O       (80.0)    (30.0)                 EISENBERG 69 HBC  +  4.3,5.3 GAMMA P     12/69
W      941   79.0      12.0                  ALSTCN-GA 70 HBC  +  7.0 PI+P,3PI P       1/71
W   O  280  (70.0)    (29.0)                 BOCKMANN  70 HBC    05. PI+P              5/70
W   A  581 (135.0)    (26.0)                 CASO      70 HBC   - 11.2PI-P,PI RHO      1/73
W   O       (90.0)    (20.0)                 DIAZ      70 HBC  +- 0. PBAR P, 4 PI      5/70
W   D       (35.0)    (35.0)                 GARFINKEL 70 DBC   -   4.5 K-D,LAMBDA     1/71
W          (215.0)    (22.0)                 GORDON    70 DBC   0 4.2 PI+ D            1/71
W      360  111.4      18.0                  BARNHAM   71 HBC  +  3.7 PI+ P,(3PI)+ 11/71
W    10000 (100.)                            BINNIE1   71 MMS   - PI-P NEAR A2 THR 11/71
W     5000   72.       16.                   BINNIE1   71 MMS   - PI-P NEAR A2 THR 11/71
W    28000  105.0       5.0                  BOWEN     71 MMS   - 5. PI- P            11/71
W    24000   99.0       5.0                  BOWEN     71 MMS  +  5. PI+ P            11/71
W    17000  103.0       5.0                  BOWEN     71 MMS   - 7. PI- P            11/71
W   O  160  (72.)     (25.)                  BLOODWORT 72 HBC  +  5.45 PI+ P,P 3PI 12/72
W  P        115.       15.                   ANTIPOV1  73 CNTR -  25.,40. PI- P        1/74
W     1580   99.       15.                   CHALOUPKA 73 HBC  -  3.9 PI- P,P A2       2/73
W  P  1600  112.       18.                   EMMS      75 DBC    04.  PI+N,P A20      11/75*
W  P S1200  122.       14.                   WAGNER    75 HBC    07.  PI+P,DEL++A2   11/75*
W
W   O   ONLY EXPERIMENTS GIVING MASS ERROR LT. 15 MEV KEPT FOR AVERAGING    12/75*
W   E   BACKGROUND SUBTRACTION MODEL-DEPENDENT.                              5/70
W   D   MAY BE DIFFERENT OBJECT, ALTHOUGH JPC=2++. COMPARE CRENNELL 69.
W  A    ANALYSIS COMPLICATED BY NEARBY PEAK (A1.5) AND/OR A1
W    S  WIDTH ERRORS ENLARGEC BY US TO 4*WIDTH/SQRT(N)
W  P    FROM A FIT TO JP=2+ RHO PI PARTIAL WAVE
W            . . . . . . . . .
W   AVG      101.7      2.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
W   STUDENT  101.9      2.9      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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```
                        12  A2 WIDTH (MEV), K KBAR MODE

WK       60   56.0      28.0                 BARLOW    67 HBC  +-  1.2 PBAR P, KK     9/67
WK       80   56.0      15.0                 BARLOW    67 HBC  +-  1.2 PBAR P, KK     9/67
WK  N        (88.)     (23.)      (22.)      BEUSCH    67 OSPK  0 5-12 PI-P,K1K1    11/71
WK      130  (90.0)                          CONFORTO  67 HBC  +-  0. PBAR P IN KK   9/67
WK            47.       18.                  DAHL      67 HBC   -  2.7-4.5 PI- P     8/67
WK  N        (80.5)    (36.5)                DAHL      67 HBC   0 2.7-4.5 PI- P     11/71
WK  N        (21.0)    (10.0)      (6.0)     CRENNELL  68 HBC   0 6.0 PI-P,K1K1     11/71
WK      132   90.0      24.0                 ALSTON-GA 70 HBC  +  7.0 PI+P,K+KS P    1/71
WK      190  125.0      19.0       16.0      CRENNEL   71 HBC   - 4.5 PI- P,KSK-P   11/71
WK     1500  123.0       7.0                 GRAYER    71 ASPK  - 17.2 PI-P,K-KS P 11/71
WK      730  113.0      19.0                 FOLEY     72 CNTR  - 20.3 PI- P,K- KS 12/72
WK  N   THE NEUTRAL MODE CAN INTERFERE WITH THE F MESON
WK           . . . . . . . . .
WK  AVG      104.2      12.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.3)
WK  STUDENT  107.4       9.1      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                       (SEE IDECGRAM BELOW )
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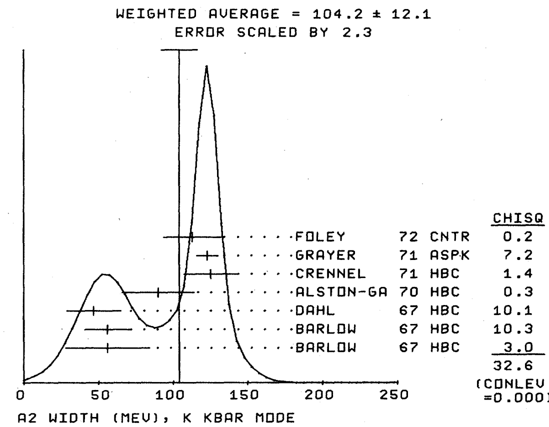


```
                        12  A2 WIDTH (MEV), ETA PI MODE

W       189  103.0      20.0                 ALSTCN-GA 70 HBC  +  7.0 PI+P,PI ETA    1/71
W           (120.0)                          CASO      70 HBC   - 11.2PI-P,PI ETA    5/70
W        32  (41.0)    (20.0)     (16.0)     DZIERBA   70 HBC   -  8. PI- P,PI ETA 11/70
W    T   30  (38.0)    (30.0)                JOHNSTON  70 HBC   -  7.PI-P,PI-ETA P  1/73
W            120.       30.                  ESPIGAT   72 HBC  +- 0.PBAR P,ETA 2PI 11/71
W      1000  108.        9.                  KEY       73 OSPK -  6.PI-P,P PI-ETA    1/74
W    M 6200 (104.)      (9.)                 CONFORTC  73 OSPK -  6.PI-P,P MMS-      1/74
W    M   MISSING MASS WITH ENRICFED MMS=ETA PI-, ETA = 2 GAMMA
W    T   WIDTH ERRCRS ENLARGED BY US TO 4*WIDTH/SQRT(N)
W            . . . . . . . . .
W   AVG      108.1       7.9      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT  108.0       8.5      AVERAGE USING STUCENT10(H/1.11) -- SEE TEXT
```

```
                        12  A2 PARTIAL DECAY MODES

                                                        DECAY MASSES
P1       A2 INTO RHO PI                                773+ 139
P2       A2 INTO K KBAR                                493+ 497
P3       A2 INTO ETA PI                                548+ 139
P4       A2 INTO OMEGA PI PI                           139+ 139+ 783
P5 S     A2 INTO PI+ PI- PIO EXCL.RHO PI               139+ 139+ 134
P6 S     A2 INTO PI+ PI- PI- EXCL.RFO PI               139+ 139+ 139
P7 S     A2 INTO PI GAMMA                              139+   0
P8 S     A2 INTO ETA PRIME PI                          958+ 139
P  S      SMALL, NOT USED IN THE FIT
```

FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
        P 1          P 2          P 3          P 4
P 1 .7C94+-.0179
P 2   -.0332   .0471+-.0054
P 3   -.3024     -.0893   .1504+-.0119
P 4   -.7620     -.2008     -.3224  .0930+-.0186
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```
                        12  A2 BRANCHING RATIOS

R1     A2 (CHARGED ONLY) INTO (K KBAR)/(RHO PI)          (P2)/(P1)
R1  N       (0.13)    (0.03)             BEUSCH    67 OSPK   0 5,7,12 PI-+        9/67
R1  N  THE NEUTRAL MODE CAN INTERFERE WITH F.
R1     11    0.09      0.06      0.09    ASCOLI    68 HBC   -   5 PI-P              6/68
R1           0.054     0.022             CHUNG     68 HBC   -   3.2 PI-P          . 1/67
R1          (0.03)    (0.012)            DCNALD    68 HBC  +-   1.2 PBAR P        . 2/72
R1           0.06      0.03              ABRAMOVIC 70 HBC   -   3.93 PI- P          1/71
R1           0.07      0.03              NEF       70 MMS   -   7.0 PI- P           6/70
R1    113    0.097     0.018             ALSTON-GA 71 HBC  +    7.0 PI+ P           2/71
R1     50    0.056     0.014             CHALOUPKA 73 HBC   -  3.9 PI- P,P A2       2/73
R1          . . . . . . . . .
R1  AVG      0.0677    0.0089  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  STUDENT  0.067     0.010   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1  FIT      0.0665    0.C078 FRCM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2     A2 INTO (ETA PI)/(RHO PI + K KBAR + ETA PI)      (P3)/(P1+P2+P3)
R2     34    0.15      0.04              BARNHAM   71 HBC  +  3.7 PI+ P            11/71
R2           0.13      0.04              ESPIGAT   72 HBC  +- 0.PBAR P,            11/71
R2          . . . . . . . . .
R2  AVG      0.140     0.028   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  STUDENT  0.140     0.030   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2  FIT      0.166     0.012  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
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Mesons

$A_2(1310)$

Data Card Listings

For notation, see key at front of Listings.

```
R3      A2 INTO (ETA PI) / (RHO PI)                                   (P3)/(P1)
R3              0.3       0.2                ADERHOLZ  64 HBC          4.0 PI+P
R3              0.22      0.09               CONTE     67 HBC   -     11.0 PI-P            8/67
R3        22    0.23      0.08               ASCOLI    68 HBC   -      5 PI-P              6/68
R3              0.12      0.C8               CHUNG     68 HBC   -      3.2 PI-P           12/66
R3              0.16      0.10               KEY       68 HBC   -      3 PI-P            .11/67
R3   D         (0.18)    (0.06)              VETLITSKY 69 HBC   -      3.3 PI- P           9/68
R3              0.3       0.13               ABRAMCVIC 70 HBC   -      3.93 PI- P        . 1/71
R3        15    0.25      0.09               BOCKMANN  70 HBC   +      5.0 PI+P            9/69
R3              0.34      0.17      0.34     BOCKMANN  70 HBC     0  5.0 PI+ P             9/69
R3   D    39   (0.18)    (0.C7)              DZIERBA   70 HBC   -      8. PI- P           11/71
R3       167    0.246     0.042              ALSTON-GA 71 HBC   +      7.0 PI+ P           2/71
R3       149    0.211     0.044              CHALOUPKA 73 HBC   -    3.9 PI- P,P A2        2/73
R3        52    0.22      0.05               ANTIPCV   73 CNTR -    40. PI-P,P A2-         1/74
R3            . . . . . . . . .
R3   AVG        0.221     0.021   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3   STUDENT    0.222     0.023   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R3   FIT        0.212     0.019  FRCM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4      A2 INTO (ETA PRIME PI) / TOTAL                                (P8)
R4             (0.1)  OR LESS                CHUNG     65 HBC   -    3.2 PI-P
R4             (0.02) OR LESS  CL=.97        BARNHAM   71 HBC   +   3.7 PI+ P            . 2/72

R5      A2 INTO (ETA PRIME PI)/(RHC PI)                               (P8)/(P1)
R5              0.04      0.03      0.04     BOCKMANN  70 HBC     0 5.0 PI+ P              9/69
R5   D     8   (0.15)    (0.09)              DZIERBA   70 HBC   -    8. PI- P             11/71
R5   D      STRONGLY DEPENDENT ON BACKGROUND SUBTRACTION                                  11/71
R5             (0.04) OR LESS                ALSTCN-GA 71 HBC   +    7.0 PI+ P             2/71
R5             (0.011)OR LESS  CL=.90        EISENSTEI 73 HBC   -   5.PI- P,P 6PI          1/74

R6      A2 INTO (PI+ PI- PI0) / (RFG PI)                              (P5)/(P1)
R6             (0.17) OR LESS                BENSON    66 DBC     0 3.7 PI+D

R7      A2 INTO (ETA PI)/(K KBAR)                                     (P3)/(P2).
R7   E         (3.0)   OR LESS               FOSTER    68 HBC   -    PBAR P,PBA REST. 11/71
R7   E SUPERSEDED BY ESPIGAT 72 (SEE UNDER R2 AND R8)                                     11/71
R7            . . . . . . . . .
R7   FIT        3.19      0.46    FROM FIT

R8      A2  INTO (K KBAR)/(RHO PI + K KBAR + ETA PI)                  (P2)/(P1+P2+P3)
R8        17    0.06      0.03               BARNHAM   71 HBC   +  3.7 PI+ P,KSK+P    11/71
R8   A         (0.020)   (0.004)             ESPIGAT   72 HBC   +- 0.PBAR P,              2/72
R8   A    NOT AVERAGED BECAUSE OF DISCREPANCY BETWEEN MASSES                          .
R8   A    FROM  (K KBAR)  AND  (RFO PI)  MODES
R8         8    0.03      0.02               DAMERI    72 HBC   -  11. PI- P            12/72
R8              0.05      0.02               TOET      73 HBC   +  5. PI+ P,P K+ KO 12/75*
R8              0.09      0.04               TOET      73 HBC     0 5.PI+P,PI+P K KB 12/75*
R8            . . . . . . . . .
R8   AVG        0.048     0.012   AVERAGE (ERRGR INCLUDES SCALE FACTCR OF 1.0)
R8   STUDENT    0.048     0.014   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R8   FIT        0.0520    0.0C58 FRCM FIT (ERRGR INCLUDES SCALE FACTOR OF 1.0)

R9      A2 INTO (PI+ PI- PI-)/(RHO0 PI-)                              (P6C)/(P1C)
R9             (0.23) OR LESS  CL=.90        ABRAMGVIC 70 HBC   -   3.93 PI- P            1/71

R11     A2 INTO (PI GAMMA)/TCTAL                                      (P7)
R11 R          (0.005)   (0.005)   (0.003)EISENBERG 72 HBC        PHOTOPRODUCTICN     11/71
R11 R     PION EXCHANGE MODEL USEC IN THIS ESTIMATION                                     11/71

R12     A2 INTO (OMEGA PI PI)/(RFO PI)                                (P4)/(P1)
R12  D          0.19      0.08               DEFOIX    73 HBC     0 0.7 PBAR P,7 PI      1/74
R12  D    DECAYS TO B1(1040) PI, B1 INTC CMEGA PI .
R12  D    ERROR INCREASED TO ACCOUNT FOR POSSIBLE SYST. ERRORS
R12  D    OF COMPLICATED ANALYSIS.
R12             0.08      0.05               GARNJOST  72 HBC     0 7.1 PI+ P             2/73
R12      279    0.10      0.05               CHALOUPKA 73 HBC   -  3.9 PI- P,P A2         2/73
R12       60    0.28      0.09               DIAZ      74 DBC     0 6.PI+N,P(5PI)0        1/74
R12  K 140      0.29      0.08               KARSHCN   74 HBC     0 4.9 PI+P,DEL++A2 12/75*
R12  K  60       .10       .04               KARSHON   74 HBC   + 4.9 PI+P,P A2+     12/75*
R12  K    KARSHON 74 SUGGEST AN ACDITIONAL I=0 STATE, STRONGLY COUPLED
R12  K    TO OMEGA PI PI  COULD EXPLAIN DISCREPANCIES IN BRANCHING RATIOS
R12  K    AND MASSES.
R12           . . . . . . . . .
R12 AVG         0.131     0.032   AVERAGE (ERROR INCLUDES SCALE FACTCR OF 1.4)
R12 STUDENT     0.127     0.027   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R12 FIT         0.131     0.029  FRGM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)
                                 (SEE IDEOGRAM BELOW )
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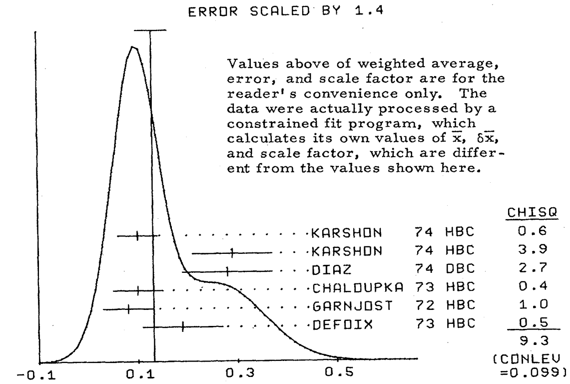
WEIGHTED AVERAGE = 0.131 ± 0.032
ERROR SCALED BY 1.4



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REFERENCES FOR A2


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ADERHCLZ 64 PL 10 248            (AACHEN+BERLIN+BIRM+BCNN+FAMBURG+LOIC+MPIM)
CHUNG    64 PRL 12 621           +DAHL,HARDY,HESS,KALBFLEISCH,KIRZ      (LRL)
GOLDHABE 64 DUBNA CONF   1 480 G GOLDHABER,S GOLDHABER,OFALLORAN,SHEN(LRL)
LANDER   64 PRL 13 346           +ABOLINS,CARMONY,HENDRIKS,XUONG+ (LA JOLLA)

ABOLINS  65 ATHENS(OHIO)CONF.  +CARMONY,LANDER,XUONG,YAGER       (LA JOLLA)I=1
ADERHOLZ 65 PR 138 B 897            (AACHEN+BERL+BIRM+BONN+HAMB+LOIC+MPIM)
ALITTI   65 PL 15 69             ALITTI,BATON,DELER,CRUSSARD+  (SACLAY+BGNA)  JP
CHUNG    65 PRL  15  325         +CAHL,HARDY,HESS,JACOBS,KIRZ,MILLER    (LRL)
FORINO   65 PL 19 68             +GESSAROLI+        (BGNA+BARI+FIRZ+ORSA+SACL)
LEFEBVRE 65 PL 19 434            CERN MISSING MASS SPECTROMETER GROUP (CERN)
SEIDLITZ 65 PRL 15 217           L SEIDLITZ,O I CAHL,D H MILLER         (LRL)

BARNES   66 PRL 16 41            BARNES,FOWLER,LAI,ORENSTEIN +     (BNL+CUNY)
BENSON   66 MICH COO-1112-4      G.C.BENSON, THESIS                    (MICH)
   ALSO  66 PRL 16 1177          G BENSON,LOVELL,MARQUIT,ROE  +        (MICH)
EHRLICH  66 PR 152 1194          R. EHRLICH,W.SELOVE,H.YUTA            (PENN)
FERBEL   66 PL 21 111            FERBEL                           (ROCHESTER)
LEVRAT   66 PL  22  714          CERN MISSING MASS SPECTROMETER GROUP (CERN)

ARMENISE 67 PL 25B 53            ARMENISE,FORINO,+     (BARI+BGNA+FIRZ+ORSAY)
BALTAY   67 PL 25B 160           +KIRSCH+KUNG+YEH+RABIN    (COLU+BNL+RUTGERS)
BARLOW   67 NC 50A 701           +LILLESTOL+MCNTANET+  (CERN+CDEF+IRAD+LIVP)
BARTSCH  67 PL 25B 48            +DEUTSCHMANN+GROTE+COCCGNI+(AACH+BERL+CERN)
BEUSCH   67 PL 25 B 357          +FISCHER,GOBBI,ASTBURY+           (ETHZ+CERN)
CASON    67 PRL 18 880           +LAMSA,BISWAS,DERADO,GROVES,+    (NOTREDAME)
CHIKOVAN 67 PL 25B 44            CERN MISSING MASS SPECTROMETER GROUP (CERN)
CHUNG    67 PRL 18 100           +DAHL,HARDY,HESS,KIRZ,MILLER           (LRL)
   ALSO  66 UCRL-16832           RICHARD I HESS--THESIS,BERKELEY        (LRL)
COHN     67 NP B1 57             +MCCULLCCH+BUGG+CONDO       (ORNL+UNIV.TENN.)
CONFORTO 67 NP B3 469            +MARECHAL,MCNTANET+     (CERN+CDEF+IPN+LIVP)
CONTE    67 NC  51 A  175        +TOMASINI,CORDS+(GENOVA+HAMB+MILANO+SACLAY)
DAHL     67 PR 163 1377          +HARDY+HESS+KIRZ+MILLER                (LRL)
DANYSZ   67 NC 51 A 801          DANYSZ+FRENCH+SIMAK                   (CERN)
SLATTERY 67 NC 50A 377           +KRAYBILL+FORMAN+FERBEL          (YALE+ROCH)  JP

ARMENISE 68 PL 26B 336           ARMENISE,FORINO,+      (BARI+BGNA+FIRZ+ORSAY)
ASCOLI   68 PRL 20  1321         +CRAWLEY,MORTARA,SHAPIRO,BRIDGES+(ILLINOIS)  JP
BALLAM   68 PRL 21 934           +BRODY,CHADWICK,FRIES,GUIRAGOSSIAN+  (SLAC)
BENZ     68 PL 28 B 233          CERN MISSING MASS SPECTROMETER GROUP (CERN)
BOESEBEC 68 NP B 4 501           BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CASO     68 NC 54 A 983          +CONTE+CORDS+DIAZ+ (GENOVA+HAMB+MILAN+SACL)
CHUNG    68 PR 165 1491          S.U.CHUNG,O.DAHL,J.KIRZ,D.H.MILLER     (LRL)
CRENNELL 68 PRL 20 1318          +KARSHON+KWAN LAI,SCARR,SKILLICORN     (BNL)
DONALD   68 PL 26 B  327         +FRODESEN+BETTINI+    (LIVERPOOL+OSLO+PADUA)
FOSTER   68 NP B 8 174           +GAVILLET,LABROSSE,MCNTANET,+    (CERN+CDEF)
FRIDMAN  68 PR 167 1268          +MAURER,MICHALON,OUDET+(HEID    +STRASBOURG)
JUNKMANN 68 NP B8 471            +COCCONI,+          (AACH+BERL+BONN+CERN+WARS)
KEY      68 PR 166 1430          +PRENTICE+COOPER+MANNER+     (TNTO+ANL+WISC)
LAMSA    68 PR 166 1395          +CASON+BISWAS+DERADO+GROVES+     (NOTRECAME)
VCN KROG 68 PL 27 B 253          +MIYASHITA,KOPELMAN,MARSHALL LIBBY    (COLO)

ADERHOLZ 69 NP B 11 259          +BARTSCH,+           (AACH+BERL+CERN+JAGL+WARS)
AGUILAR 169 PL 29 B  62          +BARLOW,JACOBS,DELLA NEGRA+(CERN+CDEF+LIVP)
AGUILAR 269 PL 29 B  241         M.AGUILAR-BENITEZ,J.BARLOW,+     (CERN+CDEF)
ANDERSON 69 PRL 22 1390          +COLLINS,+                        (BNL+CARN)
ARMENISE 69 LNC 2 501            +GHIDINI,FORINO,CARTACCI+  (BARI+BGNA+FIRZ)
CHIKOVAN 69 PL 28 B  526         CERN MISSING MASS SPECTROMETER GROUP (CERN) JP
CRENNELL 69 PRL 22 1327          +KARSHON,KWAN WU LAI,+                (BNL)IJP
DONALD   69 NP B 12 325          +EDWARDS,FOSTER,MOORE            (LIVERPOOL)
EISENBER 69 PRL 23 1322          EISENBERG,HABER,BALLAM,CHACWICK+(REHO+SLAC)
VETLITSK 69 SJNP 9 596           VETLITSKY,GRIGOREYEV,GRISHIN,+        (ITEP)

ABRAMOVI 70 NP B 29 466          ABRAMOVICH,BLUMENFELD,BRUYANT,+     (CERN)  JP
ALSTON-GA70 PL 33 B 607          +BARBARO,BUHL,DERENZO,EPPERSON,FLATTE+(LRL)
ASCOLI   70 PRL 25 962           +BROCKWAY,CRAWLEY,EISENSTEIN,HANFT,+  (ILL)  JP
BASILE   70 LNC 4 838            +CALPIAZ,FRABETTI,MASSAM,+ (CERN+BGNA+STRB)
BAUD1    70 PL 31B  397          CERN BOSON SPECTROMETER GROUP         (CERN)
BAUD2    70 PHILAD.CONF.P.311    CERN BOSON SPECTROMETER GROUP         (CERN)
BAUD3    70 PL 31 B 401          CERN BOSON SPECTROMETER GROUP         (CERN)
BOCKMANN 70 NP B 16 221          +MAJOR,POLS,+     (BONN+DURH+NIJM+EPOL+TORI)
BUTLER   70  UCRL 19845          THESIS                                 (LRL)
CAROLL   70 PRL 25 1393          +FIREBAUGH,GARFINKEL,MORSE,OH,+ (WISC+TNTO)
CASO     70 LNC 3 707            +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
DIAZ     70 NP B 16 239          +GAVILLET,LABROSSE,MCNTANET+    (CERN+CDEF)JP
DZIERBA  70 PR D 2 2544          +SHEPHARD,BISWAS,CASCN,JOHNSON,KENNEY(NDAM)
   ALSO  68 LAMSA
GARFINKE 70 PL 33 B 536          GARFINKEL,AMMANN,CARMCNY,YEN         (PURD)JPC
GORDON   70  COO 1195 179        THESIS,ILLINOIS                        (ILL)
JOHNSTCN 70 NP B 24 253          +KEY,PRENTICE,YOON,GARFINKEL,+  (TNTO+WISC)
KRUSE    70 PHILAD.CONF.P.359 U.KRUSE, PARTIAL WAVE ANALYSIS           (ILL)   JP
NEF      70  THESIS+PRIV.COMM.CERN BOSON SPECTROMETER GROUP            (CERN)
SUTHERLA 70 PHILAD.CCNF.P.369 G.SUTHERLAND,INTERFERING RESONANCE(GLASGOW)

AGUILAR  71 PR D 4 2583          AGUILAR-BENITEZ,EISNER,KINSON          (BNL)
ALSTON-GA71 PL 34 B 156          +BARBARO,BUHL,DERENZO,EPPERSON,FLATTE+(LRL)
BARNHAM  71 PRL 26 1494          +ABRAMS,BUTLER,COYNE,GOLDHABER,HALL,+ (LBL)
BEKETOV  71 SJNP 4 765           +SOMBKOWSKY,KONOWALOV,KRUTSCHININ,+  (ITEP)   JP
BINNIE1  71 PL 36 B 257          +CAMILLERI,DUANE,FARUQI,BURTCN,+(LOIC+SHMP)
BINNIE2  71 PL 36 B 537          +CAMILLERI,DUANE,FARUQI,BURTON,+(LOIC+SHMP)
BOWEN    71 PRL 26 1663          +FARLES,FAISSLER,BLIEDEN,+       (NEAS+STON)
CRENNEL  71 PL 35 B 185          +GORDON,KWAN-WU LAI,SCARR              (BNL)
FARBER   71 NP B 29 237          +DE PINTO,BISWAS,CASGN,DEERY,KENNEY,+(NCAM)
FOLEY    71 PRL 26 413           +LOVE,OZAKI,PLATNER,LINDENBAUM,+ (BNL+CUNY)
GRAYER   71 PL 34 B 333          +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
LYNCH    71 UCRL 20022 AND 71 AMSTERDAM CONF.  G.LYNCH                 (LBL)
RINAUDO  71 NC 5 A 239           +BOECKMANN,MAJOR+(TORI+BONN+DURH+NIJM+EPOL) JP

ANKENBRA 72 PRL 29 1688          ANKENBRANDT,BRABSON,CRITTENDEN,HEINZ,+(IND)
BERENYI  72 NP B 37 621          +PRENTICE,STEENBERG,YOON,WALKER (TNTO+WISC)
BLOODWOR 72 NP B 37 203          BLOCDWORTH,JACKSCN,PRENTICE,YOON      (TNTO)
DAMERI   72 NC 9 A 1             +BORZATTA,GOUSSU,+          (GENO+MILA+SACL)
DAMGAARD 72  UNPUBLISHED MEMO +LECHANOINE,MARTIN                 (BOHR+GEVA)
DIEBOLD  72  BATAV.CONF.         R.DIEBCLD  RAPPCRTEUR TALK             (ANL)
EISENBER 72 PR D 5 15            EISENBERG,BALLAM,DAGAN,+    (REHO+SLAC+TELA)
ESPIGAT  72 NP B 36 93           +GHESQUIERE,LILLESTOL,MONTANET  (CERN+CDEF)
FOLEY    72 PR D 6 747           +LOVE,OZAKI,PLATNER,LINDENBAUM,+ (BNL+CUNY)
GARNJOST 72  PRIV.COMMUNIC.      M.ALSTON-GARNJOST                      (LBL)
GETTNER  72  PREPRINT NUB2145 M.GETTNER                               (NEAS)
KIENZLE  72  UNPUBLISHED MEMO W.KIENZLE                               (CERN)
LASSILA  72 PRL 28 1491          LASSILA,YOUNG                         (IOWA)
MORSE    72 NP B 43 77           +OH,WALKER,JOHNSTCN,YOON         (WISC+TNTO)
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Data Card Listings

Mesons

For notation, see key at front of Listings. $A_2(1310)$, E(1420), $X_0(1430)$, $X_1(1440)$, f′(1514)


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AMMANN   73 PR D 7 1345         +CARMONY,GARFINKEL,GUTAY,MILLER+(PURD+IUPU)
ANKEBRAN 73 PR D 8 2785         ANKEBRANDT,BRABSCN,CRITTENCEN,HEINZ,+ (IND)
ANTIPOV  73 NP B 63 175         +ASCOLI,BUSNELLO,FOCACCI,+       (CERN+SERP)  JP
ANTIPOV1 73 NP B 63 153         +ASCOLI,BUSNELLO,FOCACCI,+       (CERN+SERP)  JP
ANTIPOV2 73 NP B 63 141         +ASCOLI,BUSNELLC,FOCACCI,+       (CERN+SERP)  JP
BLOODWOR 73  AIX CONF. PAPER    BLOODWORTH,FRIDMAN,JACKSON,PATEL,+    (IPPC)
CASON    73 NP B 64 14          +MACDEN,BISHOP,BISWAS,KENNEY,+        (NDAM)
CHALOUPK 73 PL 44 B 211         CHALOUPKA,DOBRZYNSKI,FERRANDO,LOSTY,+(CERN)
CONFORTO 73 PL 45 B 154         +MOBLEY,KEY,PERPOST,+  (EFI+FNAL+TNTO+WISC)
DEFOIX   73 PL 43 B 141         +DOBRZYNSKI,ESPIGAT,NASCIMENTO,+      (CDEF)
EISENSTE 73 PR D 7 278          EISENSTEIN,SCHULTZ,ASCOLI,IOFFREDO,+   (ILL)
KEY      73 PRL 30 503          +CONFORTO,MOBLEY,+     (TNTO+EFI+FNAL+WISC)
TOET     73 NP B 63 248         +THUAN,MAJOR,RINAUDO,+(NIJM+BONN+DURH+TORI)

DIAZ     74 PRL 32 260          +DIBIANCA,FICKINGER,ANDERSON,+  (CASE+CARN)
KARSHON  74 PRL 32 852          +MIKENBERG,PITLUCK,EISENBERG,RONAT+  (REHO)
OTTER    74 NP B80 1            +RUDOLPH+        (AACH+BERL+BCNN+CERN+HEID)  JP
TABAK    74  BOSTON             +RCNAT,ROSENFELD,LASINSKI+       (LBL+SLAC)  JP
THOMPSO1 74 PR D9 560           THCMPSON,GAIDOS,MCILWAIN,WILLMANN    (PURD)  JP
THOMPSO2 74 NP B69 381          THOMPSON,BADEWITZ,GAIDOS,MCILWAIN+   (PURD)  JP

ABASHIAN 75 PRL 34 691          +BEAMER,BROSS,EISENSTEIN,+    (ILL+ANL+ISU)
EMMS     75 PL 58B 117          +JONES,KINSON,STACEY,BELL+ (BIRM+DURH+RHEL)  JP
LOSTY    75 PL 56B 96           +CHALOUPKA,MONTANET,GANDOIS+     (CERN+SACL)  JP
UNDERWOO 75 PR D11 2345         UNDERWOOD,CONFORTO,KEY+(EFI+FNAL+TNTO+WISC)
    ALSO 73 CONFORTO, 73 KEY
WAGNER   75 PL 58B 201          +TABAK,CHEW                            (LBL)  JP

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E(1420)

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6  E(1420,JPG=A +) I=0

BAILLON 67 FAVOR JP=0-. DAHL 67 FAVOR 1+ BUT DO NOT
EXCLUDE 2-, 0-. LORSTAD 69 FIND 0- CR 1+.
VUILLEMI 75 FAVOUR 1+.

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                    6  E MASS (MEV)

M          1425.      7.              BAILLON   67 HBC    0. PBAR P       11/66
M          1420.     20.              DAHL      67 HBC   1.6-4.2 PI- P     9/66
M          1423.0    10.0             FRENCH    67 HBC    3-4 PBAR P       6/67
M      310 1420.      7.              LORSTAD   69 HBC 0.7 PB P, 4,5-BODY  9/69
M      170 1398.     10.              DEFOIX    72 HBC   0.7 PBAR P,7 PI   1/73
M      280 1406.      7.              DUBOC     72 HBC   1.2 PBAR P,2K4PI 12/72
M          . . . . . . . . . .
M   AVG    1415.5     4.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
M   STUDENT1416.0     4.3     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    6  E WIDTH (MEV)

W            80.     10.              BAILLON   67 HBC    0. PBAR P       11/66
W            60.0    20.0             DAHL      67 HBC   1.6-4.2 PI- P    10/66
W            45.     20.              FRENCH    67 HBC    3-4 PBAR P       6/67
W      310   60.     20.              LORSTAD   69 HBC 0.7 PB P, 4,5-BODY  9/69
W      170   50.     10.              DEFOIX    72 HBC   0.7 PBAR P,7 PI   1/73
W      280   50.     12.              DUBOC     72 HBC   1.2 PBAR P,2K4PI 12/72
W          . . . . . . . . . .
W   AVG      59.8     6.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
W   STUDENT  58.3     6.7     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    6  E PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     E INTO K K*(892)                                 497+ 892
P2     E INTO K KBAR PI                                 497+ 497+ 139
P3     E INTO PI PI RHO                                 134+ 134+ 773
P4     E INTO DELTA PI                                  976+ 139
P5     E INTO ETA PI PI                                 548+ 139+ 139

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                    6  E BRANCHING RATIOS

R1     E INTO (KBAR K*(892) + C.C.)/(K KBAR PI)         (P1)/(P2)
R1            .50       .10           BAILLCN   67 HBC     0.0 PBAR P      11/66

R2     E INTO (PI PI RHO) / (K KBAR PI)                 (P3)/(P2)
R2          (2.0)  OR LESS            DAHL      67 HBC  0  1.6-4.2 PI- P .10/66

R3     E INTO (ETA 2 PI)/(K KBAR PI)                    (P5)/(P2)
R3          (1.5)  OR LESS  CL=.95    FOSTER    68 HBC  - 0.0 PBAR P        9/69
R3           1.5       0.8            DEFOIX    72 HBC     0.7 PBAR P       1/73

R4     E INTO (DELTA PI)/(ETA PI PI)                    (P4)/(P5)
R4           0.4       0.2            DEFCIX    72 HBC     0.7 PBAR P,7 PI  1/73

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REFERENCES FOR E


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BAILLON  67 NC 50A  393         +EDWARDS+D.ANDLAU+ASTIER+  (CERN+CDEF+IRAD)
BARASH   67 PR 156  1399        BARASH,KIRSCH,MILLER,TAN          (COLUMBIA)
DAHL     67 PR 163 1377         +HARDY+HESS+KIRZ+MILLER              (LRL)I JP
    ALSO 65 PRL 14 1074         MILLER,CHUNG,DAHL,HESS,HARDY,KIRZ+(LRL+UCB)
FRENCH   67 NC 52A 438          +KINSON+MCDONALD+RIDDIFORD+      (CERN+BIRM)

FOSTER   68 NP B 8 174          +GAVILLET,LABRCSSE,MCNTANET,+    (CERN+CDEF)
BETTINI  69 NC 62 A 1038        +CRESTI,LIMENTANI,BERTAUZA,BIGI+(PADO+PISA)IC
LORSTAD  69 NP B 14 63          B.LCRSTAD,D.ANDLAU,ASTIER,+      (CDEF+CERN)  JP
DEVONS   71 PRL 27 1614         +KOZLOWSKI,HORWITZ,+             (COLU+SYRA)

CHAPMAN  72 NP B 42 1           +CHURCH,LYS,MURPHY,RING,VANDER VELDE (MICH)
DEFOIX   72 NP B 44 125         +NASCIMENTO,BIZZARRI,+           (CDEF+CERN)
DUBOC    72 NP B 46 429         +GOLDBERG,MAKOWSKI,DCNALD,+      (LPNP+LIVP)

VUILLEMI 75 LNC 14 165          VUILLEMIN,+      (LAUS+NEUC+LPNP+LIVP+GLAS)  JP

HANDLER  76 NP                  +PLANO,BRUCKER,KOLLER+      (RUTG+STEV+SETO)

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$X_0(1430) \rightarrow K_S K_S, \rho^0 \rho^0$

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29  X(1430,JPG=    ) I=0

EVIDENCE NOT COMPELLING.OMITTED FROM TABLE.
PEAKS SEEN IN (KS KS) SPECTRA QUOTED UNDER
X(1440) (I=1) AS WELL.

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                    29  X(1430) MASS (MEV)

M    -------RHOO RHOO MODE-------
M        (1410.0)                     BETTINI   66 DBC   0 0. PBAR N,5 PI   2/74

M    -------KS KS MODE ----------
M   B     POSSIBLY SEEN               ABRAMS    67 HBC     4.25 K- P        5/67
M   B     THE AUTHORS ASSOCIATE THE PEAK WITH THE F PRIME, BUT BACKGROUND
M   B     ESTIMATION IS DIFFICULT
M         1412.      23.              BARLOW    67 HBC     1.2 PBAR P       5/67
M         1439.0      5.0      6.0    BEUSCH    67 OSPK    5,7,12 PI-P      9/67
M         . . . . . . . . . .
M   AVG   1437.5      5.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1437.7     5.9     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    29  X(1430) WIDTH (MEV)

W    -------RHOO RHOO MODE-------
W         (90.0)                      BETTINI   66 DBC   0 0. PBAR N,5 PI   2/74

W    -------KS KS MODE ----------
W          100.      70.              BARLOW    67 HBC     1.2 PBAR P       5/67
W           43.0     17.0     18.0    BEUSCH    67 OSPK    5,7,12 PI-P      9/67
W         . . . . . . . . . .
W   AVG     46.4     17.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT 46.2     18.5     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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REFERENCES FOR X(1430)


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BETTINI  66 NC 42A 695          +CRESTI,LIMENTANI,LORIA,PERUZZO+(PACO+PISA)
ABRAMS   67 PRL 18 620          +KEHOE,GLASSER,SECHI-ZORN,WOLSKY (MARYLAND)
BARLOW   67 NC  50 A  701       +MCNTANET,C-ANDLAU+    (CERN+CDEF+IRAD+LIVP)
BEUSCH   67 PL 25 B 357         +FISCHER,GOBBI,ASTBU+            (ETHZ+CERN)
DONALD   69 NP B 11 551         +EDWARDS,BURAN,BETTINI,+    (LIVP+OSLO+PADO)

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$X_1(1440) \rightarrow K_S K_S$

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38  X(1440,JPG=    ) I=1

EVIDENCE NOT COMPELLING.OMITTED FROM TABLE.
PEAKS SEEN IN (KS KS) SPECTRA QUOTED UNDER
X(1430) (I=0) AS WELL.

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                    38  X(1440) MASS (MEV)

M   B     POSSIBLY SEEN               ABRAMS    67 HBC     4.25 K- P        5/67
M   B     THE AUTHORS ASSOCIATE THE PEAK WITH THE F PRIME, BUT BACKGROUND
M   B     ESTIMATION IS CIFFICULT
M         1412.      23.              BARLCW    67 HBC     1.2 PBAR P       5/67
M         1439.0      5.0      6.0    BEUSCH    67 OSPK    5,7,12 PI-P      9/67
M        (1425.0)                     FOLEY     71 CNTR  - 20.3 PI- P,K- KS 2/71
M        (1405.)                      DEFOIX    73 HBC   0 0.7 PBAR P,7 PI  1/74
M         . . . . . . . . . .
M   AVG   1437.5      5.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1437.7     5.9     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    38  X(1440) WIDTH (MEV)

W          100.      70.              BARLOW    67 HBC     1.2 PBAR P       5/67
W           43.0     17.0     18.0    BEUSCH    67 OSPK    5,7,12 PI-P      9/67
W         (20.0)  OR LESS             FOLEY     71 CNTR  - 20.3 PI- P,K- KS 2/71
W         (40.)                       DEFOIX    73 HBC   0 0.7 PBAR P,7 PI  1/74
W         . . . . . . . . . .
W   AVG     46.4     17.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT 46.2     18.5     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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REFERENCES FOR X(1440)


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ABRAMS   67 PRL 18 620          +KEHOE,GLASSER,SECHI-ZORN,WOLSKY (MARYLAND)
BARLOW   67 NC  50 A  701       +MONTANET,D'ANDLAU+    (CERN+CDEF+IRAD+LIVP)
BEUSCH   67 PL 25 B 357         +FISCHER,GOBBI,ASTBURY+          (ETHZ+CERN)
FOLEY    71 PRL 26 413          +LOVE,OZAKI,PLATNER,LINDENBAUM,+ (BNL+CUNY)
DEFOIX   73 PL 43 B 141         +DOBRZYNSKI,ESPIGAT,NASCIMENTO,+      (CDEF)

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f′(1514)

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13  F PRIME(1514,JPG=2++) I=0
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                    13  F PRIME MASS (MEV)

M       14(1480.0)                    CRENNELL  66 HBC      6.0 PI- P       8/66
M   B    5(1460.)    (10.)            ABRAMS    67 HBC     4.25 K- P        5/67
M   B   BACKGROUND ESTIMATION DIFFICULT.                                    5/67
M          1515.0     7.0             AMMAR     67 HBC      5.5 K-P         9/67
M   S   70(1513.0)   (7.0)            BARNES    67 HBC      4.6, 5. K- P   12/72
M   S   SUPERSEDED BY AGUILAR 72
M      100 1519.      7.              AGUILAR   72 HBC     3.9,4.6 K- P    12/72
M       46 1514.      4.              COLLEY    72 HBC     10.K+ P         12/72
M       47 1521.      7.              VIDEAU    72 HBC     4.K- P,L FPRIME 12/72
M          . . . . . . . . . .
M   AVG    1516.1     2.8     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1516.1     3.1     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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Mesons

f'(1514), F_1(1540), ρ'(1600)

Data Card Listings

For notation, see key at front of Listings.

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                    13  F PRIME WIDTH (MEV)

W   B    5  (53.)     (18.)           ABRAMS    67 HBC     4.25 K- P          5/67
W   B   BACKGROUND ESTIMATION DIFFICULT.                                      5/67
W           35.0      25.0            AMMAR     67 HBC      5.5 K-P           9/67
W   S   70  (87.0)    (15.0)          BARNES    67 HBC      4.6, 5. K- P     12/72
W   S   SUPERSEDED BY AGUILAR 72
W      100   69.       22.            AGUILAR   72 HBC     3.9,4.6 K- P      12/72
W       46   28.       15.            COLLEY    72 HBC     10.K+ P           12/72
W   E   47   40.       20.            VIDEAU    72 HBC     4.K- P,L FPRIME   12/72
W   E   ERROR INCREASED BY US.SEE TYPED NOTE ON K* MASS.                     12/72
W        . . . . . . . . .
W   AVG       39.9      9.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT   39.3     11.0      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    13  F PRIME PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      F PRIME INTO PI+ PI-                                139+ 139
P2      F PRIME INTO K KBAR                                 497+ 497
P3      F PRIME INTO K K*(892)                              493+ 892
P4      F PRIME INTO ETA ETA                                548+ 548
P5      F PRIME INTO PI PI ETA                              139+ 139+ 548
P6      F PRIME INTC PI K KBAR                              139+ 497+ 497
P7      F PRIME INTO PI+ PI+ PI- PI-                        139+ 139+ 139+ 139

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                    13  F PRIME BRANCHING RATIOS

R1      F PRIME INTO (PI+ PI-)/(K KBAR)                   (P1)/(P2)
R1            (0.2)  OR LESS  CL=.67   AMMAR     67 HBC      5.5 K-P           9/67
R1            (0.36) OR LESS  CL=.95   AGUILAR   72 HBC     3.9,4.6 K- P      12/72
R1 M           (.01) OR LESS           BEUSCH    75 OSPK    8.9 PI-P,KO KO N  12/75*
R1 M     MODEL DEPENDENT

R3      F PRIME INTO (ETA ETA)/(K KBAR)                   (P4)/(P2)
R3            (0.50) OR LESS           BARNES    67 HBC      4.6, 5.0 K- P    10/67

R4      F PRIME INTO (PI PI ETA)/(K KBAR)                 (P5)/(P2)
R4            (0.3)  OR LESS  CL=.67   AMMAR     67 HBC                       10/67
R4   A        (0.25)   (0.13)          BARNES    67 HBC      4.6, 5.0 K- P    10/67
R4   A   SUPERSEDED BY AGUILAR 72
R4            (0.41) OR LESS  CL=.95   AGUILAR   72 HBC     3.9,4.6 K- P      12/72

R5      F PRIME INTO (PI K KBAR + K K*(892))/(K KBAR)     (P6+P3)/(P2)
R5            (0.4)  OR LESS  CL=.67   AMMAR     67 HBC                       10/67
R5            (0.35) OR LESS  CL=.95   AGUILAR   72 HBC     3.9,4.6 K- P      12/72

R6      F PRIME INTC (PI+ PI+ PI- PI-)/(K KBAR)           (P7)/(P2)
R6            (0.32) OR LESS  CL=.95   AGUILAR   72 HBC     3.9,4.6 K- P      12/72

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                          REFERENCES FOR F PRIME

BARNES    65 PRL 15 322         +CULWICK,GUIDONI,KALBFLEISCH,GOZ+(BNL+SYRA)
CRENNELL  66 PRL  16  1025      + KALBFLEISCH,LAI,SCARR,SCHUMANN +     (BNL)I
ABRAMS    67 PRL 18 620         +KEHOE,GLASSER,SECHI-ZORN,WOLSKY (MARYLAND)
AMMAR     67 PRL  19  1071      +DAVIS,HWANG,DAGAN,DERRICK +     (NWES+ANL)  JP
BARNES    67 PRL  19  964       +DORNAN,GOLDBERG,LEITNER +   (BNL+SYRACUSE)ICJP
ALITTI    68 PRL 21 1705        +BARNES,CRENNELL,FLAMINIO,GOLDBERG,+  (BNL)

LORSTAD   69 NP B 14 63         B.LORSTAD,D.ANDLAU,ASTIER,+       (CDEF+CERN)
SCOTTER   69 NC 62 A 1057       +ERSKINE,PALER,+  (BIRM+GLAS+LOIC+MPIM+OXF)

AGUILAR   72 PR D 6 29          AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS   (BNL)
COLLEY    72 NP B 50 1          +JOBES,RIDDIFORD,GRIFFITHS,+      (BIRM+GLAS)
VIDEAU    72 PL 41 B 213        +VIDEAU,ROUGE,BARRELET,DEBRICN,+(EPCL+SACL)

BEUSCH    75 PL 60 B 101        +BIRMAN,WEBSDALE,WETZEL           (CERN+ETHZ)

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F_1(1540) → KKπ

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47  F1(1540,JPG=   ) I=1

JP = 2-,1+ FAVCRED .
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                    47  F1 MASS (MEV)

M        10(1490.0)   (20.0)          ADERHOLZ  69 HBC  +   8 PI+ P,KKBARPI.11/69
M       142 1540.0      5.0           AGUILAR   69 HBC     0.7PBARP,KKBARPI 11/69
M        25(1543.0)    (3.0)          DUBOC     71 HBC    0 1.1-1.2 PBAR P . 2/72
M   B    70(1557.)    (10.)           BAKKEN    75 HBC  +  19 PP,PN3PI      12/75*
    B    DUBIOUS BACKGROUND SUBTRACTION

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                    47  F1 WIDTH (MEV)

W        10   (85.0)   (39.0)         ADERHOLZ  69 HBC  +   8 PI+ P,KKBARPI 11/69
W       142    40.0     15.0          AGUILAR   69 HBC     0.7PBARP,KKBARPI 11/69
W        25   (16.0)   (10.0)         DUBOC     71 HBC    0 1.1-1.2 PBAR P   2/72
W   B    70   (40.)    (10.)          BAKKEN    75 HBC  +  19 PP,PN3PI      12/75*
    B    DUBIOUS BACKGROUND SUBTRACTION

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                    47  F1 PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      F1 INTO K KBAR PI                                   134+ 497+ 497
P2      F1 INTO K*(892) KBAR                                892+ 497
P3      F1 INTO 3 PI                                        139+ 139+ 139

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                          REFERENCES FOR F1

ADERHOLZ  69 NP B 11 259        +BARTSCH,+          (AACH+BERL+CERN+CRAC+WARS)
AGUILAR   69 PL 29 B 379        +BARLOW,JACOBS,D ANDLAU,ASTIER+ (CERN+CDEF)
AGUILAR   69 NP B 14 195        +BARLOW,JACOBS,D ANDLAU,ASTIER+ (CERN+CDEF)

DUBOC     71 PL 34 B 343        +GOLDBERG,MAKOWSKI,TOUCHARD,+    (IPNP+LIVP)

CHAPMAN   72 NP B 42 1          +CHURCH,LYS,MURPHY,RING,VANDER VELDE (MICH)
DUBOC     72 NP B 46 429        +GOLDBERG,MAKOWSKI,DONALD,+      (LPNP+LIVP)

BAKKEN    75 NP B90 227         +JACOBSEN,OLSSON,SKJEVLING              (OSLO)G=-

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ρ'(1600) → 4π

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65  RHO PRIME(1600,JPG=1-+) I=1
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The ρ' was first seen in

$$\gamma \text{ (real or virtual) } \rightarrow \rho'^0 \rightarrow \rho^0\pi^+\pi^-$$

with the $\pi^+\pi^-$ pair apparently in an S wave (BINGHAM 72, DAVIER 73, SCHACHT 74, ALEXANDER 75). A peak seen in the cross section of the reaction $e^+e^- \rightarrow \pi^+\pi^-\pi^+\pi^-$ has also been claimed as evidence for the ρ' (BARBARINO 72, CONVERSI 74); however, exchange mechanisms can be invoked that reproduce these results without any ρ' (HIRSCHFELD 74).

Evidence for a 2π decay has been looked for in several phase-shift analyses of one $\pi^-p \rightarrow \pi^-\pi^+n$ experiment (GRAYER 74). The first phase-shift solution found yielded clear evidence for $\rho' \rightarrow \pi^+\pi^-$ (HYAMS 73, OCHS 73). Since then, however, it has been recognized that at least four distinct solutions fit the data, and at most two of these exhibit any ρ' effect (ESTABROOKS 74, HYAMS 75). In an attempt to constrain the solutions further (by requiring them to be compatible with fixed-t and fixed-u analyticity for negative values of t and u), FROGGATT 75 conclude that only one solution is favored: essentially solution B of ESTABROOKS 74 or solution +-- of HYAMS 75. This solution shows considerable evidence for the $\rho' \rightarrow \pi\pi$ signal.

Note that none of the solutions has any evidence for a ρ'(1250). Finally, there is indirect evidence for the ρ' from a model-independent analysis of the pion form factor data in the space-like and time-like regions (LANG 75).

The mass and width values listed below are only indicative, because for such a broad peak they are extremely dependent on the parametrization chosen (SMADJA 72). Note also that the mass dependence of the width will be strongly affected by the inelastic channels with their rather high thresholds. For the photoproduction data, possibly diffractive background could explain the observed energy dependence of the width (SCHACHT 74).

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Data Card Listings

For notation, see key at front of Listings.

Mesons

$\rho'(1600)$, $A_3(1640)$

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                    65  RHO PRIME MASS (MEV)

M   C      (1600.)   APPROX.          BARBARINO 72 OSPK  0 E+ E- TO 4 PI     1/73
M   C    SUPERSEDED BY CONVERSI 74
M      400 1430.       50.            BINGHAM   72  HBC  0 9.3 GAM P,P 4PI  12/72
M          1590.       20.            HYAMS     73 ASPK  0 17 PI-P,N PI+PI-  1/74
M          1550.       60.            CONVERSI  74 OSPK   0 E+ E- TO 4PI    12/75*
M      160 1550.       50.            SCHACHT   74 STRC   05.5-9 G P,P 4PI  12/75*
M      340 1450.      130.            SCHACHT   74 STRC   09-18 G P,P 4PI   12/75*
M       65 1570.       60.            ALEXANDER 75 HBC    07.5 GAM P,P 4PI  12/75*
M   P      (1600.)    (50.)           FROGGATT  75 RVUE    17 PI-P,PI+PI-N  12/75*
M   P    FROM PHASE SHIFT ANALYSIS OF HYAMS 73 DATA
M         . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

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                    65  RHO PRIME WIDTH (MEV)

W      400  650.      100.            BINGHAM   72  HBC  0 9.3 GAM P,P 4PI  12/72
W           180.       50.            HYAMS     73 ASPK  0 17 PI-P,N PI+PI- 12/75*
W           360.      100.            CONVERSI  74 OSPK   0 E+ E- TO 4PI    12/75*
W  E   160  400.      120.            SCHACHT   74 STRC   05.5-9 G P,P 4PI  12/75*
W  E   340  850.      200.            SCHACHT   74 STRC   09-18 G P,P 4PI   12/75*
W  E    65  340.      160.            ALEXANDER 75 HBC    07.5 GAM P,P 4PI  12/75*
W   P      (220.)     (70.)           FROGGATT  75 RVUE    17 PI-P,PI+PI-N  12/75*
W   P    FROM PHASE SHIFT ANALYSIS OF HYAMS 73 DATA
W  E     WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N)
W         . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)

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                    65  RHO PRIME PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      RHO PRIME INTO RHO PI PI                        139+ 139+ 773
P2      NEUTRAL RHO PRIME INTO ALL 4 CHARGED PI MODES   139+ 139+ 139+ 139
P3      RHO PRIME INTO RHO RHO                          773+ 773
P4      RHO PRIME INTO PI PI                            139+ 139
P5      RHO PRIME INTO KBAR K                           493+ 493
P6      RHO PRIME INTO PI OMEGA                         139+ 783
P7      RHO PRIME INTO PI+ PI- PIO PIO                  139+ 139+ 134+ 134

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                    65  RHO PRIME BRANCHING RATIOS

R1      RHO PRIME INTO (RHO PI+ PI-)/(4 PI, ALL CHARGED) (P1)/(P2)
R1 S       DOMINANT                   BARBARINO 72 OSPK  0 E+E- TO 4 PI      1/73
R1 S         (.80)                    BINGHAM   72  HBC  0 9.3 GAM P,P 4PI   1/73
R1      500    0.7       0.1          SCHACHT   74 STRC   05.5-18 G P,P 4PI 12/75*
R1 S     THE PI PI SYSTEM IS IN S WAVE                                       1/73

R2      RHO PRIME INTO (RHO 0 RHO 0)/(RHO 0 PI+ PI-)      (P3)/(P1)
R2            NONE    (FORBIDDEN BY I=1)BINGHAM   72  HBC  0 9.3 GAM P,P 4PI   1/73

R3      RHO PRIME INTO (PI+ PI-)/(4 PI, ALL CHARGED)      (P4)/(P2)
R3           (.2)  OR LESS  2 SIGMA  BINGHAM   72  HBC  0 9.3 GAM P,P 2PI   1/73
R3          (0.14) OR LESS  ESTIMATE DAVIER    73 STRC  0 6-18 G P,P 4PI    1/74

R4      RHO PRIME INTO (KBAR K)/(4 PI, ALL CHARGED)       (P5)/(P2)
R4          (.04) OR LESS  2 SIGMA  BINGHAM   72  HBC  0 9.3 GAM P         . 1/73

R5      RHO PRIME INTO (PI+PI-)/TOTAL                     (P4)
R5  E       (0.15) OR LESS            EISENBERG 73 HBC   0 5 PI+ P,DEL++2PI  1/74
R5  E    ESTIMATED USING OPE MODEL.
R5           0.25      0.05           HYAMS     73 ASPK  0 17 PI-P,N PI+PI-  1/74
R5  P        (.35)     (.10)          FROGGATT  75 RVUE    17 PI-P,PI+PI-N  12/75*
R5  P    FROM PHASE SHIFT ANALYSIS OF HYAMS 73 DATA

R6      RHO PRIME INTO (PI+ PI- PIO PIO)/(4PI, ALL CHARGED)
R6                                                        (P7)/(P2)
R6          (1.)    OR LESS  ESTIMATE DAVIER    73 STRC  0 6-18 G P,P 4PI    1/74

R7      RHO PRIME INTO (PI+ PI- + NEUTRALS)/(4PI,ALL CHARGED)
R7                                                        (P7+....)/(P2)
R7  U       (2.6)     (0.4)           BALLAM    74 HBC    0 9.3 GAMMA P     12/75*
R7  U    UPPER LIMIT. BACKGROUND NOT SUBTRACTED

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REFERENCES FOR RHO PRIME


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ALVENSLE 71 PRL 26 273          ALVENSLEBEN,BECKER,BERTRAM,CHEN,+(DESY+MIT) G
BRAUN    71 NP B30 213          +FRIDMAN, GERBER, GIVERNAUD,+  (STRASBOURB) G
BULOS    71 PRL 26 149          +BUSZA,KEHOE,BENISTON,+  (SLAC+UMD+IBM+LBL) G

BACCI    72 PL 38B 551          +PENSO,SALVINI,STELLA,BALDINI-CE(ROMA+FRAS) JPC
BARBARIN 72 LNC 3 689           BARBARINO,CERADINI,+    (FRAS+ROMA+PADO+UMD)IGJP
BARTOLI  72 PR D 6 2374         +FELICETTI,OGREN,+           (FRAS+ROMA+NAPL)IGJP
BINGHAM  72 PL 41B 635          +RABIN,ROSENFELD,SMADJA,YOST+(LBL,UCB,SLAC)IGJP
BRAMON   72 LNC 3 693           +GRECO (THEORETICAL PAPER)        (FRASCATI)
DIEBOLD  72  BATAV.CONF.        R.DIEBOLD  RAPPORTEUR TALK              (ANL)
EISENBER 72 PR D 5 15           EISENBERG,BALLAM,DAGAN,+   (REHO+SLAC+TELA)
LAYSSAC  72 NC 10A 407          J.LAYSSAC,F.M.RENARD                   (MONT)
SMADJA   72 PHIL.CONF.PROC349 +BINGHAM,FRETTER,BALLAM,CHADWICK+(LBL+SLAC)

CERADINI 73 PL 43 B 341         +CONVERSI,EKSTRAND,GRILLI,+(ROMA+FRAS+PADO)IGJP
DAVIER   73 NP B 58 31          +DERADO,FRIES,LIU,MOZLEY,ODIAN,PARK,+(SLAC)
EISENBER 73 PL 43 B 149         EISENBERG,KARSHON,MIKENBERG,PITLUCK,+(REHO)
HYAMS    73 NP B 64 134         +JONES,WEILHAMMER,BLUM,DIETL,+  (CERN+MPIM)
KREUZER  73 PR D 8 1431         H.J.KREUZER,A.N.KAMAL     (UNIV. OF ALBERTA)
OCHS     73 THESIS              THESIS                                 (MPIM)
PARK     73 NP B 58 45          J.C.H.PARK                             (MPIM)  JP

BALLAM   74 NP B76 375          +CHADWICK,BINGHAM,FRETTER+  (SLAC+LBL+MPIM)
BERNABEI 74 LNC 11 261          +D.ANGELO,SPILLANTINI,VALENTE     (ROMA+FRAS)
CONVERSI 74 PL 52B 493          +PAOLUZI,CERADINI,GRILLI+         (ROMA+FRAS)
ESTABROO 74 NP B79 301          P.ESTABROOKS,A.D.MARTIN                (DURH)
FERBEL   74 PR D9 824           T.FERBEL AND P.SLATTERY                (ROCH)
GRAYER   74 NP B 75 189         G.GRAYER,HYAMS,BLUM,DIETL,+       (CERN+MPIM)
HIRSHFEL 74 NP B74 211          A.C.HIRSHFELD,G.KRAMER                 (HAMB)
SCHACHT  74 NP B81 205          +DERADO,FRIES,PARK,YOUNT               (MPIM)

ALEXANDE 75 PL 57B 487          ALEXANDER,BENARY,GANDSMAN,LISSAUER+  (TELA)
ALLES    75 NC 30A 136          ALLES-BORELLI,BERNARDINI+  (CERN+BGNA+FRAS)
ESTABROO 75 NP B95 322          P.ESTABROOKS,A.D.MARTIN                (DURH)
FROGGATT 75 NP B91 454          C.D.FROGGATT,J.L.PETERSEN         (GLAS+NORD)
HYAMS    75 NP B100 205         +JONES,WEILHAMMER,BLUM,DIETL+     (CERN+MPIM)
LANG     75 PL 58B 450          C.B.LANG,I.S.STEFANESCU                (KARL)
LANGACKE 75 PREPRINT UPR0049T P.LANGACKER,G.SEGRE                      (PENN)
ROOS     75 NP B 97 165         M.ROOS                                 (HELS)

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$A_3(1640)$

34 A3(1640, JPG=2--) I = 1

The $A_3(1640)$ is seen as a bump in the diffractive-like process $\pi N \to (\pi\pi\pi)N$. The dominant effect is a ∿300 MeV wide enhancement in the $J^P=2^-$ $f\pi$ S-wave system, starting from $f\pi$ threshold. Neither additional (narrower) structure in the 3π mass distribution, nor other decay modes, have been clearly established. The situation would appear to be similar to that of the A_1, but there are certain additional complications:

a) Experiments with incident π^- observe little variation of the $J^P=2^-$ $f\pi$ phase in the A_3 mass region (ANTIPOV1 73, ASCOLI1 73), whereas experiments with incident π^+ show evidence for variations consistent with a resonance interpretation (OTTER 74, THOMPSON 74).

b) The A_3 region is not well described by the Deck-like model of Ascoli et al., although the agreement could probably be improved by a series of more or less well motivated adjustments to the model (ASCOLI2 73, ASCOLI 74). Nevertheless, relative phase variations of ∿40° through the A_3 mass region are predicted for the 2^- $f\pi$ wave.

c) Other partial waves contribute strongly in the A_3 region. The 2^- $\rho\pi$ P wave may exhibit a broad enhancement; no phase variation relative to 2^- $f\pi$ is observed (ANTIPOV1 73, ASCOLI1 73, OTTER 74, THOMPSON 74). ANTIPOV1 73 show some evidence for an enhancement in the 2^+ $f\pi$ P wave with M ∿ 1750 MeV, Γ ∿ 200 MeV. The relative phases are not inconsistent with a resonance interpretation.

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                    34  A3 MASS (MEV)

M        30(1600.0)                   FORINO    65 DBC    04.5 PI+ D         10/66
M        20(1630.0)    (30.0)         VETLITSKY 66 HBC  -  4.7 PI- P         12/75*
M          (1630.)     (10.)          BALTAY    68 HBC  +  7, 8.5 PI+ P      12/75*
M          (1660.0)    (16.0)         BARTSCH   68 HBC  +  8. PI+ P,3PI P    12/75*
M          (1610.)     (19.)          LAMSA     68 HBC  -  8.0 PI-P, PI-F    12/75*
M       297(1673.0)    (40.0)         ARMENISE  69 DBC  +  5.1 PI+D,3PI++-   12/75*
M          (1680.)     (20.0)         CASO      69 HBC  -  11 PI- P           5/70
M          (1660.0)    (20.0)         CASO      69 HBC  -  11 PI-P, PI-F     12/75*
M          (1645.0)    (10.0)         CRENNELL  70 HBC  -  6. PI- P,F PI     12/75*
M    M     (1633.0)    (12.0)         MIYASHITA 70 HBC  -  6.7 PI-P,PI-F      1/71
M    M  BACKGROUND SUBTRACTION DIFFICULT.
M          (1672.0)                   BEKETOV   71 HBC  -  4.45 PI- P        11/71
M          (1600.)     (50.)          PALER     71 DBC  + 13.PI+ D,D(3PI)+.12/75*
M       260(1660.)     (25.)          CASO      72 HBC  + 11.7 PI+ P         12/75*
M   F      (1658.)      (8.)          HARRISON  72 HBC  - 13.,20. PI- P      12/72
M   F   FIT ASSUMES AN ADDITIONAL PEAK AT 1830 MEV.                          12/72
M   F   EVIDENCE FOR A SUBSTANTIAL DECAY INTO 3PI CLAIMED
M  P       (1650.)     (30.)          ANTIPOV1  73 CNTR - 25.,40. PI- P      12/75*
M  P       (1660.)     (10.)          ASCOLI 1  73 HBC  - 5.-25.PI- P,P A3   12/75*
M  P E     (1600.)     (10.)          THOMPSON  74 HBC  + 13. PI+ P,P A3+    12/75*
M    E  EVIDENCE FOR A ROTATION OF THE PHASE CLAIMED.
M       575(1640.)     (10.)          KALELKAR  75 HBC  + 15 PI+P,P PI+F     12/75*
M  P    FROM A FIT TO JP=2- F PI PARTIAL WAVE
M
M   AVERAGING NOT MEANINGFUL

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Mesons

A_3(1640), ω(1675)

Data Card Listings

For notation, see key at front of Listings.

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                34  A3 WICTH (MEV)

W       20 (100.)                          VETLITSKY 66 HBC   -  4.7 PI-P          6/66
W   M      (70.)     (40.)                 BALTAY    68 HBC   +  7, 8.5 PI+ P      6/68
W          (115.0)   (45.0)                BARTSCH   68 HBC   +  8. PI+ P,3PI P   12/75*
W   M      (100.)    (50.)      (30.)      LAMSA     68 HBC   -  8.0 PI-P  PI-F   11/67
W   A  297 (240.0)   (50.0)                ARMENISE  69 CBC   +  5.1 PI+D,3PI++-   5/70
W   A   BACKGROUND SUBTRACTION MODEL-DEPENDENT.                                    5/70
W          (130.)                          CASO      69 HBC   -  11 PI- P          6/68
W          (150.0)                         CASO      69 HBC   - 11.0 PI-P,PI- F    6/68
W          (130.0)   (30.0)                CRENNELL  70 HBC   -  6. PI- P,F PI   . 5/70
W   M       (37.0)   (24.0)                MIYASHITA 70 HBC   -  6.7 PI-P,PI-F     1/71
W   M   BACKGROUND SUBTRACTICN DIFFICULT.
W          (128.0)                         BEKETOV   71 HBC   -  4.45 PI- P       11/71
W          (220.)    (80.)                 PALER     71 CBC   + 13.PI+ D,D(3PI)+.12/75*
W  P        200. TO 400.                   CASO      72 HBC   + 11.7 PI+ P         1/72
W      260 (190.)   (100.)                 CASO      72 HBC   + 11.7 PI+ P        12/75*
W   F       (53.)    (20.)      (16.)      HARRISON  72 HBC   - 13.,20. PI- P     12/72
W   F   FIT ASSUMES AN ADDITIONAL PEAK AT 1830 MEV.                               12/72
W   F   EVIDENCE FOR A SUBSTANTIAL DECAY INTO 3PI CLAIMEC
W  P       (300.)    (50.)                 ANTIPOV1  73 CNTR - 25.,40. PI- P     12/75*
W  P       (270.)    (60.)                 ASCOLI 1  73 HBC   - 5.-25.PI- P,P A3 12/75*
W  P E     (310.)    (40.)                 THCMPSON  74 HBC   + 13. PI+ P,P A3+  12/75*
W    E  EVIDENCE FOR A ROTATION OF THE PHASE CLAIMED.
W      575 (240.)    (30.)                 KALELKAR  75 HBC   +  15 PI+P,P PI+F   12/75*
W  P    FROM A FIT TO JP=2- F PI PARTIAL WAVE
W
W   AVERAGING NOT MEANINGFUL

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                34  A3 PARTIAL DECAY MODES

                                                                DECAY MASSES
P1      A3 INTO 3 PI                                          134+ 134+ 134
P2      A3 INTO RHO PI                                        134+ 773
P3      A3 INTO ETA PI                                        134+ 548
P4      A3 INTO 5 PI
P5      A3 INTO K K*(892)                                     497+ 892
P6      A3 INTO K KBAR PI                                     497+ 497+ 134
P7      A3 INTO K KBAR                                        497+ 497
P8      A3 INTO F PI                                         1271+ 134
P9      A3 INTO OMEGA PI PI                                   783+ 134+ 134

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                34  A3 BRANCHING RATIOS

R2      A3+- INTO (PI+- RHO0)/(ALL PI+- PI+ PI-)          (P2C)/(P1C)
R2            (0.3)  OR LESS           BARTSCH   68 HBC  +   8. PI+ P,3PI P    8/69
R2            (0.4)  OR LESS           FERBEL    68 RVUE +-                  . 9/68
R2             (.18) OR LESS  CL=.95   PALER     71 DBC  +  13.P++ D,D(3P+)+ 11/71

R3      A3+- INTO (PI+- F)/(ALL PI+- PI+ PI-)             (P8)/(P1C)
R3                   (WITH F INTO PI+ PI-)
R3             INDICATION SEEN         LUBATTI   66 HLBC    16 PI-           11/66
R3            (0.59)FOR JP=2-          BARTSCH   68 HBC  +   8. PI+ P,3PI P    8/69
R3            (0.51)FOR JP=1+          BARTSCH   68 HBC  +   8. PI+ P,3PI P    8/69
R3            (0.20)FOR JP=0-          BARTSCH   68 HBC  +   8. PI+ P,3PI P    8/69
R3            (0.35)    (0.20)         BALTAY    68 HBC  +  7-8.5 PI+P       . 5/68
R3             CONSISTENT WITH 1.0     CASO      68 HBC  -   11 PI- P          6/68
R3            (0.76)    (0.24)  (0.34) ARMENISE  69 CBC  +   5.1 PI+D,3PI++-   5/70
R3             CONSISTENT WITH 1.0     CRENNELL  70 HBC  -   6. PI- P,F PI   . 5/70
R3             (.85) OR MORE  CL=.95   PALER     71 DBC  +  13.P++ D,D(3P+)+ 11/71
R3             CONSISTENT WITH 1.0     LICHTMAN  74 HBC  +- 18.5 PI+-P,P 3PI 12/75*
R3             CONSISTENT WITH 1.0     KALELKAR  75 HBC  +  15 PI+P,P 3PI    12/75*

R5      A3+- INTO (PI+- ETA)/(ALL PI+- PI+ PI-)           (P3)/(P1C)
R5                  (ALL ETA DECAYS)
R5            (0.09) OR LESS           BALTAY    68 HBC  +  7-8.5 PI+P         5/68
R5            (0.10) OR LESS           CRENNELL  70 HBC  -   6. PI- P,F PI     5/70

R6      A3+- INTO (PI+- 2PI+ 2PI-)/(ALL PI+- PI+ PI-)     (P4C)/(P1C)
R6            (0.1)  OR LESS           BALTAY    68 HBC  +  7,8.5 PI+ P        6/68
R6            (0.10) OR LESS           CRENNELL  70 HBC  -   6. P+- P,F P+     5/70

R8      A3+- INTO (RHO PI)/(F PI)                         (P2)/(P8)
R8            (0.03)    (0.37)  (0.03) CASO      69 HBC  -   11 PI- P         12/75*

R9      A3+- INTO (PI+- PI+ PI-)/(F PI)                   (P1C-P8)/(P8)
R9            (0.06)    (0.47)  (0.06) CASO      69 HBC  -   11 PI- P         12/75*
R9           POSSIBLY SEEN             HARRISON  72 HBC  -  13.,20. PI- P     12/72

R10     A3+- INTO (UNCORREL.PI+- PI+ PI-)/(ALL PI+- PI+ PI-)
R10 M          (.05) OR LESS  CL=.95   PALER     71 DBC  +  13. PI+D,D(3PI)+ 11/71
R10 M        MODEL DEPENDENT FIT                                             11/71

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REFERENCES FOR A3


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FORINO    65 PL 19 68              +GESSAROLI+       (BGNA+BARI+FIRZ+ORSA+SACL)
FOCACCI   66 PRL  17  890          CERN MISSING MASS SPECTROMETER GROUP (CERN)
LEVRAT    66 PL   22  714          CERN MISSING MASS SPECTROMETER GROUP (CERN)
LUBATTI   66 THESIS BERKELEY       H.J.LUBATTI                          (LRL)1-2-
VETLITSK  66 PL   21  579          VETLITSKY,GUSZAVIN,KLIGER,ZOLGANOV+  (ITEP)
DANYSZ    67 NC 51 A 801           DANYSZ+FRENCH+SIMAK                  (CERN)
DUBAL     67 NP 83 435             CERN MISSING MASS SPECTROMETER GROUP (CERN)
   ALSO   68 THESIS 1456           L.DUBAL                            (GENEVE)

BALTAY    68 PRL 20 887            +KUNG+YEH+FERBEL+      (COLU+ROCH+RUTG+YALE)I=1
BARTSCH   68 NP B 7 345            +KEPPEL,KRAUS,+              (AACH+BERL+CERN) JP
CASO      68 NC 54 A 983           +CONTE+CORDS+DIAZ+  (GENOVA+HAMB+MILA+SACL)
FERBEL    68 PHILA.CONF.335        T.FERBEL                          (ROCHESTER)
IOFFREDO  68 PRL 21 1212           +BRANDENBURG,BRENNER,EISENSTEIN+  (HARVARD)
LAMSA     68 PR 166 1395           +CASON+BISWAS+DERADO+GROVES+    (NOTREDAME)

ARMENISE  69 LNC 2 501             +GHIDINI,FORINO,CARTACCI+  (BARI+BGNA+FIRZ)
BARNES    69 PRL 23 142            +CHUNG,EISNER,FLAMINIO,+               (BNL)
CASO      69 LNC 2 437             +CONTE,TOMASINI,CANTORE+   (GENO+MILA+SACL)
   ALSO   68 CASO

BRANDENB  70 NP B16 369            +BRENNER,IOFFREDO,JOHNSON,KIM+     (HARVARD)
CRENNELL  70 PRL 24 781            +KARSHON,LAI,SCARR,SIMS                (BNL)
CHIEN     70 PHILAD.CONF.P.275 C.Y.CHIEN, REVIEW               (JOHNS HOPKINS)
MIYASHIT  70 PR D 1 771            MIYASHITA,VCN KROGH,KOPELMAN,LIBBY     (COLO)

BEKETOV   71 SJNP 4 765            +SCMBKOWSKY,KONGWALOV,KRUTSCHININ,+  (ITEP)  JP
PALER     71 PRL 26 1675           +BADEWITZ,BARTON,MILLER,PALFREY,TEBES(PURD)

ALEXANDE  72 NP B 45 29            ALEXANDER,BAR-NIR,BENARY,DAGAN,+      (TELA)
ARMENISE  72 LNC 4 201             +FORINO,CARTACCI,+           (BARI+BGNA+FIRZ)
CASO      72 NP B 36 349           +MADDOCK,BASSLER+(DURH+GENC+DESY+MILA+SACL)
HARRISON  72 PRL 28 775            +HEYDA,JOHNSON,KIM,LAW,MUELLER,+      (HARV)
SALZBERG  72 NP B 41 397           +HARRISON,HEYDA,JOHNSON,KIM,LAW,+     (HARV)

ANTIPOV1  73 NP B 63 153           +ASCOLI,BUSNELLO,FOCACCI,+      (CERN+SERP)  JP
ANTIPOV2  73 NP B 63 141           +ASCOLI,BUSNELLO,FOCACCI,+      (CERN+SERP)  JP
ASCOLI 1  73 PR D 7 669            INTERNAT. COLLABORATION              (ILL+)  JP
ASCOLI 2  73 PR D 8 3894           +JONES,WEINSTEIN,WYLD                 (ILL)  JP

ASCOLI    74 PR D9 1963            +CUTLER,JONES,KRUSE,ROBERTS,WEINSTEIN+(ILL)
LICHTMAN  74 NP B81 31             +BISWAS,CASON,KENNEY,MCGAHAN,+        (NDAM)
OTTER     74 NP B80 1              +RUDOLPH+          (AACH+BERL+BONN+CERN+EID) JP
TABAK     74  BOSTON               +RONAT,ROSENFELD,LASINSKI+      (LBL+SLAC)  JP
THOMPSON  74 PRL 32 331            +BADEWITZ,GAIDOS,MCILWAIN,PALER,+    (PURD)  JP
    ALSO  74 NP B69 381            THOMPSON,BADEWITZ,GAIDOS,MCILWAIN+   (PURD)  JP

BEKETOV   75 SJNP 20 379           +ZOMBKOVSKII,KAIDALOV,KONOVALOV+     (ITEP)
EMMS      75 PL 60 B 109           +JONES,KINSON,BELL,DALE+     (BIRM+DURH+RHEL)  JP
HORNE     75 PR D11 996            +S.HAGOPIAN,V.HAGOPIAN,BENSINGER+(FSU+BRAN)
KALELKAR  75 THESIS(NEVIS 207) M.S.KALELKAR                             (COLU)
WAGNER    75 PL 58B 201            +TABAK,CHEW                           (LBL)  JP

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ω(1675)
$\rightarrow \rho^0\pi^0$

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45  OMEGA(1675,JPG=3--) I=0.

THIS RESONANCE OVERLAPS IN ITS 3PI MODE WITH THE A3,
BUT IN SOME EXPERIMENTS ONE CAN ESTABLISH THE DECAY
MODE RHOO PIO,THUS I=0.WAGNER 74 FINCS JP=3- UNIQUELY.
THE DECAYS INTO 5PI AND OMEGA PI+PI- NEED FURTHER
CONFIRMATION(SEE ALSO X(1690)).

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                45  OMEGA(1675) MASS (MEV)

M           1636.      20.              ARMENISE  68 CBC   5.1 PI+N,P(3PI)0  9/68
M           1670.      20.              KENYON    69 DBC   8.  PI+N,P(3PI)0  8/69
M       200 1679.      17.              MATTHEWS  71 CBC   7.0 PI+N,P(3PI)0. 1/71
M       500 1678.      14.              DIAZ      74 DBC   6.  PI+N,P(3PI)0  1/74
M     Q 200 1660.      13.              DIAZ      74 DBC   6.  PI+N,P(5PI)0  1/74
M     Q  FROM (OMEGA PI PI) MODE
M   P   600 1669.      11.              WAGNER    75 HBC   7. PI+P,DEL++3PI 11/75*
M   P    FROM A FIT TO I=0, JP=3- RHO PI PARTIAL WAVE
M          . . . . . . . . .
M      AVG     1667.1      6.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M      STUDENT1667.5       6.7     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                45  OMEGA(1675) WIDTH (MEV)

W           112.       60.              ARMENISE  68 CBC   5.1 PI+N,P(3PI)0  9/68
W           100.       40.              KENYON    69 DBC   8.  PI+N,P(3PI)0  8/69
W     S 200 155.       40.              MATTHEWS  71 CBC   7.0 PI+N,P(3PI)0 11/75*
W       500 167.       40.              DIAZ      74 CBC   6.  PI+N,P(3PI)0  1/74
W     Q 200 122.       39.              DIAZ      74 CBC   6.  PI+N,P(5PI)0  1/74
W     Q  FRCM (OMEGA PI PI) MODE
W   P S 600 173.       28.              WAGNER    75 HBC   7. PI+P,DEL++3PI 11/75*
W   P    FROM A FIT TO I=0, JP=3- RHO PI PARTIAL WAVE
W     S  WIDTH ERRORS ENLARGEC BY US TO 4*WIDTH/SQRT(N)
W          . . . . . . . . .
W      AVG     145.8      15.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W      STUDENT 146.0      17.9     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                45  OMEGA(1675) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      OMEGA(1675) INTO 3 PI (INCL. RHO PI)              134+ 134+ 134
P2      OMEGA(1675) INTO 5 PI (INCL. OMEGA PI+PI-)        134+ 134+ 134+ 134
P3      OMEGA(1675) INTO RHO PI                           773+ 134
P4      OMEGA(1675) INTO OMEGA PI+ PI-                    783+ 134+ 134
P5      OMEGA(1675) INTO B(1235) PI                      1228+ 134

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                45  OMEGA(1675) BRANCHING RATIOS

R1      OMEGA(1675) INTO (5 PI)/(3 PI)                     (P2)/(P1)
R1              (0.10)    (0.10)            KENYON    69 DBC    8.  PI+N,P(3PI)0. 8/69
R1      200      0.97      0.28             DIAZ      74 DBC    6.  PI+N,P(5PI)0  1/74

R2      OMEGA(1675) INTO (RHO PI)/(3 PI)                   (P3)/(P1)
R2      200   (0.70) OR MORE                MATTHEWS  71 CBC    7.0 PI+N,P(3PI)0 11/71

R3      OMEGA(1675) INTO (OMEGA PI+ PI-)/(RHO PI)          (P4)/(P3)
R3      100      0.47      0.18             DIAZ      74 DBC    6.  PI+N,P(5PI)0  1/74

R4      OMEGA(1675) INTO (B(1235) PI)/(RHO PI)             (P5)/(P3)
R4            POSSIBLY SEEN                 DIAZ      74 CBC    6.  PI+N,P(5PI)0  1/74

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REFERENCES FOR OMEGA(1675)


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ARMENISE 68 PL 26B 336        +GHIDINI,FORINO+ (BARI+BGNA  +FIRZ  +ORSAY)

KENYON    69 PRL 23 146       +KINSON,SCARR,+                (BNL+UCND+ORNL)

ARMENISE 70 LNC 4 199         +GHIDINI,FORINO,CARTACCI,+ (BARI+BGNA+FIRZ)

MATTHEWS 71 PR D 3 2561       +PRENTICE,YOON,CARROLL,+          (TNTO+WISC)
MATTHEW1 71 LNC 1 361         +PRENTICE,YOON,CARROLL,+          (TNTO+WISC)

DIAZ      74 PRL 32 260       +DIBIANCA,FICKINGER,ANDERSON,+  (CASE+CARN)

WAGNER    75 PL 58B 201       +TABAK,CHEW                           (LBL)  JP

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Data Card Listings

For notation, see key at front of Listings.

Mesons
g(1680)

g(1680)

15 G(1680,JPG = 3-+) I=1

This entry contains the 2π, 4π, ωπ, K$\bar{K}$, and K$\bar{K}$π peaks in the region of 1700 MeV. The spin-parity determination and the mass and width in the Meson Table come from the 2π mode. An elasticity of 24% is found at resonance in the ππ elastic partial-wave analysis (HYAMS 75); this is consistent with the assumption that at least some of the effects listed are due to g decay into various channels. On the other hand, some discrepancies in masses, widths, and branching ratios reported indicate that there may be more than one $I^G=1^+$ meson in this region (BARNHAM 70, HOLMES 72, THOMPSON 74). Although we have collected all the data here under a common entry, we do not imply that they are necessarily all related.

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                    15   G MASS (MEV)

M      PI+ PI- MODE
M
M          (1700.0)  (100.0)           BELLINI   65 HLBC   0 6.1 PI-P         12/75*
M          (1640.0)                    FORINO    65 DBC    0 4.5 PI+D          6/66
M           1670.0     30.0            GOLDBERG  65 HBC    0 6 PI+D, 8 PI-P
M          (1683.)    (13.)            ARMENISE  68 DBC    0 5.1 PI+ D       . 6/68
M           1720.0     20.0            CRENNELL  68 HBC    0 6.0 PI- P        12/68
M          (1655.0)   (10.0)           JOHNSTON  68 HBC    0 7.0 PI- P       . 6/68
M           1737.0     23.0            ARMENISE  70 DBC    0 9 PI+ N           1/71
M           1687.      21.             STUNTEBEC 70 HDBC  0 8. PI-P,5.4 PI+D  2/72
M           1678.      12.             MATTHEWS  71 DBC   0  7. PI+ N          2/72
M           1652.      13.             MATTHEWS  71 HBC   0  7. PI- P          2/72
M  E    600 1690.       7.             ENGLER    74 DBC    0 6. PI+N,PI+PI-P 12/75*
M  G        1693.       8.             GRAYER    74 ASPK   0 17 PI-P,PI+PI-N  2/74
M  GI      (1692.)    (12.)            ESTABROOK 75 RVUE    17 PI-P,PI+PI-N  12/75*
M   I      (1722.)     (3.)            HYAMS     75 ASPK   0 17 PI-P,PI+PI-N 12/75*
M
M  E    MASS ERRORS ENLARGED BY US TO WIDTH/SQRT(N)
M   I   FROM PHASE-SHIFT ANALYSIS
M       ERROR TAKES ACCOUNT OF SPREAD OF DIFFERENT PHASE-SHIFT SOLUTICNS
M  G    USES SAME DATA AS HYAMS 75
M             . . . . . . . . .
M   AVG     1687.8      6.4    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
M   STUDENT1688.7       4.9    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                               (SEE IDEOGRAM BELOW )

M      (2PI)+- MODE
M
M           1640.0     25.0            CRENNELL  68 HBC   -   6.0 PI- P       12/68
M       122 1650.0     35.0            BARTSCH   70 HBC   +  8 PI+ P,2 PI      5/70
M          (1632.)     (5.)            THOMPSON  74 HBC   +  13 PI+ P         12/75*
M             . . . . . . . . . .
M   AVG     1643.4     20.3    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1643.4      21.9    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M      K KBAR + K KBAR PI MODE
M
M          (1675.)                     EHRLICH   66 HBC   +-  7.9 PI-P,K KBAR  2/72
M  K       (1700.)                     FRENCH    67 HBC     0 3,3.6 PBAR P     7/67
M  K    OBSERVED IN NEUTRAL(K* KBAR) MODE  (G-PARITY UNKNOWN)
M  F       (1740.)                     FRENCH    67 HBC   (K0 K+-) 3-4 PBAR P  7/67
M  F        SEE FIG. 9 CF FRENCH 67
M           1640.0     20.0     25.0   CRENNELL  68 HBC   +-  6.0 PI-P,KBAR K 12/68
M           1690.0     16.0            ADERHOLZ  69 HBC   +   8 PI+ P,KKBARPI  8/69
M           1692.       6.             BLUM      75 ASPK   018.4 PI-P,N K+K- 11/75*
M             . . . . . . . . . .
M   AVG     1688.7      8.6    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
M   STUDENT1689.5       6.1    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M      (4PI)+- MODE
M
M           1720.      15.             BALTAY    68 HBC   +   7, 8.5 PI+ P     6/68
M  J       (1675.0)   (10.0)           JOHNSTCN  68 HBC   -   7.0 PI- P        6/68
M       144 1680.0     40.0            BARTSCH   70 HBC   +  8 PI+ P,4 PI      4/71
M        90(1640.0)   (20.0)           BARTSCH   70 HBC   +  8 PI+ P,A2 PI     4/71
M  F    102(1689.0)   (20.0)           BARTSCH   70 HBC   +  8 PI+ P,2 RHO     4/71
M           1705.0     21.0            CASO      70 HBC   - 11.2PI-P,RHO 2PI   5/70
M       300(1710.)                     ARMENISE  72 HBC   -  9.1 PI- P,P 4PI  12/72
M           1630.      15.             HOLMES    72 HBC   +  10.-12. K+ P      1/73
M           1687.      20.             CASON     73 HBC   -  8.,18.5 PI- P     1/74
M  F       (1685.)    (14.)            CASCN     73 HBC   -  8.,18.5 PI- P     1/74
M  F     66(1733.)     (9.)            KLIGER    74 HBC   - 4.5 PI-P,P 4PI    12/75*
M           1670.      10.             THCMPSON  74 HBC   +  13 PI+ P         12/75*
M
M  F    FROM (RHO+- RHO0) MODE
M             . . . . . . . . . .
M   AVG     1677.1     13.0    AVERAGE (ERRCR INCLUDES SCALE FACTOR OF 2.0)
M   STUDENT1677.9       9.0    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                               (SEE IDEOGRAM BELOW )
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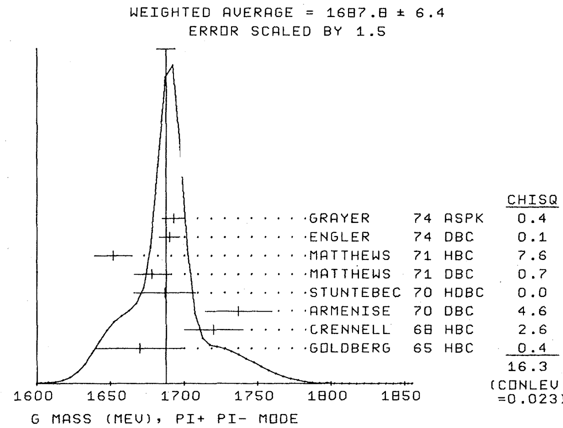

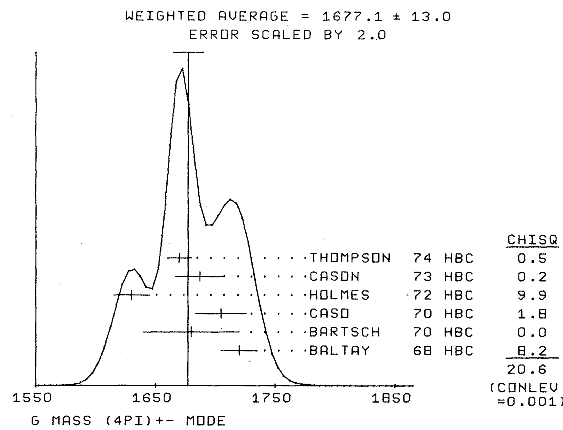


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M      RHO0 RHO0 MODE
M
M          (1700.0)                    MAURER    70 HBC    05.7 PBAR P,7 PI . 2/71
M          (1700.0)                    BRAUN     71 HBC    05.7 PBAR P,7 PI  11/71

M      CMEGA PI  MODE
M
M           1654.      24.             BARNHAM   70 HBC   +  10 K+ P,CMEGA PI  6/70
M           1630.0     11.0            CASO      70 HBC   - 11.2PI-P,PI OMEG   5/70
M          (1666.)    (50.)            CASON     73 HBC   -  8.,18.5 PI- P     1/74
M           1686.       9.             THCMPSCN  74 HBC   +  13 PI+ P         12/75*
M             . . . . . . . . . .
M   AVG     1662.8     18.7    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.8)
M   STUDENT1665.4      14.0    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M       R PEAKS FRCM MMS. (FOR DIFFICULTIES WITH MMS EXPTS. SEE
M                        THE A2 MINI-REVIEW IN THE 1973 EDITION)
M
M  NR1     (1632.)    (15.)            FOCACCI   66 MMS   -   7-12 PI-P,P MMS 12/72
M  NR2     (1700.)    (15.)            FOCACCI   66 MMS   -   7-12 PI-P,P MMS 12/72
M  NR3     (1748.)    (15.)            FOCACCI   66 MMS   -   7-12 PI-P,P MMS 12/72
M  N    NCT SEEN BY BOWEN 72
M   R      (1700.0)   (47.0)           ANDERSON  69 MMS   -  16 PI- P,BACKW    8/69
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                    15   G WIDTH (MEV)

W      PI+ PI- MODE
W
W           (40.0)                     FORINO    65 DBC    0 4.5 PI+D          6/66
W           180.0      40.0            GOLDBERG  65 HBC    0 6 PI+D, 8 PI-P
W           188.       45.             ARMENISE  68 DBC    0 5.1 PI+ D         6/68
W           200.0     100.0            CRENNELL  68 HBC    0 6.0 PI- P        12/68
W           (80.0)    (20.0)           JOHNSTCN  68 HBC    0 7.0 PI- P       . 6/68
W           171.0      65.0            ARMENISE  70 DBC    0 9 PI+ D           1/71
W          267.        72.      46.    STUNTEBEC 70 HDBC  0 8. PI-P,5.4 PI+D  2/72
W           156.       36.             MATTHEWS  71 DBC   0  7. PI+ N          2/72
W            73.       36.             MATTHEWS  71 HBC   0  7. PI- P          2/72
W       600 167.       40.             ENGLER    74 DBC    0 6. PI+N,PI+PI-P 12/75*
W  G        200.       18.             GRAYER    74 ASPK   0 17 PI-P,PI+PI-N  2/74
W  GI      (240.)     (30.)            ESTABROOK 75 RVUE    17 PI-P,PI+PI-N  12/75*
W   I      (267.)     (30.)            HYAMS     75 ASPK   0 17 PI-P,PI+PI-N 12/75*
W
W   I   FROM PHASE-SHIFT ANALYSIS
W       ERROR TAKES ACCOUNT OF SPREAD OF DIFFERENT PHASE-SHIFT SOLUTICNS
W  G    USES SAME CATA AS HYAMS 75
W             . . . . . . . . . .
W   AVG      177.2     15.2    AVERAGE (ERROR INCLUDES SCALE FACTOR CF 1.3)
W   STUDENT 181.2      14.6    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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Mesons

g(1680)

Data Card Listings

For notation, see key at front of Listings.

```
W     (2PI)+- MODE
W
W           200.0     100.0              CRENNELL  68 HBC   -  6.0 PI- P         12/68
W      122  180.0      30.0              BARTSCH   70 HBC   + 8 PI+ P,2 PI        5/70
W           (42.)     (20.)              THOMPSON  74 HBC   + 13 PI+ P           12/75*
W           . . . . . . . . . .
W   AVG     181.7      28.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT 181.6      31.0      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W     K KBAR + K KBAR PI MODE
W
W   F      (120.)    APPROX.             FRENCH    67 HBC  (K0 K+-) 3-4 PBAR P 11/69
W   F       ABOVE VALUE ESTIMATED FROM FIG. 9 OF FRENCH 67
W            79.0      70.0      25.0    CRENNELL  68 HBC  +-  6.0 PI-P,KBAR K 12/68
W           112.0      60.0              ADERHOLZ  69 HBC   +  8 PI+ P,KKBARPI  8/69
W           205.       20.               BLUM      75 ASPK   018.4 PI-P,N K+K- 11/75*
W           . . . . . . . . . .
W   AVG     179.6      33.8      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
W   STUDENT 182.6      23.1      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W     (4PI)+- MODE
W
W           100.       35.               BALTAY    68 HBC   +   7, 8.5 PI+ P      6/68
W   J       (90.0)    (20.0)             JOHNSTON  68 HBC   -   7.0 PI- P         6/68
W   J       NOT SEPARATED FROM 2 PI DECAY
W      144  135.0      30.0              BARTSCH   70 HBC   + 8 PI+ P,4 PI        4/71
W       90 (180.0)    (30.0)             BARTSCH   70 HBC   + 8 PI+ P,A2 PI       4/71
W   F  102 (160.0)    (30.0)             BARTSCH   70 HBC   + 8 PI+ P,2 RHO
W          (160.0)                       CASO      70 HBC   - 11.2PI-P,RHO 2PI  5/70
W      300 (200.)                        ARMENISE  72 HBC   - 9.1 PI- P,P 4PI  12/72
W           130.       30.               HOLMES    72 HBC   + 10.-12. K+ P        1/73
W           169.       70.       48.     CASON     73 HBC   - 8.,18.5 PI- P       1/74
W   F      (125.)     (83.)     (35.)    CASON     73 HBC   - 8.,18.5 PI- P       1/74
W   F   66 (150.)                        KLIGER    74 HBC   - 4.5 PI-P,P 4PI   12/75*
W           106.       25.               THOMPSON  74 HBC   + 13 PI+ P         12/75*
W
W   F   FROM (RHO+- RHO0) MODE
W           . . . . . . . . . .
W   AVG     120.6      14.2      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT 120.6      15.7      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W     OMEGA PI  MODE
W
W           130.       73.       43.     BARNHAM   70 HBC   + 10 K+ P,OMEGA PI   6/70
W           (60.0)                       CASO      70 HBC   - 11.2PI-P,PI OMEG  5/70
W          (194.)     (94.)     (60.)    CASON     73 HBC   - 8.,18.5 PI- P       1/74
W            89.       25.               THOMPSON  74 HBC   + 13 PI+ P         12/75*
W           . . . . . . . . . .
W   AVG      95.4      23.0      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT  95.3      25.0      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W      R PEAKS FROM MMS. (FOR DIFFICULTIES WITH MMS EXPTS. SEE
W                    THE A2 MINI-REVIEW IN THE 1973 EDITION)
W
W  NR1      (21.)    OR LESS             FOCACCI   66 MMS   -   7-12 PI-P,P MMS 12/72
W  NR2      (30.)    OR LESS             FOCACCI   66 MMS   -   7-12 PI-P,P MMS 12/72
W  NR3      (38.)    OR LESS             FOCACCI   66 MMS   -   7-12 PI-P,P MMS 12/72
W  N     NOT SEEN BY BOWEN 72
W   R      (195.0)                       ANDERSON  69 MMS   -  16 PI- P,BACKW    8/69

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15 G PARTIAL DECAY MODES

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                                                                DECAY MASSES
P1      G INTO PI PI                                          139+ 139
P2      G INTO 4PI                                            139+ 139+ 139+ 139
P3      G INTO 2 RHO                                          773+ 773
P4      G INTO PI PI RHO                                      139+ 139+ 773
P5      G INTO A2 PI                                         1310+ 139
P6      G INTO K KBAR                                         497+ 497
P7      G INTO OMEGA PI                                       139+ 783
P8      G INTO K KBAR PI                                      497+ 497+ 139
P9      G INTO PHI PI                                        1020+ 139
P10     G INTO ETA PI                                         548+ 139
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15 G BRANCHING RATIOS

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R1      G INTO (2PI)/TOTAL                                  (P1)
R1  P         (0.4)                     BARTSCH   70 HBC  + 8. PI+ P           2/72
R1  P         (0.22)    (0.04)          MATTHEWS  71 HDBC  0 7. PI+N,PI-P       2/72
R1  P    OPE MODEL USED IN THIS ESTIMATION
R1  G         (.245)    (.006)          ESTABROOK 75 RVUE    17 PI-P,PI+PI-N  12/75*
R1  G    FROM PHASE-SHIFT ANALYSIS OF HYAMS 75 DATA
R1 S           .24       .01            HYAMS     75 ASPK  0 17 PI-P,PI+PI-N 12/75*
R1 S     ERROR TAKES ACCOUNT OF SPREAD OF 4 DIFFERENT PHASE-SHIFT SOLUTIONS

R2      G INTO (PI+- PI0) / (ALL PI+- PI+ PI- PI0)          (P1)/(P2C)
R2  D         (0.08) OR LESS            BALTAY    68 HBC  +   7-8.5 PI+ P       6/68
R2  D          USING DATA OF DEUTSCHMANN 65 ON PI+P TO PI+ PI0 P                6/68
R2             0.8       0.2            JOHNSTON  68 HBC  -   7. PI- P          2/72
R2             0.8       0.15           BARTSCH   70 HBC  + 8. PI+ P            2/72
R2            (0.12) OR LESS            BALLAM    71 HBC  -   16. PI- P         2/72
R2            (0.2)  OR LESS            HOLMES    72 HBC  + 10.-12. K+ P        1/73
R2             0.35      0.11           CASON     73 HBC  - 8.,18.5 PI- P       1/74
R2            . . . . . . . . . .
R2  AVG        0.56      0.16     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)
R2  STUDENT    0.57      0.12     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R3      G+- INTO (2PI)/(2RHO)                               (P1)/(P3)
R3  S         (0.48) OR LESS            BISWAS    68 HBC  -   8. PI- P          2/72
R3  S    SUPERSEDED BY CASON 73                                                 1/74

R4      G+- INTO (K KBAR)/(2PI)                             (P6)/(P1)
R4             0.08      0.08      0.03 CRENNELL  68 HBC      6.0 PI- P        12/68
R4             0.08      0.03           BARTSCH   70 HBC  +   8. PI+ P          1/71
R4            . . . . . . . . . .
R4  AVG        0.080     0.026    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R4  STUDENT    0.080     0.028    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R5      G+- INTO (K KBAR PI)/(2PI)                          (P8)/(P1)
R5             0.10      0.03           BARTSCH   70 HBC  + 8. PI+ P            2/72

R6      G+- INTO (RHO 2PI)/(ALL 4PI)                        (P4)/(P2)
R6             CONSISTENT WITH 1.       CASO      68 HBC  -  11 PI- P           6/68
R6             1.        0.15           BARTSCH   70 HBC  + 8. PI+ P            2/72
R6             0.88      0.15           BALLAM    71 HBC  -   16. PI- P         2/72
R6            . . . . . . . . . .
R6  AVG        0.94      0.11     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R6  STUDENT    0.94      0.12     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R7      G+- INTO (2RHO)/(ALL 4PI)                           (P3)/(P2)
R7             0.7       0.15           BARTSCH   70 HBC  + 8. PI+ P            2/72
R7            (0.92)                    ARMENISE  72 HBC  - 9.1 PI- P,P 4PI    12/72
R7  A         (0.78)    (0.33)          CASON     73 HBC  - 8.,18.5 PI- P       1/74
R7  A    ASSUMING (ALL 4PI)=(RHO RHO) + (OMEGA PI)
R7        66   (.56)                    KLIGER    74 HBC   - 4.5 PI-P,P 4PI    12/75*
R7  T         (0.13)    (0.09)          THOMPSON  74 HBC  + 13 PI+ P           12/75*
R7  T    RHO RHO AND A2 PI MODES ARE INDISTINGUISHABLE

R8      G+- INTO (2 RHO)/(ALL RHO 2PI)                      (P3)/(P4)
R8             0.48      0.16           CASO      68 HBC  -  11 PI- P           6/68
R8            (0.75) OR MORE            BISWAS    68 HBC  -   8. PI- P          2/72

R9      G+- INTO (PI+- A20)/(ALL 4PI)
R9                            (WITH A20 INTO (PI+ PI- PI0))
R9             0.40      0.20           BALTAY    68 HBC  +   7,8.5 PI+P        6/68
R9             NOT SEEN                 JOHNSTON  68 HBC  -   7 PI- P           6/68
R9            (0.6)     (0.15)          BARTSCH   70 HBC  + 8. PI+ P            2/72
R9             NOT SEEN                 CASON     73 HBC  - 8.,18.5 PI- P       1/74

R10     G+- INTO (PI OMEGA)/(ALL 4PI)                       (P7)/(P2)
R10                           (WITH OMEGA INTO(PI+ PI- PI0))
R10            0.25      0.10           BALTAY    68 HBC  +   7-8.5 PI+P        5/68
R10             .25      0.10           JOHNSTON  68 HBC  -   7.0 PI- P         6/68
R10            0.12       0.07          BALLAM    71 HBC  -   16. PI- P         2/72
R10 A         (0.22)    (0.08)          CASON     73 HBC  - 8.,18.5 PI- P       1/74
R10 A    ASSUMING (ALL 4PI)=(RHO RHO) + (OMEGA PI)
R10           (.09) OR LESS             KLIGER    74 HBC   - 4.5 PI-P,P 4PI    12/75*
R10            0.33      0.07           THOMPSON  74 HBC  + 13 PI+ P           12/75*
R10           . . . . . . . . . .
R10 AVG        0.233     0.050    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R10 STUDENT    0.236     0.051    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R11     G+- INTO (PI PHI)/(ALL 4PI)                         (P9)/(P2)
R11           (0.11) OR LESS            BALTAY    68 HBC  +   7,8.5 PI+P        6/68

R12     G+- INTO (PI+- 2PI+ 2PI- PI0)/(ALL PI+- PI+ PI- PI0)
R12           (0.15) OR LESS            BALTAY    68 HBC  +   7,8.5 PI+ P       6/68

R13     G+- INTO (PI ETA)/(ALL 4PI)                         (P10)/(P2)
R13           (0.02) OR LESS            THOMPSON  74 HBC  + 13 PI+ P           12/75*

R14     G0 INTO (2PI+ 2PI-)/(2PI)                           (P2C)/(P1)
R14     G0 INTO (2PI+ 2PI-) FORBIDDEN IF 4PI MODE IS (RHO RHO)
R14            0.44      0.20           KALELKAR  75 HBC    015 PI+P           12/75*

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REFERENCES FOR G


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BELLINI  65 NC 40 A 948         BELLINI,DI CORATO,DUIMIO,FIORINI   (MILANO)
DEUTSCHM 65 PL 18 351           M.DEUTSCHMANN ET AL     (AACHEN+BERLIN+CERN)
FORINO   65 PL 19 65            FORINO,GESSAROLI +   (BOLOGNA+ORSAY+SACLAY)
GOLDBERG 65 PL 17 354           GOLDBERG+ (CERN+EPOL+ORSAY+MILANO+CEA-SACL)

EHRLICH  66 PR 152 1194         R. EHRLICH,W.SELOVE,H.YUTA   (PENNSYLVANIA)
FOCACCI  66 PRL  17  890        CERN MISSING MASS SPECTROMETER GROUP (CERN)
LEVRAT   66 PL  22  714         CERN MISSING MASS SPECTROMETER GROUP (CERN)
SEGUINOT 66 PL 19 712           CERN MISSING MASS SPECTROMETER GROUP (CERN)

ABRAMS   67 PRL 18 620          +KEHOE+GLASSER+SECHI-ZORN+WOLSKY (MARYLAND)
DANYSZ   67 PL 24B 309          +FRENCH+KINSON+SIMAK+       (CERN+LIVERPOOL)
DUBAL    67 NP B3 435           +FOCACCI+KIENZLE+LECHANOINE+LEVRAT+  (CERN)
   ALSO  68 THESIS 1456         L.DUBAL                            (GENEVE)
FRENCH   67 NC 52A 442          +KINSON+MCDONALD+RIDDIFORD+      (CERN+BIRM)

ARMENISE 68 NC 54 A 999         +FORINO+CARTACCI+(BARI+BGNA +FIRENZE+ORSAY)I
BALTAY   68 PRL 20 887          +KUNG+YEH+FERBEL+      (COLU+ROCH+RUTG+YALE)I=1
BISWAS   68 PRL 21 50           +CASON,DZIERBA,GROVES,KENNEY,+        (NDAM)
BOESEBEC 68 NP B 4 501          BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CASO     68 NC 54 A 983         +CONTE+CORDS+DIAZ+  (GENOVA+HAMB+MILA+SACL)
CRENNELL 68 PL 28 B 136         +KARSHON,LAI,SCARR,SKILLICORN          (BNL)
JOHNSTON 68 PRL 20 1414         +PRENTICE,STEENBERG,YOON      (TORONTO+WISC)IJP

ADERHOLZ 69 NP B 11 259         +BARTSCH,+         (AACH+BERL+CERN+JAGL+WARS)
ANDERSON 69 PRL 22 1390         +COLLINS,BLIEDEN+                 (BNL+CARN)
BARISH   69 PR 184  1375        +SELOVE,BISWAS,CASON,+      (PENN+NDAM+ROCH)
CASO     69 NC 62 A 755         +CONTE,BENZ,+     (GENO+DESY+HAMB+MILA+SACL)
VETLITSK 69 SJNP 9 461          +GUZHAVIN,KLIGER,KOLGANOV,LEBEDEV+    (ITEP)

ARMENISE 70 LNC 4  199          +GHIDINI,FORINO,CARTACCI,+ (BARI+BGNA+FIRZ)
BARNHAM  70 PRL 24 1083         +COLLEY,JOBES,KENYON,PATHAK,RIDDIFORD(BIRM)
BARTSCH  70 NP B 22 109         +KRAUS,TSANOS,GROTE,KOTZAN+(AACH+BERL+CERN)
CASO     70 LNC 3 707           +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
KRAMER   70 PRL 25 396          +BARTON,GUTAY,LICHTMAN,MILLER,+     (PURDUE)
MAURER   70  THESIS NO.588      G.MAURER                       (STRASBOURG)
STUNTEBE 70 PL 32 B 391         STUNTEBECK,KENNEY,DEERY,BISWAS,CASON+(NDAM)

BALLAM   71 PR D 3 2606         +CHADWICK,GUIRAGOSSIAN,JOHNSON,+      (SLAC)
BRAUN    71 NP B 30 213         +FRIDMAN,GERBER,GIVERNAUD,KAHN,+      (STRB)
GRAYER   71 PL 35 B 610         +HYAMS,JONES,SCHLEIN,BLUM,+      (CERN+MPIM)JP3-
MATTHEWS 71 NP B 331            +PRENTICE,YOON,CARROLL,+         (TNTO+WISC)JP3-

ARMENISE 72 LNC 4 205           +FORINO,CARTACCI,+         (BARI+BGNA+FIRZ)
    ALSO 75 LNC 14 177          +FOGLI-MUCIACCIA,FORINO+   (BARI+BGNA+FIRZ)  JP
BOWEN    72 PRL 29 890          +EARLES,FAISSLER,BLIEDEN,+       (NEAS+STON)
CLAYTON  72 NP B 47 81          +MASON,MUIRHEAD,RIGOPOULOS,+     (LIVP+PATR)
GRAYER   72 PHIL.CONF.PROC. 5 +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
HOLMES   72 PR D 6 3336         +FERBEL,SLATTERY,WERNER                (ROCH)

ARNOLD   73 LNC 6 707           +ENGEL,ESCOUBES,KURTZ,LLORET,PATY,+  (STRB)
CASON    73 PR D 7 1971         +BISWAS,KENNEY,MADDEN,SANDER,SHEPHARD(NDAM)
CASON 1  73 NP B 64 14          +MADDEN,BISHOP,BISWAS,KENNEY,+        (NDAM)
HYAMS    73 NP B 64 134         +JONES,WEILHAMMER,BLUM,DIETL,+  (CERN+MPIM)
ROBERTSO 73 PR D 7 2554         ROBERTSON,WALKER,DAVIS             (DUKE+WISC)

DUBOVIKO 74 SJNP 19 568         DUBOVIKOV,MATSYUK,NILOV,SOKOLOV       (ITEP)
ENGLER   74 PR D10 2070         +KRAEMER,TOAFF,WEISSER,DIAZ+     (CARN+CASE)
GRAYER   74 NP B 75 189         G.GRAYER,HYAMS,BLUM,DIETL,+      (CERN+MPIM)
KLIGER   74 SJNP 19 428         +BEKETOV,GRECHKO,GUZHAVIN,DUBOVIKOV+ (ITEP)
OREN     74 NP B71 189          +COOPER,FIELDS,RHINES,WHITMORE,+  (ANL+OXF)
THOMPSON 74 NP B69 220          +GAIDOS,MCILWAIN,MILLER,MULERA,+      (PURD)

BLUM     75 PL 57B 403          +CHABAUD,DIETL,GARELICK,GRAYER+ (CERN+MPIM) JP
ESTABROO 75 NP B95 322          P.ESTABROOKS,A.D.MARTIN               (DURH)
HYAMS    75 NP B100 205         +JONES,WEILHAMMER,BLUM,DIETL+    (CERN+MPIM)
KALELKAR 75 THESIS(NEVIS 207) M.S.KALELKAR                        (COLU)I=1

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Data Card Listings

For notation, see key at front of Listings.

Mesons

X(1690), X⁻(1795), A$_4$(1900), S(1930)

X(1690) →ωππ

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64  X(1690)

THIS ENTRY CONTAINS (OMEGA PI PI) PEAKS ARCUND
1690 MEV. EVIDENCE NOT COMPELLING. OMITTED FROM TABLE.

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                    64  X(1690) MASS (MEV)

M   N     (1689.)    (10.)           DANYSZ     67 HBC    0 3,3.6 PBAR P     2/74
M   N   NOT SEEN IN HIGH STATISTICS EXP. OF OREN 74
M          1670.0     18.0           YOST       68 HBC    04.3 K-P,LMBD.5PI. 2/74
M          1695.0     20.0           BARNES     69 HBC    0 4.6 K-P,CMEG2PI  2/74
M          . . . . . . . . . .
M   AVG    1681.2     13.4      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1681.1     15.1      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    64  X(1690) WIDTH (MEV)

W   N       (38.)    (18.)           DANYSZ     67 HBC    0 3,3.6 PBAR P     1/73
W   N   NOT SEEN IN HIGH STATISTICS EXP. OF OREN 74
W            50.0     15.0           YOST       68 HBC    04.3 K-P,LMBD.5PI. 1/73
W            90.      20.            BARNES     69 HBC    0 4.6 K-P,CMEG2PI  1/73
W          . . . . . . . . . .
W   AVG      64.4     19.2      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
W   STUDENT  63.8     14.7      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                        REFERENCES FOR X(1690)

DANYSZ    67 NC 51 A 801       CANYSZ+FRENCH+SIMAK                     (CERN)
YOST      68  UMD  T.REPORT849 +YODH,EINSCHLAG,DAY,GLASSER              (UMD)
BARNES    69 PRL 23 142        +CHUNG,EISNER,FLAMINIO,+                 (BNL)
OREN      74 NP B71 189        +COOPER,FIELDS,RHINES,WHITMORE,+   (ANL+OXF.)
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X⁻(1795)

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63  X-(1795,JPG=    ) I=1

SEEN AS A (PBAR N) BOUND STATE IN PBAR D ANNIHILATIONS
AT REST. NEEDS FURTHER CONFIRMATION.CMITTED FROM TABLE.

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                    63  X-(1795) MASS (MEV)

M    D      1794.5      1.4          GRAY       71 DBC  -  0.PBAR D            1/72
M    D      DECAYS TC FOUR CR MORE PICNS

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                    63  X-(1795) WIDTH(MEV)

W    D        (8.)    OR LESS  CL=.95  GRAY     71 DBC  -  0.PBAR D            1/72
W    D      DECAYS TO FOUR OR MORE PIONS.

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                        REFERENCES FOR X-(1795)

GRAY      71 PRL 26 1491        +HAGERT,KALOGEROPCULOS                 (SYRA)
BOGDANOV  72 PRL 28 1418       BCGDANOVA,DALKAROV,SHAPIRO              (ITEP)
GRAY      73 PRL 30 1091       +PAPADOPOULOU,KARAGEROPOULCS,+    (ATEN+SYRA)
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A$_4$(1900)

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43  A4(1900,JPG=  -)  I=1

OMITTED FRCM TABLE.


THIS ENTRY CONTAINS THE DIFFRACTIVE-LIKE 3PI AND 5PI
BUMPS IN THE REGION OF 1900 MEV,AS WELL AS VARIOUS
PEAKS NEARBY.NOTE THAT THE EXISTENCE OF AN S-WAVE
GPI THRESHOLD BUMP (AS A CONTINUATICN TO A1 AND A3)
IS NOT UNEXPECTED.  OMITTED FROM TABLE.

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                    43  A4 MASS  (MEV)

M          (1900.)                    HUSCN     68 HLBC -  16.PI-A,A 5PI      2/74
M          (1830.)                    SALZBERG  72 HBC  -  13,20 PI-P,P 3PI   2/74
M    B   40(1960.)     (30.)          BASTIEN   73 CBC  -  15.PI-D,D 3PI      2/74
M    B   MARGINAL STATISTICAL SIGNIFICANCE.
M          (1800.)                    DEUTSCHM  75 HBC  +  16 PI+P,P 3PI     12/75*
M       208(2080.)     (40.)          KALELKAR  75 HBC  +  15 PI+P,P PI+G    12/75*

M        VARIOUS PEAKS
M    K     (1820.)     (12.)          FRENCH    67 HBC     0 3,3.6 PBAR P     7/67
M    K        OBSERVED IN (KS KO PIO...) MODE  (G-PARITY UNKNOWN)
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                    43  A4 WIDTH  (MEV)

W           (130.)                    SALZBERG  72 HBC  -  13,20 PI-P,P 3PI   2/74
W    B   40 (200.)                    BASTIEN   73 CBC  -  15.PI-D,D 3PI      2/74
W       208 (340.)     (80.)          KALELKAR  75 HBC  +  15 PI+P,P PI+G    12/75*

W        VARIOUS PEAKS
W    K       (50.)     (20.)          FRENCH    67 HBC    0 3-4 PBAR P        7/67

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                    43  A4 PARTIAL DECAY MCDES

                                                          DECAY MASSES
P1       A4 INTO 3PI                                    139+ 139+ 139
P2       A4 INTO RHO PI                                 773+ 139
P3       A4 INTO F PI                                  1271+ 139
P4       A4 INTO G PI                                  1690+ 139

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                    43  A4 BRANCHING RATIOS

R1       A4 INTO (G PI)/(ALL 3PI)                          (P4)/(P1)
R1           DOMINANT                   KALELKAR  75 HBC  +  15 PI+P,P 3PI     12/75*

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                        REFERENCES FOR A4

DANYSZ    67 NC 51A 801         DANYSZ+FRENCH+SIMAK                    (CERN)
FRENCH    67 NC 52A 442         +KINSON+MCDONALD+RIDDIFORD+       (CERN+BIRM)

HUSCN     68 PL 28 B 208        +LUBATTI,BELLINI,BINGHAM,+   (ORSA+MILA+LBL)

BEMPORAD  71 NP B 33 397        +DUFEY,CODLING,+         (CERN+ETHZ+LOIC+MILA)

CLAYTCN   72 NP B 47 81         +MASON,MUIRHEAD,RIGGPOULOS,+     (LIVP+PATR)
HARRISON  72 PRL 28 775         +HEYDA,JOHNSON,KIM,LAW,MUELLER,+      (HARV)
SALZBERG  72 NP B 41 397        +HARRISON,HEYCA,JOHNSON,KIM,LAW,+     (HARV)

BASTIEN   73 UPPSALA CONF. 73   +DUNN,HARRIS,LUBATTI,BINGHAM,+    (SEAT+UCB)

OREN      74 NP B71 189         +COOPER,FIELDS,RHINES,WHITMORE,+  (ANL+OXF)

DEUTSCHM  75 NP B99 397         DEUTSCHMANN,+         (ABBCCHW COLLABCRATION)
KALELKAR  75 THESIS(NEVIS 207)  M.S.KALELKAR                          (COLU)
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S(1930) REGION

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31  S(1930,JPG=   )
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This entry contains the structure observed in s-channel $\bar{N}N$ annihilations, as well as various peaks claimed in this region by production experiments. The resonant interpretation of the broad structure observed in $\bar{p}p$ backward elastic scattering (CLINE 70, D'ANDLAU 75) has been criticized (PINSKY 71, BIZZARRI 72). Although accurate measurements of both total and elastic scattering have produced evidence for a narrow bump in this region (CARROLL 74, MARZANO 76), the charge-exchange reaction shows no such structure (GARNJOST 75, MARZANO 76). Measurements of exclusive channel cross sections and of the spectator momentum distribution in $\bar{p}d$ annihilations have suggested more complicated structure (DEFOIX 75, KALOGEROPOULOS 75). We prefer to wait for further clarification before entering the S meson into the table of established resonances.

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                    31  S MASS (MEV)

M       S CHANNEL NBAR N
M    C     (1940.)     (8.)                   CLINE      70 HBC   0  .25-.74 PBAR P    2/72
M    B     (1968.)                            BENVENUTI  71 HBC   0  .1 - .8 PBAR P    2/72
M    S     (1932.)     (2.)                   CARROLL    74 CNTR    S CHAN.PBAR P,D  12/75*
M    C     (1942.)     (5.)                   D.ANDLAU   75 HBC   0 .175-.750 PBAR P 12/75*
M          (1897.)     (1.)                   KALOGERO   75 DBC  -  PBAR N ANNIH     12/75*
M          (1934.4)    (2.6)      (1.4)       KALOGERO   75 DBC   - PBAR N ANNIH     12/75*
M    A     (1940.)                            DEFOIX     75 HBC    OPBAR P,5PI       12/75*
M    S     (1935.9)    (1.0)                  MARZANO    76 HBC    OPBAR P TOT,ELAS  12/75*
M
M
M
M       PEAKS FRCM PRODUCTICN EXPERIMENTS
M    N  226(1929.0)   (14.0)                  CHIKOVANI  66 MMSP  -  12.0 PI-P       12/75*
M       100(1900.)    (40.)                   BOESEBECK  68 HBC  +   8 PI+ P,PI+ PIO 12/75*
M        30(1973.0)   (15.0)                  CASO       70 HBC   - 11.2PI-P,RHO 2PI 12/75*
M    K   40(1975.0)   (12.0)                  KRAMER     70 HBC  +  13.1 PI+ P,2PI   11/70
M       100(1898.)    (18.)                   THCMPSON   74 HBC  +  13 PI+ P,2RHO    12/75*
M        50(1895.)    (19.)                   ABASHIAN   75 STRC -  8 PI-P,P 3PI     12/75*
M
M
M    A   FROM ENERGY DEPENDENCE OF 5PI CROSS-SECTION.
M    B   SEEN AS A BUMP IN THE PBAR P - KS KL  CROSS SECTION WITH JPC=1--.
M        NOT SEEN BY CARSON 72 WITH EQUAL STATISTICS.
M    C   FROM ENERGY DEPENDENCE OF FAR BACKWARD ELASTIC SCATTERING.
M        SCME INDICATION OF ADDITICNAL STRUCTURE.
M    K   2PI PEAK CF KRAMER NOT SEEN IN SAME EXP WITH MORE DATA(THOMPSON 74)
M    N   SEEN IN 3 CHARGED MODE.NOT SEEN BY BOWEN 73 WITH 6X STATISTICS.
M    S   NARROW BUMP SEEN IN TOTAL PBAR P,D CROSS-SECTIONS.ISOSPIN UNCERTAIN
M        NOT SEEN IN PBAR P CEX BY GARNJOST 75,MARZANO 76

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Mesons

S(1930), h(2040), ρ(~2100), T(2200)

Data Card Listings

For notation, see key at front of Listings.

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                    31   S WIDTH (MEV)

W          S CHANNEL NBAR N
W    C        (49.)       (9.)                 CLINE      70 HBC    0  .25-.74 PBAR P    2/72
W    B        (35.)                            BENVENUTI 71 HBC     0  .1 - .8 PBAR P    2/72
W    S         (9.)       (4.)       (3.)      CARROLL    74 CNTR     S CHAN.PBAR P,D   12/75*
W    C        (57.5)      (5.)                 D.ANDLAU   75 HBC    0 .175-.750 PBAR P  12/75*
W             (25.)       (6.)                 KALOGERO   75 DBC   -   PBAR N ANNIH     12/75*
W             (11.)      (11.)       (4.)      KALOGERO   75 DBC   -  PBAR N ANNIH      12/75*
W    A        (60.)                            DEFOIX     75 HBC     OPBAR P,5PI        12/75*
W    S         (8.8)      (4.3)      (3.2)     MARZANO    76 HBC     OPBAR P TOT,ELAS   12/75*
W
W
W
W          PEAKS FROM PRODUCTION EXPERIMENTS
W    N  226  (35.0)  OR LESS                   CHIKOVANI 66 MMSP  -   12.0 PI-P         12/75*
W       100 (216.)   (105.)                    BOESEBECK 68 HBC   +    8 PI+ P,PI+ PIO  12/75*
W        30  (80.0)                            CASO       70 HBC   -  11.2PI-P,RHO 2PI  12/75*
W        40  (52.0)  OR LESS   CL=.90          KRAMER     70 HBC   +  13.1 PI+ P,2PI    12/75*
W       100 (108.)     (41.)     (27.)         THCMPSON   74 HBC   +  13 PI+ P,2RHO     12/75*
W        50 (123.)     (66.)                   ABASHIAN   75 STRC  -  8 PI-P,P 3PI      12/75*
W
W
W    A   FROM ENERGY DEPENDENCE OF 5PI CROSS-SECTION.
W    B   SEEN AS A BUMP IN THE PBAR P - KS KL  CROSS SECTION WITH JPC=1--.
W        NOT SEEN BY CARSON 72 WITH EQUAL STATISTICS.
W    C   FROM ENERGY DEPENDENCE OF FAR BACKWARD ELASTIC SCATTERING.
W        SOME INDICATION OF ADDITIONAL STRUCTURE.
W    K   2PI PEAK OF KRAMER NOT SEEN IN SAME EXP WITH MORE DATA(THOMPSON 74)
W    N   SEEN IN 3 CHARGED MODE.NOT SEEN BY BOWEN 73 WITH 6X STATISTICS.
W    S   NARROW BUMP SEEN IN TOTAL PBAR P,D CROSS-SECTIONS.ISOSPIN UNCERTAIN
W        NOT SEEN IN PBAR P CEX BY GARNJOST 75,MARZANO 76

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REFERENCES FOR S


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CHIKOVAN 66 PL   22  233        CERN MISSING MASS SPECTROMETER GROUP (CERN)
FOCACCI  66 PRL   17  890       CERN MISSING MASS SPECTROMETER GROUP (CERN)
BOESEBEC 68 NP B 4 501          BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CLINE    68 PRL 21 1268         +ENGLISH,REEDER,TERRELL,TWITTY  (WISCONSIN)

CASO     70 LNC 3  707          +CORDS,COSTA,+   (GENO,DESY,HAMB,MILA,SACL)
CLINE    70  PREPRINT           D.CLINE,J.ENGLISH,D.D.REEDER          (WISC)J
  ALSO   70  KIEV CONF.         ASTIER RAPPORTEUR TALK
KRAMER   70 PRL 25 396          +BARTON,GUTAY,LICHTMAN,MILLER,+     (PURDUE)

BENVENUT 71 PRL 27 283          BENVENUTI,CLINE,RUTZ,REEDER,SCHERER  (WISC)
CLINE    71  REVIEW             D.CLINE,TALK AT ANL WORKSHOP JULY 71 (WISC)
PINSKI   71 PRL 27 1548         STEPHEN S. PINSKY              (UTAH+ARGCNNE)

BIZZARRI 72 PR D 6 160          +GUIDONI,MARZANO,CASTELLI,+      (RCMA+TRST)
BOWEN 1  72 PRL 29 890          +EARLES,FAISSLER,BLIEDEN,+       (NEAS+STON)
DIEBOLD  72  BATAV.CONF.        R.DIEBOLD  RAPPORTEUR TALK              (ANL)

BOWEN    73 PRL 30 332          +EARLES,FAISSLER,BLIEDEN,+       (NEAS+STCN)
BURNS    73 PR D 8 1286         +CONDON,DONAHUE,MANDELKERN,PRICE,+     (UCI)
KIENZLE  73 PR D 7 3520         W.KIENZLE                              (CERN)

ASTBURY  74  CERN 74-18         A.ASTBURY REVIEW AT PRAGUE 74          (RHEL)
BURNS    74 NC 20A 463          +CONDON,MANDELKERN,PRICE,SCHULTZ        (UCI)
CARROLL  74 PRL 32 247          +CHIANG,KYCIA,LI,MAZUR,MICHAEL,+        (BNL)
KALOGERO 74  BOSTON 74          T.E.KALOGEROPOULOS (REVIEW) PG.97
THOMPSON 74 NP B69 220          +GAIDOS,MCILWAIN,MILLER,MULERA,+       (PURD)

ABASHIAN 75 PRL 34 691          +BEAMER,BROSS,EISENSTEIN,+     (ILL+ANL+ISU)
D.ANDLAU 75 PL 58B 223          +COHEN-GANOUNA,LALOUM,LUTZ,PETRI(CDEF+PISA)  JP
DEFOIX   75  PALERMO CONF.      B.FRENCH, RAPPORTEURS TALK             (CDEF)
GARNJOST 75 PRL 35 1685         +KENNEY,POLLARD,ROSS,TRIPP,+      (LBL+MHCO)
KALOGERO 75 PRL 34 1047         KALOGEROPOULOS,TZANAKOS                (SYRA)
WEINGART 75 PRL 34 1201         WEINGARTEN,OKUBO                       (ROCH)

MARZANO  76 PL    PRIVATE COMMUNICATION FROM F.MARZANO  (CERN+MONS+PADO+)
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h(2040)

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16   H(2040,JPG=4++) I=0

APEL 75 AND BLUM 75 ESTABLISH JP AS 4+.
SINCE BOTH 2PIO AND K KBAR DECAY MODES ARE SEEN, I=0.
ADDITIONAL EVIDENCE FOR THE H MESON IS REPORTED
IN WAGNER 74.

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                    16   H MASS (MEV)

M        700 2030.       30.                  APEL       75 CNTR     40.  PI-P,N 2PIO 11/75*
M            2050.       25.                  BLUM       75 ASPK     18.4 PI-P,N K+K- 11/75*
M            . . . . . . . . . .
M    AVG     2041.8      19.2      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    STUDENT2041.8       20.9      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    16   H WIDTH (MEV)

W        700  180.       60.                  APEL       75 CNTR     40.  PI-P,N 2PIO 11/75*
W             225.      120.       70.        BLUM       75 ASPK     18.4 PI-P,N K+K- 11/75*
W            . . . . . . . . . .
W    AVG      192.8      50.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W    STUDENT  192.8      54.8      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    16   H PARTIAL DECAY MCDES

                                                                DECAY MASSES
P1       H INTO PI PI                                         139+ 139
P2       H INTO K KBAR                                        497+ 497

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REFERENCES FOR H


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WAGNER   74  LONDON CONF.      F. WAGNER, RAPPORTEURS TALK            (MPIM)
APEL     75 PL 57B 398         +AUGENSTEIN+      (KARL+PISA+SERP+WIEN+CERN)  JP
BLUM     75 PL 57B 403         +CHABAUD,DIETL,GARELICK,GRAYER+ (CERN+MPIM)  JP
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ρ(~2100) REGION →

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51  RHO(2100, JPG= +)

THIS ENTRY CONTAINS REFERENCES TO PARTIAL WAVE ANALYSES OF
THE REACTION PBAR P TO PI+ PI- OVER THE MASS RANGE 2-2.5 GEV.
WITHOUT POLARISATION DATA IT SEEMS UNLIKELY THAT SUCH ANALYSES
CAN PROVIDE UNIQUE SOLUTIONS.WE PREFER NOT TO LIST RESONANCE
PARAMETERS YET. OMITTED FROM TABLE.

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REFERENCES FOR RHO(2100)


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NICHOLSO 69 PRL 23 603         NICHOLSON,BARISH,DELORME,+    (CIT+RCCH+BNL)
EHRLICH  72 PRL 28 1147        +ETKIN,GLODIS,HUGHES,KONDO,LU,MORI,+ (YALE)
DONNACHI 73 LNC 7 285          A.DONNACHIE,P.R.THCMAS          (MANCHESTER)
EISENHAN 73 PL 47 B 536        EISENHANDLER,+           (LOQM+LIVP+DARE+RHEL)
NICHCLSO 73 PR D 7 2572        NICHOLSON,DELORME,CARROLL,+  (CIT+ROCH+BNL)
HYAMS    74 NP B 73 202        +JONES,WEILHAMMER,BLUM,+          (CERN+MPIM)
DONNACHI 75 NC 26 A 317        A.DONNACHIE,P.R.THCMAS          (MANCHESTER)
EISENHAN 75 NP B 96 109        EISENHANDLER,GIBSON,+ (LOQM+LIVP+DARE+RHEL)
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T(2200) REGION →

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32  T(2200,JPG=   )

THIS ENTRY CONTAINS THE BUMP OBSERVED IN S CHANNEL
NBAR N , AND VARIOUS PEAKS NEAR 2200 MEV.
OMITTED FROM TABLE.
FOR A REVIEW SEE ASTBURY 74.

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                    32   T MASS (MEV)

M          S CHANNEL NBAR N
M    B        2190.       10.               ABRAMS     70 CNTR    S CHANNEL PBAR N  1/73
M    B     SEEN AS BUMP IN I=1 STATE. SEE ALSO COOPER 68.
M    B     BRICMAN (69) SEES NO BUMP, SPIN LESS THAN 5 IS SO EXCLUDED
M    B     PEASLEE 75 CONFIRM PBAR P RESULTS OF ABRAMS 70,NC NARROW STRUCTURE
M     K      (2190.0)                       KALBFLEIS 69 HBC    O S-CHANNEL PBARP  7/69
M     K      SEEN IN PBAR P TO RHCO RHOO PIO. IG=1-.
M     K    NOT SEEN BY BACON 73.
M             2193.        2.               ALSPECTOR 73 CNTR    S CHANNEL PBAR P. 1/74
M     S      (2141.)                        DONALD     73 HBC   O S CHANNEL PBAR P  1/74
M     S    SEEN IN FINAL STATE (OMEGA PI+ PI-)
M            . . . . . . . . .
M    AVG      2192.9       2.0      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    STUDENT2192.9         2.1      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M          PEAKS FROM PRODUCTION EXPERIMENTS
M    N       (2195.0)    (15.0)             CHIKOVANI 66 MMSP  -  12.0 PI-P          12/72
M    N     NOT SEEN BY BOWEN 73.
M             2207.       13.               ALLES-BOR 67 HBC    0 5.7 PBAR P         12/66
M    A       ALLES-BORELLI 67 SEE NEUTRAL MODE ONLY (PI+PI-PIO)
M             2190.0      10.0              CLAYTCN   67 HBC  +- 2.5PBAR,A2+OMEGA  10/67
M    T       (2086.)     (38.)              ANDERSON  69 MMS   -  16 PI-P,BACKW    12/75*
M    T       (2260.)     (18.)              ANDERSON  69 MMS   -  16 PI-P,BACKW    12/75*
M    T     TWO SEPARATE PEAKS
M             2207.0      22.0              CASO       70 HBC   - 11.2PI- P,NOTE C. 5/70
M     C      SEEN IN RHO- PI+ PI- (OMEGA AND ETA ANTISELECTED IN 4 PI SYSTEM)  5/70
M             2157.0      10.0              KRAMER     70 HBC  +  13.1 PI+ P,2PI  .11/70
M         50(2070.)                         TAKAHASHI 72 HBC     8. PI-P,N 2PI     12/75*
M            . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 2.0)

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                    32   T WIDTH (MEV)

W          S CHANNEL NBAR N
W    B        (85.)                         ABRAMS     67 CNTR    S CHANNEL PBAR N  7/67
W    B          SEE NOTE B UNDER T(2200) MASS ABOVE.
W    K        BETWEEN 20 AND 80 MEV         KALBFLEIS 69 HBC    O S-CHANNEL PBARP  7/69
W               98.        8.               ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
W     S        (14.)                        DONALD     73 HBC   O S CHANNEL PBAR P  1/74
W     S    SEEN IN FINAL STATE (OMEGA PI+ PI-)

W          PEAKS FROM PRODUCTION EXPERIMENTS
W    N        (13.0)  OR LESS               CHIKOVANI 66 MMSP  -  12.0 PI-P           8/66
W               62.       52.               ALLES-BOR 67 HBC    O 5.7 PBAR P         12/66
W    T        (150.)                        ANDERSCN  69 MMS   -  16 PI-P,BACKW    12/75*
W    T         (25.)   OR LESS              ANDERSON  69 MMS   -  16 PI-P,BACKW    12/75*
W    T     TWO SEPARATE PEAKS
W             (130.0)                       CASO       70 HBC   - 11.2PI- P,NOTE C. 5/70
W    C       SEEN IN RHO- PI+ PI- (OMEGA AND ETA ANTISELECTED IN 4 PI SYSTEM)  5/70
W               68.0      22.0              KRAMER     70 HBC  +  13.1 PI+ P,2PI   11/70
W         50 (160.)                         TAKAHASHI 72 HBC     8. PI-P,N 2PI     12/75*
W            . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                    32   SIGMA (MB) FOR FORMATION BY NUCLEON ANTINUCLECN

CS A          (5.5)                         ABRAMS     70 CNTR    S CHANNEL PBAR N  1/71
CS A      FCR I=1 NEAR N
CS              2.3      0.13     0.08  ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74

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REFERENCES FOR T


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CHIKOVAN 66 PL   22  233       CERN MISSING MASS SPECTROMETER GROUP (CERN)
FOCACCI  66 PRL   17  890      CERN MISSING MASS SPECTROMETER GROUP (CERN)
ABRAMS   67 PRL 18 1209        +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+    (BNL)
ALLES-BO 67 NC 50 A 776        ALLES-BORELLI,FRENCH,FRISK,+    (CERN+BONN)G=-
CLAYTON  67 HEIDBG.CONF.P.57   +MASON,MUIRHEAD,FILIPPAS+(LIVERPOOL+ATHENS)
COOPER   68 PRL 20 1059        +HYMAN,MANNER,MUSGRAVE,VOYVODIC        (ANL)

ANDERSON 69 PRL 22 1390        +COLLINS,BLIEDEN+                 (BNL+CARN)
BRICMAN  69 PL 29 B 451        +FERRO-LUZZI,BIZARD,+       (CERN+CAEN+SACL)
CASO     69 NC 62 A 755        +CONTE,BENZ,+     (GENO+DESY+HAMB+MILA+SACL)
KALBFLEI 69 PL 29 B  259       G.KALBFLEISCH,R.STRAND,V.VANDERBURG     (BNL)
MONTANET 69 LUND CONF.P.189    L.MONTANET, RAPPORTEUR                 (CERN)

ABRAMS   70 PR D 1 1917        +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+    (BNL)
CASO     70 LNC 3 707          +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
KALBFLEI 70 PHILAD.CONF.P.409  G.KALBFLEISCH AND D.MILLER REVUES      (BNL)
KRAMER   70 PRL 25 396         +BARTON,GUTAY,LICHTMAN,MILLER,+     (PURDUE)

BACCN    71 NP B 32 66         +BUTTERWORTH,MILLER,PHELAN,+     (RHEL+LIVP)
FIELDS   71 PRL 27 1749        +COOPER,RHINES,ALLISON              (ANL+OXF)
YOH      71 PRL 26 922         +BARISH,CAROLL,LOBKOVICZ+       (CIT+BNL+ROCH)
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Data Card Listings

For notation, see key at front of Listings.

Mesons

T(2200), U(2360), $N\bar{N}_{I=0}$(2375), X(2500–3600)


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ALEXANDE 72 NP B 45 29           ALEXANDER,BAR-NIR,BEVARY,CAGAN,+      (TELA)
BERTANZA 72  CHEXBRES (CERN 72-10)  L.BERTANZA, REVIEW TALK           (PISA)
BUGG     72 PR D 6 3047          +CONDO,HART,COHN,ENDCRF,+  (TENN+ORNL+CINC)
CLAYTCN  72 NP B 47 81           +MASON,MUIRHEAD,RIGOPOULOS,+    (LIVP+PATR)
DIEBOLD  72  BATAV.CONF.         R.DIEBOLD  RAPPCRTEUR TALK            (ANL)
DONALD   72 PL 40 B 586          +GALLETLY,EDWARDS,DE BILLY,+    (LIVP+LPNP)
MING MA  72 NP B 51 77           +EASTMAN,OH,PARKER,SMITH,SPRAFKA      (MSU)
TAKAHASH 72 PR D 6 1266          TAKAHASHI,BARISH,+      (TOHO+PENN+NDAM+ANL)

ALSPECTO 73 PRL 30 511           ALSPECTOR,COHEN,CVIJANOVICH,+   (RUTG+UPNJ)
BACON    73 PR D 7 577           +BUTTERWORTH,                   (RHEL+LIVP)
BETTINI  73 NC 15 A 563          +GARNJOST,BIGI,+         (PADO+LBL+PISA+TORI)
BOWEN    73 PRL 30 332           +EARLES,FAISSLER,BLIEDEN,+      (NEAS+STON)
DONALD   73 NP B 61 333          +EDWARDS,GIBBINS,BRIAND,DUBOC,+ (LIVP+LPNP)
KIENZLE  73 PR D 7 3520          W.KIENZLE                            (CERN)

ASTBURY  74  CERN 74-18          A.ASTBURY REVIEW AT PRAGUE 74        (RHEL)
BERTANZA 74 NC 23A 209           +BIGI,CASALI,LARICCIA,+      (PISA+PADO+TORI)

HANDLER  75 NP B101 35           +JACQUES,JONES,PANDOULAS,+ (RUTG+STEV+ALBA)
HUESMAN  75 NC 25A  91           +GARNJOST,ROSS,+          (LBL+PADO+PISA+TORI)
PEASLEE  75 PL 57B 189           +CEMARZO,GUERRIERO,+      (CANB+BARI+BROW+MIT)

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U(2360) REGION →

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33  U(2360,JPG=    ) I=1

THIS ENTRY CONTAINS THE BROAD BUMP OBSERVED
IN THE S CHANNEL NBAR N, AND VARIOUS OTHER PEAKS,
MOSTLY CONTROVERSIAL. OMITTED FROM TABLE.
FOR A REVIEW SEE ASTBURY 74.

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                 33  U(2360)  MASS (MEV)

M       S CHANNEL NBAR N
M  A       2350.       10.            ABRAMS    70 CNTR    S CHANNEL NBAR N  1/73
M  A    FOR I=1 NBAR N
M   N     (2360.0)    (25.0)          OH        70 HDBC  -OPBAR(P,N),K*K2PI  1/73
M   N      NO EVIDENCE FOR THIS BUMP SEEN IN THE PBAR P DATA OF CHAPMAN 71   1/73
M   N      NARROW STATE NOT CONFIRMED BY OH 73 WITH MORE DATA.             12/75*
M   I     (2359.)     (2.)            ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
M   I   ISOSPINS 0 AND 1 NOT SEPARATED

M       PEAKS FROM PRODUCTION EXPERIMENTS
M   M     (2382.0)    (24.0)          CHIKOVANI 66 MMS   -  12.0 PI-P       12/72
M   N   NOT SEEN BY BOWEN 73.
M          2370.       17.            ANDERSON  69 ASPK  - 16 PI- BKSCAT    11/69
M  B   126 2340.       20.            BALTAY    75 HBC +   15 PI+P,P5PI    12/75*
M  B   DOMINANT DECAY INTO RHO RHO PI
M           . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

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                 33  U(2360)  WIDTH (MEV)

W       S CHANNEL NBAR N
W          (140.)                     ABRAMS    67 CNTR    S CHANNEL PBAR N  1/73
W  N        (60.0)  OR LESS           OH        70 HDBC  -OPBAR(P,N),K*K2PI 11/71
W  N       NO EVIDENCE FOR THIS BUMP SEEN IN THE PBAR P DATA OF CHAPMAN 71  11/71
W   N      NARROW STATE NOT CONFIRMED BY OH 73 WITH MORE DATA.             12/75*
W   I      (165.)     (18.)     (8.)  ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
W   I   ISOSPINS 0 AND 1 NOT SEPARATED

W       PEAKS FROM PRODUCTION EXPERIMENTS
W   M      (30.0)  OR LESS            CHIKOVANI 66 MMS   -  12.0 PI-P        8/66
W   N   NOT SEEN BY BOWEN 73.
W          (57.)                      ANDERSON  69 ASPK  - 16 PI- BKSCAT    11/69
W  B   126  180.      60.             BALTAY    75 HBC +   15 PI+P,P5PI    12/75*
W  B   DOMINANT DECAY INTO RHO RHO PI

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                 33  SIGMA (MB) FOR FORMATION BY NUCLEON ANTINUCLEON

CS  A       (3.2)                     ABRAMS    70 CNTR    S CHANNEL NBAR N  1/71
CS  A   FOR I=1 NBAR N
CS  I       (2.1)     (0.2)    (0.1)  ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
CS  I   ISOSPINS 0 AND 1 NOT SEPARATED

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                              REFERENCES FOR U(2360)

CHIKOVAN 66 PL  22  233          CERN MISSING MASS SPECTROMETER GROUP (CERN)
FOCACCI  66 PRL  17  890         CERN MISSING MASS SPECTROMETER GROUP (CERN)

ABRAMS   67 PRL 18 1209          +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+   (BNL)

ANDERSON 69 PRL 22 1390          +BLESER,BIRNBAUM,EDELSTEIN,+     (BNL+CARN)
BRICMAN  69 PL 29 B 451          +FERRO-LUZZI,BIZARD,+        (CERN+CAEN+SACL)
CASO     69 LNC 3 707            +CONTE,BENZ,+      (GENO+DESY+HAMB+MILA+SACL)

ABRAMS   70 PR D 1 1917          +COOL,GIACCMELLI,KYCIA,LEONTIC,LI,+   (BNL)
OH       70 PRL 24 1257          +PARKER,EASTMAN,SMITH,SPRAFKA,MA      (MSU)

CHAPMAN  71 PR D4 1275           +GREEN,LYS,MURPHY,RING,+             (MICH)
FIELDS   71 PRL 27 1749          +COOPER,RHINES,ALLISON            (ANL+OXF)
YOH      71 PRL 26 922           +BARISH,CAROLL,LOBKOVICZ+    (CIT+BNL+ROCH)

ASTBURY  72  CERN 72-10          A.ASTBURY REVIEW AT CHEXBRES 72      (RHEL)
DIEBOLD  72  BATAV.CONF.         R.DIEBOLD  RAPPORTEUR TALK            (ANL)
EASTMAN  72 NP B 51 29           +MING MA,OH,PARKER,SMITH,SPRAFKA      (MSU)
MING MA  72 NP B 51 77           +EASTMAN,OH,PARKER,SMITH,SPRAFKA      (MSU)

ALSPECTO 73 PRL 30 511           ALSPECTOR,COHEN,CVIJANOVICH,+   (RUTG+UPNJ)
BOWEN    73 PRL 30 332           +EARLES,FAISSLER,BLIEDEN,+      (NEAS+STCN)
DONNACHI 73 LNC 7 285            A.DONNACHIE,P.R.THOMAS         (MANCHESTER)
KIENZLE  73 PR D 7 3520          W.KIENZLE                            (CERN)
OH       73 NP B 51 57           +EASTMAN,MING MA,PARKER,SMITH,+       (MSU)

ASTBURY  74  CERN 74-18          A.ASTBURY REVIEW AT PRAGUE 74        (RHEL)
MING MA  74 NP B68 214           +MOUNTZ,ZEMANY,SMITH                 (MICH)

BALTAY   75 PRL 35 891           +CAUTIS,COHEN,KALELKAR,PISELLO,+(COLU+BING)
KEMP     75 NC 27 A 155          +LOTTS,CONTRI,TEODORC+(DURH+GENO+MILA+LPNP)

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$N\bar{N}_{I=0}$(2375) →

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41   N NBAR(2375,JPG=    ) I=0

EVIDENCE FOR RESONANCE PRELIMINARY.
OMITTED FROM TABLE.
FOR A REVIEW SEE ASTBURY 74.

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                 41   N NBAR(2375) MASS

M          2375.       10.            ABRAMS    70 CNTR    S CHANNEL NBAR N  1/71
M   I     (2359.)     (2.)            ALSPECTOR 73 CNTR    S CHANNEL PB1R P  1/74
M   I   ISOSPINS 0 AND 1 NOT SEPARATED

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                 41   N NBAR(2375) WIDTH

W          (190.)                     ABRAMS    70 CNTR    S CHANNEL NBAR N  1/71
W   I      (165.)     (18.)     (8.)  ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
W   I   ISOSPINS 0 AND 1 NOT SEPARATED

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                 41   N NBAR(2375) SIGMA (MB) FOR FORMATION BN

CS          (2.5)                     ABRAMS    70 CNTR                      1/71
CS  I       (2.1)     (0.2)    (0.1)  ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
CS  I   ISOSPINS 0 AND 1 NOT SEPARATED

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                          REFERENCES FOR N NBAR (2375)

BRICMAN  69 PL 29 B 451          +FERRO-LUZZI,BIZARD,+        (CERN+CAEN+SACL)
ABRAMS   70 PR D 1 1917          +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+   (BNL)
EASTMAN  72 NP B 51 29           +MING MA,OH,PARKER,SMITH,SPRAFKA      (MSU)
MING MA  72 NP B 51 77           +EASTMAN,OH,PARKER,SMITH,SPRAFKA      (MSU)
ALSPECTO 73 PRL 30 511           ALSPECTOR,COHEN,CVIJANOVICH,+   (RUTG+UPNJ)

ASTBURY  74  CERN 74-18          A.ASTBURY REVIEW AT PRAGUE 74        (RHEL)
MING MA  74 NP B68 214           +MOUNTZ,ZEMANY,SMITH                 (MICH)

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X(2500–3600) →

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46  X(2500-3600)

THIS ENTRY CONTAINS VARIOUS HIGH MASS NON-STRANGE
PEAKS. OMITTED FROM TABLE.
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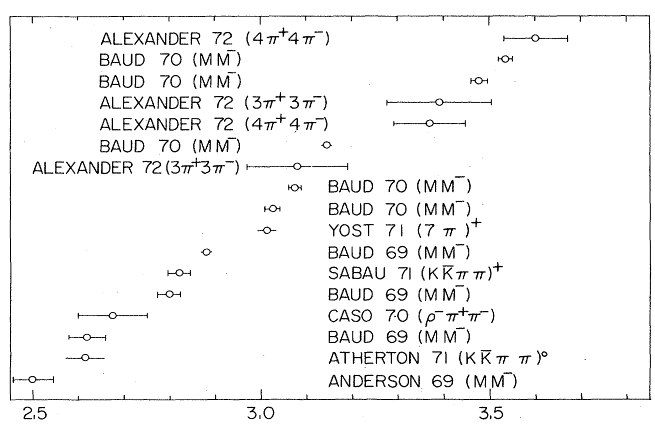
The high mass region is covered nearly continuously by evidence for peaks of various widths and decay modes (see figure). As a satisfactory grouping into particles is not yet possible, we list all the Y=0 bumps with M > 2400 MeV together, ordered by increasing mass. Note that ANTIPOV 72 ($\pi^- p \to pMM^-$ at 25 and 40 GeV/c) see no narrow bumps.



Masses and widths of reported enhancements with Y = 0, M > 2400 MeV. (—o— indicates that upper limit only was reported for the width.)

Mesons

X(2500–3600), K±, K⁰, K*(892)

Data Card Listings

For notation, see key at front of Listings.

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                    46  X(2500-3600)  MASSES AND WIDTHS  (MEV)

M         2500.0    32.0           ANDERSON  69 MMS  -  16 PI- P,BACKW9  8/69
W          (87.0)                  ANDERSON  69 MMS  -  16 PI- P,BACKW9  8/69

M     550 2620.     20.            BAUD      69 MMS  -  8.-10. PI- P     9/69
W     550   85.     30.            BAUD      69 MMS  -  8.-10. PI- P     9/69

M         2676.0    27.0           CASO      70 HBC  - 11.2PI- P,NOTE C  5/70
W         (150.0)                  CASO      70 HBC  - 11.2PI- P,NOTE C  5/70
W   C     SEEN IN RHO- PI+ PI- (OMEGA AND ETA ANTISELECTED IN 4 PI SYSTEM)  5/70

M     640 2800.     20.            BAUD      69 MMS  -  8.-10. PI- P     9/69
W     640   46.     10.            BAUD      69 MMS  -  8.-10. PI- P     9/69

M  C   15 2820.     10.            SABAU     71 HBC  + 8. PI+ P         11/71
W  C   15   50.     10.            SABAU     71 HBC  + 8. PI+ P         11/71
W  C      SEEN IN (K KBAR PI PI)+ MASS DISTRIBUTION                    11/71

M  D   90 2850.      5.            BRAUN     75 DBC    05.5 PBAR N      12/75*
W  D   90  (39.)   OR LESS         BRAUN     75 DBC    05.5 PBAR N      12/75*
   D   DECAYS TO NBAR N AND NBAR N PI

M     230 2880.     20.            BAUD      69 MMS  -  8.-10. PI- P     9/69
W     230  (15.)   OR LESS         BAUD      69 MMS  -  8.-10. PI- P     9/69

M  Y   43 3013.      5.            YOST      71 HBC  + 11.PI+ P,P(8PI)+ 11/71
W  Y   43  (40.)   OR LESS         YOST      71 HBC  + 11.PI+ P,P(8GI)   5/71
W  Y      4.3 S.D. EFFECT  . DECAY TO 7 PIONS                          11/71
   Y   NOT SEEN BY KALELKAR 75 WITH 5 TIMES MORE DATA

M         3025.0    20.0           BAUD      70 MMS  - 10.5-13 PI- P     5/70
W          (25.0)  APPROX.         BAUD      70 MMS  - 10.5-13 PI- 7

M         3075.0    20.0           BAUD      70 MMS  - 10.5-13 PI- P     5/70
W          (25.0)  APPROX.         BAUD      70 MMS  - 10.5-13 PI- P     5/70

M  D      3080.     20.            ALEXANDER 72 HBC  0 6.94 PBAR P       1/73
W  D       220.     70.            ALEXANDER 72 HBC  0 6.94 PBAR P       1/73
   D   DECAYS TO 3PI+ 3PI-
   D   NOT SEEN BY KALELKAR 75 WITH 1.5 TIMES MORE DATA

M         3145.0    20.0           BAUD      70 MMS  - 10.5-15 PI- P     5/70
W          (10.0)  OR LESS         BAUD      70 MMS  - 10.5-15 PI- P     5/70

M  D      3370.     10.            ALEXANDER 72 HBC  0 6.94 PBAR P       1/73
W  D       150.     40.            ALEXANDER 72 HBC  0 6.94 PBAR P       1/73
   D   DECAYS TO 4PI+ 4PI-

M  D      3390.     20.            ALEXANDER 72 HBC  0 6.94 PBAR P       1/73
W  D       220.    100.            ALEXANDER 72 HBC  0 6.94 PBAR P       1/73
   D   DECAYS TO 3PI+ 3PI-
   D   NOT SEEN BY KALELKAR 75 WITH 1.5 TIMES MORE DATA

M         3475.0    20.0           BAUD      70 MMS  - 14-15.5 PI- P     5/70
W          (30.0)  APPROX.         BAUD      70 MMS  - 14-15.5 PI- P     5/70

M         3535.0    20.0           BAUD      70 MMS  - 14-15.5 PI- P     5/70
W          (30.0)  APPROX.         BAUD      70 MMS  - 14-15.5 PI- P     5/70

M  D      3600.     20.            ALEXANDER 72 HBC  0 6.94 PBAR P       1/73
W  D       140.     20.            ALEXANDER 72 HBC  0 6.94 PBAR P       1/73
   D   DECAYS TO 4PI+ 4PI-

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REFERENCES FOR X(2500-3600)


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ANDERSON 69 PRL 22 1390         +COLLINS,+                            (BNL+CARN)
BAUD     69 PL  30B 129         CERN BOSON SPECTROMETER GROUP             (CERN)
ALEXANDE 70 PRL 25 63           +BAR-NIR,DAGAN,GIDAL,GRUNHAUS+       (TEL-AVIV)
BAUD     70 PL 31 B 549         CERN BOSON SPECTROMETER GROUP             (CERN)
CASO     70 LNC 3 707           +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
SABAU    71 LNC 1 514           +URETSKY                              (BUCH+ANL)
YOST     71 PR D 3 642          +MORRIS,ALBRIGHT,BRUCKER,LANNUTTI          (FSU)
ALEXANDE 72 NP B 45 29          ALEXANDER,BAR-NIR,BEVARY,DAGAN,+          (TELA)
ANTIPOV  72 PL 40B 147          +BAUD,BUSNELLO,DAMGAARD,+            (IHEP+CERN)
BRAUN    75  PREPRINT CRN 24    +BRICK,FRIDMAN,GERBER,JUILLOT,+           (STRB)
KALELKAR 75 THESIS(NEVIS 207)   M.S.KALELKAR                              (COLU)
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S=±1 MESON STATES

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K±

10 CHARGED K(494,JP=0-) I=1/2

SEE STABLE PARTICLE DATA CARD LISTINGS

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K⁰

11 NEUTRAL K(498,JP=0-) I=1/2

SEE STABLE PARTICLE DATA CARD LISTINGS

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K*(892)

18 K*(892,JP=1-) I=1/2

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                    18  K*(892) MASS (MEV)

M  CHARGED ONLY. THIS IS WHAT APPEARS CN MESON TABLE
M   S  100 (898.0)   (5.0)         CHADWICK  63 HBC  +  1.5 K+P(K PI)   12/75*
M  W  1700  891.0     1.2          WOJCICKI  64 HBC  -  1.7 K-P(KO PI-) 12/75*
M   SD 200 (889.5)   (3.6)         ADELMAN   65 HBC  -  1.5 K-P         12/75*
M   S  300 (891.0)   (3.0)         FERRO-LUZ 65 HBC  +     K+P          12/75*
M   S  300 (895.0)   (3.0)         GELSEMA   65 HBC  -  1.5 K-P(KO PI-) 12/75*
M   SD 190 (895.)    (3.6)         BOMSE     67 HBC  + 2.3 K+P (KO PI+) 12/75*
M    D 620  891.      2.3          DE BAERE  67 HBC  + 3.5 K+P (KO PI+) 12/75*
M   SD 260 (892.5)   (3.3)         DE BAERE  67 HBC  + 3.5 K+P (K+ PIO) 12/75*
M   SD  70 (898.)    (9.0)         SALLSTRCM 67 HBC  + 3. K+ P (KO PI+) 12/75*
M   SD  50 (883.)    (7.0)         SALLSTRCM 67 HBC  + 3. K+ P (K+ PIO) 12/75*
M      720  890.      3.0          BARLCW    67 HBC  +- 1.2 PBARP(KO PI) 12/75*
M      600  889.      3.0          BARLOW    67 HBC  +- 1.2 PBARP(K PI)  12/75*
M   S  300 (896.0)   (5.0)         CONFORTO  67 HBC  +- 0. PBARP(KO PI)  12/75*
M   S  430 (893.)    (3.0)         DE WIT    68 CBC  - 3.0 K-P(KOPI-)   12/75*
M    D 540  888.      2.5          DE WIT    68 HBC  - 3.0 K-P          12/75*
M   S      (891.)    (4.0)         FICENEC1  68 HBC  -  1.3 K-P (K-PIO) 12/75*
M   S      (887.)    (3.0)         FICENEC1  68 HBC  -  1.3 K-P (KOPI-) 12/75*
M   S      (890.0)   (5.0)         FICENEC2  68 HBC  -  2.7 K- P(K-PIO) 12/75*
M   S      (892.0)   (3.0)         FICENEC2  68 HBC  -  2.7 K- P(KOPI-) 12/75*
M   S  115 (896.0)   (4.0)         SCHWEINGR 68 HBC  -  4.1 K-P(KO PI-) 12/75*
M    D 341  892.0     2.6          SCHWEINGR 68 HBC  -  5.5 K-P(KO PI-) 12/75*
M   S  175 (884.0)   (5.0)         KANG      68 HBC  -  4.6 K-P(K PI)   12/75*
M     1000  891.0     2.0          CRENNELL  69 CBC  -  3.9 K-N (KOPI-) 12/75*
M     2886  894.      1.0          FRIEDMAN  69 HBC  -  2.1 K-P(KO PI-) 12/75*
M      728  892.      2.           FRIEDMAN  69 HBC  - 2.45 K-P(KO PI-) 12/75*
M     3229  892.      1.0          FRIEDMAN  69 HBC  - 2.6  K-P(KO PI-) 12/75*
M    D1027  892.      1.6          FRIEDMAN  69 HBC  - 2.7  K-P(KO PI-) 12/75*
M   SD 127 (895.)    (4.5)         LIND      69 HBC  +   9. K+ P        12/75*
M     4404  892.2     1.5          AGUILAR1  71 HBC  -  3.9,4.6 K- P    11/71
M    D 765  894.2     2.0          CLARK     73 HBC  - 3.13 K-P(KO PI-) 12/75*
M  W D1150  894.3     1.5          CLARK     73 HBC  -  3.3 K-P,P PI- KO 12/75*
M   I 9000 (891.9)   (0.7)         PALER     75 HBC  - 14.3 K-P,K*- X+  12/75*
M           . . . . . . . . . .
M   AVG     892.24    0.43    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT 892.19    0.51    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M  NEUTRAL ONLY.
M   S   70 (897.0)  (10.0)         COLLEY    62 HBC   0 2.0 PI-P        12/75*
M   S  120 (899.)    (4.0)         BARLOW    67 HBC   0 1.2 PBAR P      12/75*
M   S  310 (897.)    (4.0)         BARLOW    67 HBC   0 1.2 PBAR P      12/75*
M   S      (889.0)   (5.0)         CCNFCRTO  67 HBC   0 0. PBAR P       12/75*
M    D1040  894.7     1.4          DAUBER    67 HBC   02.0 K-P(K-PI+)   12/75*
M  AS  490 (892.0)   (4.0)         GEORGE    67 HBC   0 5.0 K+ P        12/75*
M   SD     (895.)    (4.0)         FICENEC1  68 HBC   0 1.3 K-P (K-PI+) 12/75*
M   SD     (901.)    (4.0)         FICENEC2  68 HBC   0 2.7 K-P (K-PI+) 12/75*
M   SD 150 (896.0)   (4.5)         SCHWEINGR 68 HBC   0 4.1 K-P(K-PI+)  12/75*
M   SD120  (903.0)   (5.0)         SCHWEINGR 68 HBC   0 5.5 K-P(K-PI+)  12/75*
M   S  200 (899.0)   (5.0)         KANG      68 HBC   0 4.6 K-P(K-PI+)  12/75*
M    10700  893.7     2.0          DAVIS     69 HBC   0 12. K+P(K+PI-)  12/75*
M  WAD2200 (890.0)   (1.3)         DE BAERE  69 HBC   0 5.0 K+P(K+PI-)  12/75*
M  W  4300  895.0     1.0          HABER     70 DBC   0 3. K-N (K-PI+)  12/75*
M    D?934  897.9     1.1          AGUILAR1  71 HBC   0 3.9,4.6 K- P    12/75*
M    D5362  898.0     0.7          AGUILAR1  71 HBC   0 3.9,4.6 K- P    12/75*
M  D  1700  898.4     1.3          BUCHNER   72 DBC   04.6 K+ N,K+ PI-  12/72
M     3186  896.0     1.0          LEWIS     73 HBC   02.1-2.7 K+P       2/74
M    C      894.0     1.3          LINGLIN   73 HBC   02-13 K+P,K+PI-   12/75*
M    10600  896.0     0.6          FOX       74 RVUE  0 2 K-P,K-PI+N    12/75*
M           896.0     0.6          FOX       74 RVUE  0 2 K+N,K+PI-P    12/75*
M    C      896.      2.           MATISON   74 HBC   012 K+P,K+PI-     12/75*
M     3600  895.5     1.0          MCCUBBIN  75 HBC   0 3.6 K-P,K-PI+N  12/75*
M   I  22K (897.1)   (0.7)         PALER     75 HBC   014.3 K-P,K*0 X0  12/75*
M           . . . . . . . . . .
M   AVG     896.23    0.36    AVERAGE (ERROR INCLUDES SCALE FACTOR CF 1.3)
M   STUDENT 896.12    0.33    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                     (SEE IDEOGRAM BELOW )

  A   INCLUDED IN LINGLIN 73 WORLD K+P DST
   C  FROM POLE EXTRAPOLATICN.
 D          ERRORS ENLARGED BY US TO   GAMMA/SQRT(N). SEE TYPED NOTE.
  I   INCLUSIVE REACTION. COMPLICATED BACKGROUND AND PHASE-SPACE EFFECTS
  S   DATA WITH MASS ERROR OF 3 MEV OR MORE NOT AVERAGED
 W    NUMBER OF EVENTS IN PEAK REEVALUATED BY US
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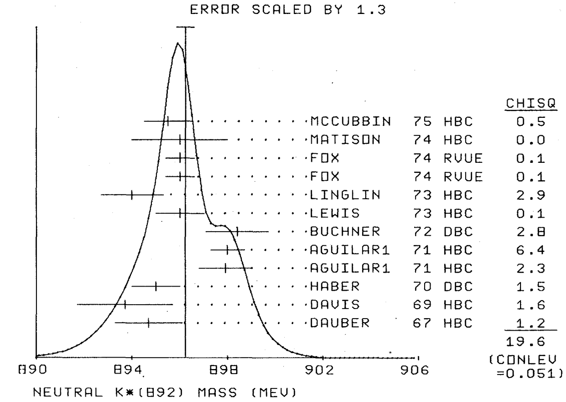
WEIGHTED AVERAGE = 896.23 ± 0.36
ERROR SCALED BY 1.3

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Data Card Listings

For notation, see key at front of Listings.

Mesons

$K^*(892)$

Note on $K^*(892)$ Masses and Mass Differences

Unrealistically small errors are reported by some experiments. We use simple "realistic" tests for the minimum errors on the determination of mass and width from a sample of N events:

$$\delta_{min}(m) = \frac{\Gamma}{\sqrt{N}}\ ,\quad \delta_{min}(\Gamma) = 4\,\frac{\Gamma}{\sqrt{N}}\ .$$

(For detailed discussion see the April 1971 edition of this note.) We consistently increase unrealistic errors before averaging.

Although in the past we have argued against taking the mass difference $m(K^{*0}) - m(K^{*\pm})$ from the separate averages of $m(K^{*0})$ and $m(K^{*\pm})$, we no longer see any reason for such caution. In fact, the difference between the separate averages agrees with direct measurements of the mass difference, and it has a smaller statistical error.

```
                         18  K*(0) - K*(+-) MASS DIFF. (MEV)

D  W   283     6.3       4.1                BARASH    67 HBC      0 PBAR P       12/75*
D   SD1400    (6.5)     (5.0)               FICENEC1  68 HBC       1.3 K- P      12/75*
D   SD1600    (9.5)     (5.0)               FICENEC2  68 HBC       2.7 K- P      12/75*
D     7338     5.7       1.7                AGUILAR1  71 HBC    -0 3.9,4.6 K- P  11/71
D           . . . . . . . . .
D   AVG        5.8       1.6    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D   STUDENT    5.8       1.7    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

   D          ERRORS ENLARGEC BY US TO   GAMMA/SQRT(N). SEE TYPED NOTE.
    S   DATA WITH MASS ERROR OF 3 MEV OR MORE NOT AVERAGED
   W    NUMBER OF EVENTS IN PEAK REEVALUATED BY US

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                         18  K*(892) WIDTH (MEV)

W  CHARGED ONLY. THIS IS WHAT APPEARS ON MESON TABLE
W   S  100  (46.0)    (8.0)              CHADWICK  63 HBC  +   1.5 K+P(K PI )  12/75*
W  W D1700   46.0      5.0               WOJCICKI  64 HBC   -  1.7 K-P(KO PI-) 12/75*
W   SD 200  (51.0)   (15.0)              ADELMAN   65 HBC   -  1.5 K-P         12/75*
W   SD 300  (47.0)   (11.0)              FERRO-LUZ 65 HBC  +   3.0 K+P         12/75*
W   SD 300  (50.0)   (12.0)              GELSEMA   65 HBC   -  1.5 K-P(KO PI-) 12/75*
W   SD 190  (50.)    (15.0)              BOMSE     67 HBC  +   2.3 K+P(KO PI+) 12/75*
W    D 620   56.0      9.0               DE BAERE  67 HBC  +   3.5 K+P(KO PI+) 12/75*
W   SD 260  (53.)    (13.0)              DE BAERE  67 HBC  +  3.5 K+P (K+ PIO) 12/75*
W   SD  70  (68.)    (33.0)              SALLSTRCM 67 HBC  +  3. K+ P (KO PI+) 12/75*
W   SD  50  (47.)    (27.0)              SALLSTRCM 67 HBC  +  3. K+ P (K+ PIO) 12/75*
W   SD 210  (44.)    (12.0)              BARLOW    67 HBC  +-  1.2 PBAR P      12/75*
W      720   43.       9.0               BARLOW    67 HBC  +- 1.2 PBARP(KO PI) 12/75*
W    D 600   53.       9.0               BARLOW    67 HBC  +- 1.2 PBARP(K PI)  12/75*
W   SD 430  (58.)    (12.0)              DE WIT    68 DBC   -  3. K- D         12/75*
W    D 540   44.0      8.0               DE WIT    68 DBC   -  3. K- D         12/75*
W   S       (58.)    (16.0)              FICENEC1  68 HBC   -  1.3 K-P (K-PIO) 12/75*
W   S       (44.)    (13.0)              FICENEC1  68 HBC   -  1.3 K-P (KOPI-) 12/75*
W   SD 115  (41.0)   (16.0)              SCHWEINGR 68 HBC   -  4.1 K-P(KO PI-) 12/75*
W   SD 341  (47.0)   (10.0)              SCHWEINGR 68 HBC   -  5.5 K-P(KO PI-) 12/75*
W   S       (57.0)   (13.0)              FICENEC2  68 HBC   -  2.7 K- P(K-PIO) 12/75*
W   S       (48.0)    (9.0)              FICENEC2  68 HBC   -  2.7 K- P(KOPI-) 12/75*
W   SD 175  (52.0)   (16.0)              KANG      68 HBC   -  4.6 K- P        12/75*
W    D2886   53.       4.0               FRIEDMAN  69 HBC   -  2.1 K-P(KO PI-) 12/75*
W    D 728   49.       7.3               FRIEDMAN  69 HBC   -  2.45K-P(KO PI-) 12/75*
W    D3229   46.       3.2               FRIEDMAN  69 HBC   -  2.6 K-P(KO PI-) 12/75*
W    D1027   49.       6.1               FRIEDMAN  69 HBC   -  2.7 K-P(KO PI-) 12/75*
W   SD 127  (50.)    (18.0)              LIND      69 HBC  +   9. K+ P         12/75*
W    D4404   54.3      3.3               AGUILAR1  71 HBC   -  3.9,4.6 K- P    12/75*
W    D 765   46.3      6.7               CLARK     73 HBC  -  3.13K-P,P PI- KO 12/75*
W  W D1150   48.2      5.7               CLARK     73 HBC  -  3.3 K-P,P PI- KO 12/75*
W   I 9000  (52.1)    (2.2)              PALER     75 HBC   - 14.3 K-P,K*- X+  12/75*
W           . . . . . . . . .
W   AVG      49.5      1.5    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT  49.4      1.8    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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W  NEUTRAL CNLY.
W   SD  70  (60.0)   (29.0)           COLLEY    62 HBC   0 2.0 PI-P          12/75*
W   S  310  (53.)    (13.0)           BARLOW    67 HBC   0 1.2 PBAR P        12/75*
W   SD 120  (34.)    (12.5)           BARLOW    67 HBC   0 1.2 PBAR P        12/75*
W    D1040   44.       5.5            DAUBER    67 HBC   0  2.0 K- P         12/75*
W   S       (52.)    (12.0)           FICENEC1  68 HBC   0 1.3 K-P (K-PI+)   12/75*
W   S       (50.0)    (8.0)           FICENEC2  68 HBC   0 2.7 K- P(K-PI+)   12/75*
W   SD 200  (48.0)   (16.0)           KANG      68 HBC   0 4.6 K-P(K-PI+)    12/75*
W   SD 120  (51.0)   (19.0)           SCHWEINGR 68 HBC   0 5.5 K-P(K-PI+)    12/75*
W   SD 150  (53.0)   (17.5)           SCHWEINGR 68 HBC   0 4.1 K-P(K-PI+)    12/75*
W  D 10700   53.2      2.1            DAVIS     69 HBC   0 12. K+P(K+PI-)    12/75*
W  DAW2200  (58.0)    (5.0)           DE BAERE  69 HBC   0 5.0 K+P(K+PI-)    12/75*
W  W D4300   54.0      3.3            HABER     70 DBC   0 3. K-N (K-PI+)    12/75*
W     2934   55.8      4.2      3.4   AGUILAR1  71 HBC   0 3.9,4.6 K- P      11/71
W    D5362   48.5      2.7            AGUILAR1  71 HBC   0 3.9,4.6 K- P      12/75*
W  D  1700   51.4      5.0            BUCHNER   72 CBC  0 4.6 K+ N,K+ PI-P   12/72
W    D3186   46.0      3.3            LEWIS     73 HBC  0 2.1-2.7 K+P        12/75*
W   C       (46.5)    (1.5)           LINGLIN   73 HBC  0 2-13 K+P,K+PI-      1/74
W    10600   47.       2.             FOX       74 RVUE  0 2 K-P,K-PI+N      12/75*
W            51.       2.             FOX       74 RVUE  0 2 K+N,K+PI-P      12/75*
W   C       (47.)     (3.)            MATISON   74 HBC   012 K+P,K+PI-       12/75*
W     3600   48.       3.       2.    MCCUBBIN  75 HBC   0 3.6 K-P,K-PI+N    12/75*
W   I  22K  (50.6)    (2.5)           PALER     75 HBC   014.3 K-P,K*0 XO    12/75*
W           . . . . . . . . .
W   AVG      50.0      1.0    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
W   STUDENT  49.9      1.1    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

    A   INCLUDED IN LINGLIN 73 WORLD K+P DST
     C  FRCM POLE EXTRAPCLATICN.
   D          ERRORS ENLARGED BY US TO 4*GAMMA/SQRT(N). SEE TYPED NOTE.
    I   INCLUSIVE REACTION. COMPLICATED BACKGROUND AND PHASE-SPACE EFFECTS
    S   DATA WITH MASS ERRCR OF 3 MEV OR MORE NOT AVERAGED
   W    NUMBER OF EVENTS IN PEAK REEVALUATED BY US

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                  18  K*(892) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     K*(892) INTO K PI                                 493+ 139
P2     K*(892) INTO K PI PI                              493+ 139+ 139
P3     K*(892) INTO K GAMMA                              493+   0

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                  18  K*(892) BRANCHING RATIOS

R1     K*(892) INTO (K PI PI)/(K PI)                    (P2)/(P1)
R1       0   (0.002)OR LESS          WOJCICKI2 64 HBC   -  1.7 K-P

R2     K*(892)  INTO (K  GAMMA)/TCTAL  (UNITS 10**-3)   (P3)
R2           (1.6)  OR LESS  CL=.95   BEMPORAD  72 CNTR +  10.-16. K+A,COUL  1/73
R2            1.5      0.7            CARITHERS 75 CNTR  0 8-16KOBAR A,CCUL 12/75*

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REFERENCES FOR K*(892)


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ALSTCN    61 PRL 6 300           ALSTON,ALVAREZ,EBERHARD,GOOD,GRAZIANO+(LRL)
ALEXANDE  62 PRL 8 447           ALEXANDER,KALBFLEISCH,MILLER,G SMITH  (LRL)
CCLLEY    62 CERN CONF 315       D COLLEY,N GELFAND +     (COLUMBIA+RUTGERS)

CHADWICK  63 PL 6 309            CHADWICK,CRENNELL,CAVIES,BETTINI+(OXF+PADO)
GOLDHABE  63 ATHENS CONF 92      SULAMITH GOLDHABER                    (LRL)

WOJCICKI  64 PR 135 B 484        STANLEY G WOJCICKI                    (LRL)

ADELMAN   65 ATHENS 527          STUART LEE ADELMAN              (CAVENDISH)
FERRO-LU  65 NC 36 1101          FERRO-LUZZI,GEORGE,HENRI,JONGEJANS   (CERN)
FERRO-LU  65 NC 39 417           FERRO-LUZZI,GEORGE,GOLDSCHMIDT-CLER+ (CERN)
GELSEMA   65 THESIS              E.S.GELSEMA (SEE ALSO PL 10 341)(AMSTERDAM)
WANGLER   65 PR 137 B 414        WANGLER,ERWIN,WALKER            (WISCONSIN)

BARASH    67 PR  156  1399       EARASH,KIRSCH,MILLER,TAN         (COLUMBIA)
BARLOW    67 NC  50 A  701       +MONTANET,D.ANDLAU+   (CERN+CDEF+IRAD+LIVP)
BCMSE     67 PR 158 1298         +BORENSTEIN+COLE+GILLESPIE+  (JOHN HOPKINS)
CONFORTO  67 NP B3 469           +MARECHAL,MONTANET+CERN+CDEF+IPN+LIVERPOOL
DAUBER    67 PR 153 1403         +SCHLEIN,SLATER,TICHC                (UCLA)
DE BAERE  67 NC 51 A 401         +GOLDSCHMIDT-CLERMCNT,HENRI+    (BRUX+CERN)
FRENCH    67 NC 42A 442          +KINSON+MCDONALD+RIDDIFORD+     (CERN+BIPM)
GEORGE    67 NC 49A 9            +GOLDSCHMIDT-CLERMCNT+HENRI+    (CERN+BRUX)
SALLSTRG  67 NC 49A 348          SALLSTROM+OTTER+EKSPCNG         (STOCKHOLM)

DE WIT    68  THESIS             S. DE WIT                       (AMSTERDAM)
FICENEC1  68 PR 169 1034         +HULSIZER+SWANSON+TROWER              (ILL)
FICENEC2  68 PR 175 1725         FICENEC, GORDON, TROWER          (ILLINOIS)
KANG      68 PR 176 1587         Y.W.KANG                             (IOWA)
SCHWEING  68 PR 166 1317         SCHWEINGRUBER,DERRICK,FIELDS+    (ANL+NWES)

CRENNELL  69 PRL 22  487         +KARSHON,LAI,ONEALL,SCARR             (BNL)
DAVIS     69 PRL 23 1071         +DERENZO,FLATTE,ALSTON,LYNCH,SOLMITZ  (LRL)
DE BAERE  69 NC 61 A 397         +GOLDSCHMIDT-CLERMCNT,HENRI,+   (BELG+CERN)
FRIEDMAN  69  UCRL-18860         J.FRIEDMAN,PH.D. THESIS               (LRL)
JUHALA    69 PR 184  1461        +LEACOCK,RHODE,KOPELMAN,LIBBY,+ (ISU+COLO)
LIND      69 NP B 14 1           +ALEXANDER,FIRESTONE,FU,GOLDHABER     (LRL)

ATHERTCN  70 NP B 16 416         +FRANEK,FRENCH,FRISK,BEDNAR+    (CERN+PRAG)
DE BAERE  70  CERN PHYS 70 41    +DEBAISIEUX,DE WOLF,DUFOUR,+    (BELG+CERN)
HABER     70 NP B 17 289         +SHAPIRA,ALEXANDER+   (REHO+SACL+BGNA+EPOL)

AGUILAR   71 PRL 26 466          +BARNES,BASSANO,EISNER,KINSON,SAMIOS  (BNL)
AGUILAR1  71 PR D 4 2583         +EISNER,KINSON                        (BNL)
BARNHAM   71 NP B 28 171         +COLLEY,JOBES,GRIFFITHS,HUGHES,+(BIRM+GLAS)
BUCHNER   71 NP B 29 381         +DEHM,GOEBEL,GOLDSCHMIDT,+ (MPIM+CERN+BELG)
CORDS     71 PR D 4 1974         +CARMONY,ERWIN,MEIERE,+     (PURD+UCD+IUPU)
MERCER    71 NP B32 381          +ANTICH,CALLAHAN,CHIEN,COX,+ (JOHN HOPKINS)
YUTA      71 PRL 26 1502         +DERRICK,ENGELMANN,MUSGRAVE       (ANL+EFI)

ABRAMOVI  72 NP B 39 189         ABRAMCVICH,CHALCUPKA,CHUNG,HILPERT,+ (CERN)
BINGHAM   72 NP B 41 1           +           (INTERNATIONAL K+ COLLABORATION)
BEMPORAD  72 NP B 51 1           +BEUSCH,FREUDENREICH,+     (CERN+ETHZ+LOIC)
BRUNET    72 NP B 37 114         +DANYSZ,GOLDSACK,+    (CDEF+SACL+LOIC+LOWC)
BUCHNER   72 NP B 45 333         +DEHM,CHARRIERE,CORNET,+   (MPIM+CERN+BRUX)
CHARRIER  73 NP B 51 317         CHARRIERE,ORIJARD,DE BAERE,+    (CERN+BELG)
CRENNELL  72 PR D 6 1220         +GCRDON,KWAN-WU LAI,SCARR             (BNL)
DEUTSCHM  72 NP B 36 373         DEUTSCHMANN,+           (ABCLV COLLABCRATION)
ENGELMAN  72 PR D 5 2162         ENGELMANN,MUSGRAVE,FORMAN,+       (ANL+EFI)
ROUGE     72 NP B 46 29          +VIDEAU,VOLTE,DE BRICN,+        (EPCL+SACL)
TIECKE    72 NP B 39 596         +GRIJNS,HEINEN,DE GROOT,+       (NIJM+ZEEM)
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Mesons

K*(892), κ(1250)

Data Card Listings

For notation, see key at front of Listings.

BERTHON 73 NP B 63 54 +MONTANET,PAUL,BERTRANET,+ (CERN+SACL)
CLARK 73 NP B 54 432 +LYONS,RADOJICIC (OXFORD)
LEWIS 73 NP B 60 283 +ALLEN,JACOBS,DANYSZ,BORG,+(LOWC+LOIC+CDEF)
LINGLIN 73 NP B 55 408 D.LINGLIN (CERN)
WALUCH 73 PR D 8 2837 +FLATTE,FRIEDMAN (LBL)

FOX 74 NP B80 403 G.C.FOX,M.L.GRISS (CIT)
MATISON 74 PR D9 1872 +GALTIERI,GARNJOST,FLATTE,FRIEDMAN,+ (LBL)

BRANDENB 75 PL 59 B 405 BRANDENBURG,CARNEGIE,CASHMORE,DAVIER+(SLAC)
CARITHER 75 PRL 35 349 CARITHERS,MUHLEMANN,UNDERWOOD,+ (ROCH+MCGI)
MCCUBBIN 75 NP B86 13 N.A.MCCUBBIN,L.LYONS (OXF)
PALER 75 NP B96 1 +TOVEY,SHAH,SPIRO,CHAURAND+(RHEL+SACL+EPCL)

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κ(1250)

19 K PI S WAVE, CALLED KAPPA

S-Wave Kπ Interactions in the Region 750-1700 MeV

Kπ interactions in the $I(J^P)=1/2(0^+)$ wave can be described by the elastic phase shift δ_0^1 from the Kπ threshold (∿630 MeV) up to at least 1100 MeV (BINGHAM 72). The first inelastic S-wave thresholds are Kπππ and Kη, neither of which is known to be important below 1400 MeV. Apart from the inelastic thresholds, the S-wave ππ and Kπ interactions are reminiscent of each other.

All phase-shift solutions (MERCER 71, BINGHAM 72, FIRESTONE 71, 72, MATISON 72, 74, BAKER 73, GALTIERI 73, YUTA 73, FOX 74, LAUSCHER 75) share the following intrinsic ambiguities:

1) The standard modulo-180° ambiguity.
2) If one amplitude is dominant [the P wave near $K^*(892)$ or the D wave near $K^*(1420)$], then the observed S-P or S-D interference can be explained by two ambiguous S-wave solutions, known as "up" and "down". For an illustration see our 1972 edition.

The resulting "up-down" ambiguity of the S-wave phase shift in the $K^*(892)$ region (BINGHAM 72) was restricted by an analysis of 12 GeV/c $K^+p \to K^+\pi^-\Delta^{++}$ (MATISON 72, 74, GALTIERI 73) to only two points at 890 and 900 MeV, where the P wave goes through 90°. The "up" solution is therefore excluded, except for a possibility of a very narrow (Γ < 7 MeV) S-wave resonance. Moreover, CHUNG 72 imposes positivity on physical-region Kπ moments, and finds a narrow resonance most unlikely.

FIRESTONE 71 and 72 have continued Kπ partial-wave analysis up to 1700 MeV. They find that δ_0^1 crosses 90° near 1300 MeV, and indeed shows the "up-down" ambiguity near the $K^*(1420)$.

Meanwhile several groups have attempted to clarify the situation around 1300 MeV. CORDS 72, FRATI 72, ROUGE 72, and LAUSCHER 75 give support to the resonant S-wave interpretation of FIRESTONE 71. The other groups (AGUILAR 72, BUCHNER 72, CRENNELL 72, ENGELMANN 72, BAKER 73) agree that the S wave is important but not necessarily resonant.

In a review of the status of the 0^+ nonet, MORGAN 75 shows that the resonant interpretation, κ(1250), is consistent with the information on the other S-wave systems, ππ, $K\bar{K}$, and ηπ (see the corresponding mini-reviews), suggesting a non-ideally mixed nonet.

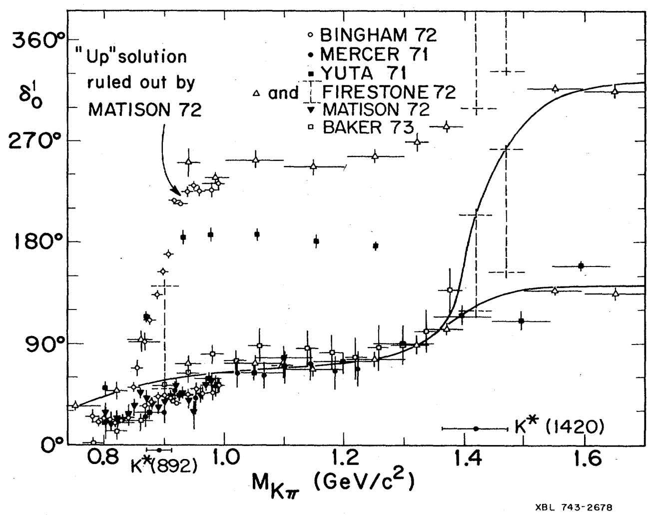

Fig. 1. The S-wave Kπ phase shift. An "up-down" ambiguity occurs at the mass of K*(892), K*(1420), ..., which can be resolved by precise measurement of σ(Kπ). At K*(892), the "up" solution was ruled out by MATISON 72; earlier "up" solutions are plotted only to show historical progress.

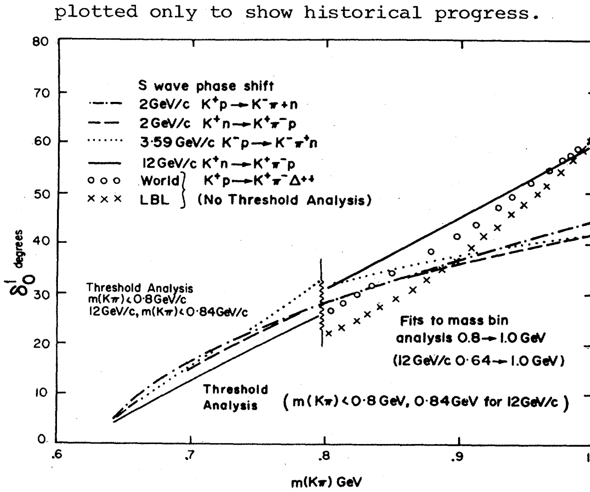

Fig. 2. Summary of six different S-wave Kπ phase-shift analyses, including four solutions of FOX 74. (Figure from FOX 74.)

Data Card Listings

For notation, see key at front of Listings.

Mesons

$\kappa(1250)$, Q

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                    19  KAPPA MASS (MEV)
M         1250.     100.              MORGAN    75 RVUE            12/75*
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                    19  KAPPA WIDTH (MEV)
W         (450.)    APPROX.           MORGAN    75 RVUE            12/75*
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REFERENCES FOR KAPPA


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TRIPPE    68 PL 28 B 203          +CHIEN,MALAMUD,MELLEMA,SCHLEIN,+     (UCLA)

CRENNELL 69 PRL 22 487           +KARSHON,LAI,O.NEALL,SCARR             (BNL)
DODD      69 PR 177 1994          +JOLDERSMA,PALMER,SAMIOS               (BNL)
GOLDBERG 69 PL 30 B 434          SABRE COLLABOR.  (SACL+AMST+BGNA+REHO+EPOL)
SCHLEIN   69 ARGONNE CONF. 446 P.SCHLEIN                             (UCLA)

FIRESTON 71 PRL 26 1460          A.FIRESTONE,G.GOLDHABER,D.LISSAUER    (LRL)
MERCER    71 NP B32 381           +ANTICH,CALLAHAN,CHIEN,COX,+ (JOHN HOPKINS)
YUTA      71 PRL 26 1502          +DERRICK,ENGELMANN,MUSGRAVE        (ANL+EFI)

AGUILAR   72 PR D 6 11            AGUILAR-BENITEZ,CHUNG,EISNER           (BNL)
BINGHAM   72 NP B 41 1            +           (INTERNATIONAL K+ COLLABORATION)
BUCHNER   72 NP B 45 333          +DEHM,CHARRIERE,CORNET,+    (MPIM+CERN+BRUX)
CHUNG     72 PRL 29 1570          +EISNER,AGUILAR-BENITEZ                (BNL)
CRENNELL 72 PR D 6 1220          +GORDON,KWAN-WU LAI,SCARR              (BNL)
DIEBOLD   72  BATAV.CONF.         R.DIEBOLD  RAPPORTEUR TALK             (ANL)
ENGELMAN 72 PR D 5 2162          ENGELMANN,MUSGRAVE,FORMAN,+        (ANL+EFI)
FIRESTON 72 PR D 5 2188          +GOLDHABER, LISSAUER, TRILLING      (LBL)PWA
FRATI     72 PR D 6 2361          +HALPERN,HARGIS,SNAPE,CARNAHAN,+(PENN+CINC)
ROUGE     72 NP B 46 29           +VIDEAU,VOLTE,DE BRION,+          (EPOL+SACL)
MATISON   72 LBL 1537 (THESIS) REVISED VERSION WILL GO TC PHYS.REV.    LBL

BAKER     73  IC/HEP/73/12        +BANNERJEE,CAMPBELL,HALL,ISLAM,+(LOIC+LOWC)
CORDS     73 NP B 54 109          +CARMONY,LANDER,MEIERE,+    (PURD+UCD+IUPU)
GALTIERI 73  PREP.LBL 1772       +MATISON,GARNJOST,FLATTE,FRIEDMAN,+   (LBL)
LINGLIN   73 NP B 55 408          D.LINGLIN                             (CERN)
YUTA      73 NP B 52 70           +ENGELMANN,MUSGRAVE,FCRMAN,+       (ANL+EFI)

FOX       74 NP B80 403           G.C.FOX,M.L.GRISS                      (CIT)
MATISON   74 PR D9 1872           +GALTIERI,GARNJCST,FLATTE,FRIEDMAN,+  (LBL)
    ALSO 72 MATISON,73 GALTIERI
MORGAN    74 PL 51B 71            D.MORGAN                              (RHEL)

BAKER     75 NP B99 211           +BANERJEE,CAMPBELL,ALLEN,MARCH+ (LOIC+LOWC)
LAUSCHER 75 NP B86 189           +OTTER,WIECZOREK,+    (ABCLV COLLABORATION)
MORGAN    75  PREPRINT RL75133 D.MORGAN                              (RHEL)
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Q REGION, $K\pi\pi(1240-1400)$

28 Q REGION (1200-1400) MEV I=1/2

The main effect in the Q region is a broad bump in the $K\pi\pi$ spectrum between 1200 and 1400 MeV (not far above the $K^*(892)\pi$ threshold), produced by K beams without charge exchange. In particular, it has been observed in coherent K^+d interactions (FIRESTONE 72) and in coherent interactions on heavy nuclei (BINGHAM 73). Throughout the entire region, $J^P = 1^+$ and $I = 1/2$.

Evidence for narrower states in the Q region has been reported from reactions with incident π^- and $\bar{p}$ (ASTIER 69, CRENNELL 67, 72, DAVIDSON 74, DORE 75). FIRESTONE1 72 observe a bump in the backward direction with a shape similar to that of the Q. WERNER 73 find no evidence for narrow states in the charge-exchange reaction $K^-p \to (K\pi\pi)^0 n$, but the data can accommodate some broad Q production. The $(K\pi\pi)^0$ system appears to have an important $J^P=1^+$ contribution (OTTER1 75).

The broad Q peak does not have a simple Breit-Wigner shape. It can be fitted at all energies by a superposition of two Breit-Wigner amplitudes (FIRESTONE 70, BARNHAM 71, BOWLER 71, BARLOUTAUD 73).

Dalitz plot analyses of the interference between the $K^*\pi$ and $K\rho$ modes show the relative magnitude and relative phase of the two decay amplitudes varying with $K\pi\pi$ mass. The $K\rho$ mode has a maximum intensity below that of $K^*\pi$. This is suggestive of the presence of two $J^P=1^+$ states, possibly mixtures of the strange members of the $J^{PC}=1^{++}$ ("A_1") and 1^{+-} (B) nonets (GOLDHABER 67, BARNHAM 71, BOWLER 71, GARFINKEL 71, BINGHAM 72, FIRESTONE 72, BOWLER 74). In addition to the dominant modes $K^*\pi$ and $K\rho$, there is some evidence for a $K\pi\pi$ mode, with the $\pi\pi$ or the $K\pi$ system in an S wave (ALEXANDER 69, BARNHAM 71, DAVIS 72, BARLOUTAUD 73).

Recent partial-wave analyses have confirmed the rather complex situation in the Q region (DEUTSCHMANN 74, ANTIPOV 75, OTTER2 75, OTTER3 75, TOVEY 75, BRANDENBURG 76). Although $J^P=1^+$ is the dominant contribution, other spin-parity states are necessary to describe the whole Q enhancement. Moreover, the $K^*\pi$ and $K\rho$ modes are not produced coherently and have different polarization properties (OTTER2 75, OTTER3 75, TOVEY 75, BRANDENBURG 76). Whereas the $K\rho$ mode approximately conserves s-channel helicity, the $K^*\pi$ mode is approximately t-channel helicity-conserving.

ANTIPOV 75 do not require the $K\rho$ decay mode to be present at 40 GeV/c.

ANTIPOV 75 and OTTER2 75 find no variation in the phase of the 1^+ $K^*\pi$ wave. On the other hand BRANDENBURG 76, with high-statistics spectrometer data, observe sufficient phase variation of both the 1^+ $K\rho$ and $K^*\pi$ waves to warrant proposing the existence of two 1^+ mesons, superposed on a large 1^+, mainly $K^*\pi$, Deck background. The first state has $M \sim 1300$ MeV, $\Gamma \sim 200$ MeV and decays mainly to $K\rho$; the second has $M \sim 1400$ MeV, $\Gamma \sim 160$ MeV and decays mainly to $K^*\pi$.

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Mesons

Q

Data Card Listings

For notation, see key at front of Listings.

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                    28  Q REGION MASS  (MEV)

M    PRODUCED BY BEAMS CTHER THAN K MESCNS
M  A        1242.0       9.0      10.0   ASTIER     69 HBC     0 PBAR P          . 9/69
M  A    THIS IS THE C MESCN.
M        45(1300.)                       CRENNELL   67 HBC     0 6 PI- P,LK2PI    7/67
M        40(1300.)                       CRENNELL   72 HBC     0 4.5PI-P,LK2PI   12/72
M        40(1278.)       (5.)            DAVIDSCN   74 HBC    +- 1.6-2.2 PBAR P  12/75*
M        43(1235.)      (10.)            DORE       75 OSPK    06.2 PI-P,L MM    12/75*

M    PRODUCED BY K BEAMS
M        12(1320.0)     (25.0)           ALMEIDA    65 HBC   +    3-5 K+  P      12/72
M   C      (1230.0)     (15.0)           BASSOMPIE  67 HBC   +    5. K+ P        11/67
M   C    35(1280.0)     (10.0)           BASSOMPIE  67 HBC   +    5. K+ P        11/67
M   C      (1320.0)     (15.0)           BASSOMPIE  67 HBC   +    5. K+ P        11/67
M   C    SPLIT THE Q REGICN INTO 3 BUMPS .
M          (1270.)    APPROX.            DE BAERE   67 HBC   +    3.5 K+ P        7/67
M          (1335.0)      (6.0)           BARTSCH    68 HBC        10. K-P,K NPI  .12/75*
M          (1300.)    APPROX.            BARBARO    69 HBC   +    12.K+ P (K 2PI)  9/69
M        45(1301.0)     (10.0)           BISHCP     69 HBC   +    3.5 K+P(K* PI)  12/75*
M        21(1300.0)     (10.0)           ERWIN      69 HBC     0 3.5 K+P(K* PI)  12/75*
M          (1281.)       (7.)            FRIEDMAN   69 HBC   -    2.6,2.7 K- P    12/75*
M          (1300.0)     (10.0)           ABRAMS     70 HBC   +    2.5-3.2 K+ P    12/75*
M          (1260.)      (20.)            FARBER     70 HBC   +    12.7 K+ P      .12/75*
M          (1325.0)                      DENEGRI    71 CBC   - 12.6 K-D,K 2PI D  12/75*
M          (1296.)       (5.)            BARLOUTAU  73 HBC   -  14.3 K-P,P K-2PI  12/75*
M          (1283.)       (6.)            BARLOUTAU  73 HBC   -  14.3 K-P,P KO2PI  12/75*
M          (1315.)       (7.)            BINGHAM    73 HLBC  -  5.5-12.7 COH K-A  12/75*
M          (1260.)      (10.)            LEWIS      73 HBC   +  2.1-2.7 K+ P      12/75*
M   F      (1260.)       (5.)            LEWIS      73 HBC   +  2.1-2.7 K+ P      12/75*
M   F    FROM NON-PERIPHERAL EVENTS (T GT 0.8)
M
M    AVERAGING NOT MEANINGFUL

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                    28  Q LCW (QA)  MASS  (MEV)

ML F     FRCM EXPERIMENTS SPLITTING Q REGION INTO TWO PEAKS
ML
ML         (1280.)                       SHEN       66 HBC   + 0 4.6 K+P,5 BODY  12/72
ML         (1260.0)     (10.0)           ALEXANDER  69 HBC        9.0 K+ P       12/75*
ML         (1240.0)      (5.0)           BARNHAM    70 HBC   +  10.0 K+P,K 2PI   12/75*
ML         (1243.)       (8.)            GARFINKEL  71 DBC   +  9. K+ D          12/75*
ML         (1228.)      (14.)            ANDERSON   72 DBC   -  7.3 K- D         12/75*
ML         (1260.)                       DAVIS      72 HBC   +  12. K+ P         12/72
ML         (1234.)      (12.)            FIRESTONE  72 DBC   +  12. K+ D          2/73
ML C       (1300.)    APPROX.            BRANDENB   76 ASPK +- 13 K+-P,(KPIPI)P 12/75*
ML C     COUPLES MAINLY TO RHO K
ML
ML   AVERAGING NOT MEANINGFUL

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                    28  Q HIGH (QB)  MASS  (MEV)

MH F     FROM EXPERIMENTS SPLITTING Q REGICN INTO TWO PEAKS
MH
MH       70(1320.0)     (10.0)           SHEN       66 HBC   +    4.6 K+  P      12/75*
MH         (1380.0)     (20.0)           ALEXANDER  69 HBC        9.0 K+ P       12/75*
MH         (1420.0)      (5.0)           BARNHAM    70 HBC   +  10.0 K+P,K 2PI   12/75*
MH         (1344.)       (8.)            GARFINKEL  71 CBC   +  9. K+ C          12/75*
MH         (1414.)      (15.)            ANDERSON   72 DBC   -  7.3 K- D         12/75*
MH         (1420.)                       DAVIS      72 HBC   +  12. K+ P         12/72
MH          1368.        18.             FIRESTCNE  72 DBC   +  12. K+ D         12/75*
MH D       (1400.)    APPROX.            BRANDENB   76 ASPK +- 13 K+-P,(KPIPI)P 12/75*
MH D     COUPLES MAINLY TO K* PI
MH
MH   AVERAGING NOT MEANINGFUL

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                    28  Q  REGICN WIDTH  (MEV)

W    PRODUCED BY BEAMS OTHER THAN K MESONS
W            127.0        7.0      25.0   ASTIER     69 HBC     0 PBAR P          . 9/69
W        45  (60.)                        CRENNELL   67 HBC     0 6 PI- P          7/67
W        40  (60.)                        CRENNELL   72 HBC     0 4.5PI-P,LK2PI   12/72
W   D    40  (25.)      (15.)             DAVIDSON   74 HBC    +- 1.6-2.2 PBAR P  12/75*
W   D    ERROR INCREASED BY US. SEE K* TYPED NOTE.
W        43  (30.)      (25.)     (18.)   DORE       75 OSPK    06.2 PI-P,L MM    12/75*

W    PRODUCED BY K BEAMS
W        12  (60.0)     (20.0)            ALMEIDA    65 HBC   +    3-5 K+P        12/72
W   C        (60.0)     (20.0)            BASSOMPIE  67 HBC   +    5. K+ P        11/67
W   C    35  (80.0)     (20.0)            BASSOMPIE  67 HBC   +    5. K+ P        11/67
W   C        (60.0)     (20.0)            BASSOMPIE  67 HBC   +    5. K+ P        11/67
W   C    SPLIT THE Q REGION INTO 3 BUMPS
W           (200.)    APPROX.             DE BAERE   67 HBC   +  3.5 K+ P          7/67
W           (196.0)     (16.0)            BARTSCH    68 HBC      10. K- P,K NPI  .12/75*
W   B        250. APPROX.                 BARBARO    69 HBC   +    12.K+ P (K 2PI)  9/69
W   B        NO BACKGROUND SUBTRACTION.
W        45  (40.0)     (10.0)            BISHOP     69 HBC   +    3.5 K+P(K* PI)  12/75*
W        21  (40.0)     (15.0)            ERWIN      69 HBC     0 3.5 K+P(K* PI)  12/75*
W            (51.)      (22.)             FRIEDMAN   69 HBC   -   2.6,2.7 K- P    12/75*
W            (80.0)     (20.0)            ABRAMS     70 HBC   +   2.5-3.2 K+ P    12/75*
W           (180.)      (28.)             FARBER     70 HBC   +   12.7 K+ P      .12/75*
W           (180.0)                       DENEGRI    71 CBC   - 12.6 K-D,K 2PI D   5/71
W           (326.)      (17.)             BARLOUTAU  73 HBC   -  14.3 K-P,P K-2PI 12/75*
W           (266.)      (21.)             BARLOUTAU  73 HBC   -  14.3 K-P,P KO2PI 12/75*
W           (150.)      (70.)             LEWIS      73 HBC   +  2.1-2.7 K+ P     12/75*
W   F        (47.)      (18.)             LEWIS      73 HBC   +  2.1-2.7 K+ P     12/75*
W   F    FROM NON-PERIPHERAL EVENTS (T GT 0.8)
W
W    AVERAGING NOT MEANINGFUL

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                    28  Q LCW (QA)  WIDTH  (MEV)

WL F     FROM EXPERIMENTS SPLITTING Q REGION INTO TWO PEAKS
WL
WL          (100.0)     (20.0)            SHEN       66 HBC   + 0 4.6 K+P,5 BODY  12/75*
WL           (40.0)     (10.0)            ALEXANDER  69 HBC        9.0 K+ P       12/75*
WL          (110.0)     (15.0)            BARNHAM    70 HBC   +  10.0 K+P,K 2PI   12/75*
WL           (70.)      (26.)     (18.)   GARFINKEL  71 DBC   +  9. K+ D          12/75*
WL          (111.)      (33.)             ANDERSON   72 DBC   -  7.3 K- D         12/75*
WL          (120.)                        CAVIS      72 HBC   +  12. K+ P         12/72
WL          (188.)      (21.)             FIRESTONE  72 DBC   +  12. K+ D         12/75*
WL C        (200.)    APPROX.             BRANDENB   76 ASPK +- 13 K+-P,(KPIPI)P 12/75*
WL C     COUPLES MAINLY TC RHO K
WL
WL   AVERAGING NOT MEANINGFUL

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                    28  Q HIGH (QB)  WIDTH  (MEV)

WH F     FROM EXPERIMENTS SPLITTING Q REGICN INTO TWO PEAKS
WH
WH       70  (80.0)     (20.0)           SHEN       66 HBC   +    4.6 K+P           12/75*
WH          (120.0)     (20.0)           ALEXANDER  69 HBC        9.0 K+ P          12/75*
WH        . (120.0)     (15.0)           BARNHAM    70 HBC   +  10.0 K+P,K 2PI      12/75*
WH           (60.)    OR LESS            GARFINKEL  71 DBC   +  9. K+ D             12/72
WH           (89.)      (24.)            ANDERSON   72 CBC   -  7.3 K- D            12/75*
WH           (80.)                       DAVIS      72 HBC   +  12. K+ P            12/72
WH          (241.)      (30.)            FIRESTONE  72 DBC   +  12. K+ D            12/75*
WH D        (160.)    APPRCX.            BRANDENB   76 ASPK +- 13 K+-P,(KPIPI)P    12/75*
WH D     COUPLES MAINLY TO K* PI
WH
WH   AVERAGING NOT MEANINGFUL

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                    28  Q REGION PARTIAL DECAY MODES

                                                            DECAY MASSES
P1       Q REGION INTO K*(892) PI                         892+ 139
P2       Q REGION INTO K RHO                              497+ 773
P3       Q REGION INTO K PI                               497+ 139
P4       Q REGION INTO K ETA                              497+ 548
P5       Q REGION INTO K CMEGA                            497+ 783
P6       Q REGION INTO K PI PI                            497+ 139+ 139

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                    28  Q REGICN BRANCHING RATIOS

     PRODUCED BY BEAMS OTHER THAN K MESONS
R1       Q REGION INTO (K RHO)/TOTAL (UNITS OF 10**-2)      (P2)
R1              75.0       10.0          ARMENTERO 64 HBC       0.0 PBAR P        6/66
R1            DOMINANT                   CRENNELL  72 HBC     0 4.5PI-P,LK2PI    12/72

R2       Q REGICN INTO (K* PI)/TOTAL (UNITS OF 10**-2)      (P1)
R2              25.0       10.0          ARMENTERO 64 HBC       0.0 PBAR P        6/66

R3       Q REGICN INTO (K+ PI-) / (K+0 PIO+ PI-)
R3              (0.2)  OR LESS  CL=.90   CRENNELL  67 HBC     0 6.0 PI-P          7/67

R4       Q REGICN INTO (KO PI+ PI- PIO) / (K+0 PIO+ PI-)
R4              (0.1)  OR LESS  CL=.90   CRENNELL  67 HBC     0 6.0 PI-P          7/67

     PRODUCED BY K BEAMS
R10      Q REGICN INTO (K PI) / (K*(892) PI)                (P3)/(P1)
R10             (0.8)  OR LESS           SHEN      66 HBC      4.6 K+P, 5 BODY   11/67
R10          Q REGION       INTO K*(892) PI AND K RHO (OVERLAPPING BANDS)(P1+P
R10       70    (1.0)                    SHEN      66 HBC   +    4.6 K+P          8/66

R11      Q REGICN INTO (K OMEGA)/(K*(892) PI)               (P5)/(P1)
R11             (0.1)  OR LESS           SHEN      66 HBC   +    4.6 K+P         10/66

R12      Q REGICN INTO (K PI) / (K*(892) PI)                (P3)/(P1)
R12             (0.30) OR LESS           SHEN      66 HBC   +    4.6 K+P         10/66

R13      Q REGICN INTO K*(892) PI AND K RHO (OVERLAPPING BANDS)
R13                                                         (P1+P2)
R13      200    (1.0)                    BERLINGHI 67 HBC   +    12.7 K+ P        7/67

R14      Q REGION INTO (K PI) / TOTAL                       (P3)
R14             (0.02) OR LESS           BERLINGHI 67 HBC   +    12.7 K+ P       11/67
R14             (0.02) OR LESS  CL=.95   BARTSCH   68 HBC    - 10.0 K- P

R15      Q REGION INTO (K ETA) / TCTAL                      (P4)
R15             (0.02) OR LESS           BERLINGHI 67 HBC   +    12.7 K+ P       11/67

R16      Q REGION INTO (K CMEGA) / TCTAL                    (P5)
R16             (0.02) OR LESS           BERLINGHI 67 HBC   +    12.7 K+ P       11/67
R16       12    0.01       0.005         BARTSCH   68 HBC    -   10.0 K- P        9/68

R17      Q REGION INTO (K RHO) / (K*(892) PI)               (P2)/(P1)
R17             0.91       0.25          BERLINGHI 67 HBC   +    12.7 K+ P       11/67
R17      701    0.4        0.1           BARTSCH   68 HBC    - 10.0 K- P          9/68
R17             . . . . . . . . .
R17 AVG         0.47       0.18     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
R17 STUDENT     0.46       0.11     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R18      Q REGION INTO (K PI) / (K*(892) PI)                (P3)/(P1)
R18             (0.21) OR LESS           DE BAERE  67 HBC   +    3.5 K+ P        11/66

R19      Q REGION INTO (K PI PI) / TOTAL                    (P6)
R19      201    0.22       0.08          BARTSCH   68 HBC    - 10.0 K- P          9/68
R19  S      POSSIBLY SEEN                ALEXANDER 69 HBC        9.0 K+ P         2/73
R19  S      POSSIBLY SEEN                DAVIS     72 HBC   +  12. K+ P           1/73
R19  S   WITH THE (PI PI) SYSTEM IN S-WAVE                                        1/73

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                       REFERENCES FOR Q REGICN

      PRODUCED BY BEAMS OTHER THAN K MESCNS

ARMENTER 64 DUBNA CONF 1 577  ARMENTEROS,EDWARDS,D-ANDLAU +    (CERN+CDEF)
    ALSO 64 DUBNA CONF 1 617  R ARMENTEROS (RAPPORTEUR)
    ALSO 66 PR  145  1095     BARASH,KIRSCH,MILLER,TAN             (COLUMBIA)
CRENNELL 67 PRL 19  44        +KALBFLEISCH,LAI,SCARR,SCHUMANN         (BNL)I
ASTIER   69 NP B 10 65        +MARECHAL,MONTANET,+  (CDEF+CERN+IPNP+LIVP)IJP
BETTINI  69 NC 62 A 1038      +CRESTI,LIMENTANI,BERTAUZA,BIGI+(PADO+PISA)I
CRENNELL 72 PR D 6 1220       +GORDON,KWAN-WU LAI,SCARR                (BNL)
DAVIDSON 74 PR D9 77          +CHAPMAN,GREEN,LYS,ROE                  (MICH)
DORE     75 LNC 13 265        +GUIDONI,LAAKSO,MARINI,CONFORTO+(ROMA+RHEL)

      PRODUCED BY K BEAMS

ALMEIDA  65 PL 16 184         ALMEIDA,ATHERTON,BYER,DORNAN,FORSON+ (CAVE)

SHEN     66 PRL  17  726      +BUTTERWORTH,FU,GOLDHABERS,TRILLING    (LRL)
    ALSO 66  (PRIVATE COMMUN)GERSCN GOLDHABER                        (LRL)

BASSOMPI 67 PL 26B 30         BASSOMPIERRE,GOLDSCHMIDT+  (CERN+BRUX+BIRM)IJP
BERLINGH 67 PRL 18 1087       BERLINGHIERI+FARBER+FERBEL+FORMAN    (ROCH)IJP
DE BAERE 67 NC 49A 374        +DEBAISIEUX+FAST+FILIPPAS+       (CERN+BRUX)
    ALSO PRIVATE COMMUNICATION BY B. JONGEJANS
GOLDHABE 67 PRL 19 976        G.GOLDHABER                            (LBL)

BARTSCH  68 NP B8 9           +COCCONI,+        (AACH+BERL+CERN+LOIC+VIEN)
BOMSE    68 PRL 20 1519       +BORENSTEIN,CALLAHAN,COLE,COX,+  (JOHNHOPK)  1+
DENEGRI  68 PRL 20 1194       +CALLAHAN+ETTLINGER+GILLESPIE+   (JCHNHOPK)  1+
    ALSO 70 ANTICH
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Data Card Listings

For notation, see key at front of Listings.

Mesons

Q, $K^*(1420)$


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ALEXANDE 69 NP B 13 503          G.ALEXANDER,FIRESTONE,GOLDHABER,+       (LRL)
ANDREWS  69 PRL 22 731           +LACH,LUDLAM,SANDWEISS,BERGER,+   (YALE+LRL)
BARBARO  69 PRL 22 1207          BARBARO-GALTIERI,DAVIS,FLATTE,+         (LRL)
BISHOP   69 NP B 9 403           +GOSHAW,ERWIN,WALKER                   (WISC)
CHIEN    69 PL 29B 433           +MALAMUD,MELLEMA,RUDNICK,SCHLEIN+      (UCLA)
CHUNG    69 PR 182 1443          +EISNER+BALI+LUERS                      (BNL)
COLLEY   69 NC A 59 519          +EASTWOOD,+  (BIRM+GLAS+LOIC+MPIM+OXF+RHEL)
ERWIN    69 NP B 9 364           +WALKER,GOSHAW,WEINBERG     (WISC+PRIN+VAND)
FRIEDMAN 69  UCRL-18860          J.FRIEDMAN,PH.D. THESIS                 (LRL)
WERNER   69 PR 188 2023          +AMMAR,DAVIS,KROPAC,YARGER,CHO,+ (NWES+ANL) 1+

ABRAMS   70 PR D 1 2433          +EISENSTEIN,KIM,MARSHALL,C-HALLORAN,+ (ILL)
ANTICH   70 NP B 20 201          +CARSON,CHIEN,COX,DENEGRI,ETTLINGER,+ (JHU)  1+
BARNHAM  70 NP B 25 49           +COLLEY,GRIFFITHS,ALPER,+    (BIRM+GLAS+OXF)  1+
BOWLER   70 PL 31 B 318          M.G.BOWLER                           (OXFORD)
FARBER   70 PR D 1 78            +FERBEL,SLATTERY,YUTA                  (ROCH)  1+
FIRESTON 70 PHILAD.CONF.P.229 A. FIRESTONE REVIEW                      (LRL)

BARNHAM  71 NP B25 49            +COLLEY,GRIFFITHS,ALPER, +   (BIRM+GLAS+OXF)
BOWLER   71 BOLOGNA CONF.PROC M.G.BOWLER  INTRODUCTORY TALK         (OXFORD)
DENEGRI  71 NP B 28 13           +ANTICH,CALLAHAN,CARSON,CHIEN,COX,+    (JHU)  1+
FORMAN   71 PR D 3 2610          +GELFAND,LEARY,MOSER,SEIDL,WOLFSON     (EFI)
GARFINKE 71 PRL 26 1505          GARFINKEL,HOLLAND,CARMONY,LANDER+(PURD+UCD)  1+
SLATTERY 71  UR-875-332(PREP) P.SLATTERY,A REVIEW OF STRANGE MESONS(ROCH)

ANDERSON 72 PR D 6 1823          +FRANKLIN,GODDEN,KCPELMAN,LIBBY,TAN  (COLO)
BINGHAM  72 NP B 48 589          +EISENSTEIN,GRARD,HERQUET,+       (CERN+BRUX)
BRANDENB 72 NP B 45 397          BRANDENBURG,BRODY,JOHNSON,LEITH,LOOS+(SLAC)
BRANDENB 72 PRL 28 932           BRANDENBURG,JOHNSON,LEITH,LOOS,LUSTE+(SLAC)
DAVIS    72 PR D 5 2688          +ALSTON,BARBARO,FLATTE,FRIEDMAN,LYNCH+(LBL)
FIRESTON172 NP B 47 348          A.FIRESTONE                             (CIT)
FIRESTON 72 PR D 5 505           FIRESTONE,GOLDHABER,LISSAUER,TRILLING (LBL)
FRATI    72 PR D 6 2361          +HALPERN,HARGIS,SNAPE,CARNAHAN,+(PENN+CINC)
HAATUFT  72 NP B 48 78           +ARNOLD,HAGUENAUER,+  (BERG+STRB+EPOL+MADR)

BARLOUTA 73 NP B 59 374          +DREVILLON,SHAH,+          (SACL+EPOL+RHEL)  JP
BINGHAM  73 NP B 52 31           +FARWEL,+       (LBL+ORSAY+BNL+SACLAY+MILAN)  JP
DE JONGH 73 NP B 58 110          +CORNET,CHARRIERE,+   (BRUX+MONS+CERN+MPIM)
JONES    73 NP B 52 383          G.T.JONES                              (CERN)  JP
LEWIS    73 NP B 60 283          +ALLEN,JACOBS,DANYSZ,BORG,+(LOWC+LOIC+CDEF)
WERNER   73 PR D 7 1275          +SLATTERY,FERBEL                  (ROCHESTER)

ANGELOPO 74 NC 20A 49            ANGELOPOULOS,FILIPPAS+(ATHU+ATEN+LIVP+VIEN)  JP
BOWLER   74 NP B74 493           +DAINTON,KADDOURA,AITCHISCN              (OXF)
DEUTSCHM 74 PL 49B 388           CEUTSCHMANN,+     (AACH+BERL+CERN+LOIC+VIEN)  JP

ANTIPOV  75 NP B86 381           +ASCOLI,BUSNELLO,KIENZLE+    (SERP+CERN+ILL)  JP
BOWLER   75 NP B97 227           +GAME,AITCHISON,DAINTON            (OXF+DARE)
DREVILLO 75 PL 55 B 245          DREVILLCN,BORENSTEIN+        (EPOL+BOHR+COEF)  JP
DUNWOODI 75 NP B91 189           DUNMOODIE,GRANT+         (CERN+BELG+MONS+MPIM)  JP
OTTER1   75 NP B84 333           + (AACH+BERL+CERN+LOIC+VIEN+ATHU+ATEN+LIVP)  JP
OTTER2   75 NP B93 365           +RUDOLPH,RUMPF+  (AACH+BERL+CERN+LOIC+VIEN)  JP
OTTER3   75 NP B96 29            +RUDOLPH,SEYFERT+(AACH+BERL+CERN+LOIC+VIEN)I,JP
TOVEY    75 NP B95 109           +HANSEN,BORENSTEIN,BORG+    (RHEL+EPOL+SACL)I,JP

BRANDENB 76 PRL                  BRANDENBURG,CARNEGIE,CASHMCRE,DAVIER+(SLAC)  JP
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$K^*(1420)$

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22  K*(1420,JP=2+) I=1/2

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                     22  K*(1420) MASS (MEV)

M   CHARGED ONLY, WITH FINAL STATE K PI
M    D  39 1423.       11.0              BASSANO   67 HBC  - 4.6-5.0K-P,KOPI- 12/75*
M   S    25(1440.)    (24.0)   (40.)    DE BAERE  67 HBC  + 3.5 K+P (K+ PIO) 12/75*
M   SD   13(1401.0)   (25.0)            SCHWEINGR 68 HBC  -  4.1 K- P (K PI) 12/75*
M   SD   63(1427.0)   (12.0)            SCHWEINGR 68 HBC  -  5.5 K- P (K PI) 12/75*
M   S   136(1420.0)    (20.0)           BISHOP    69 HBC  +  3.5 K+P(KO PI+) 12/75*
M      220 1416.0      10.0             CRENNELL  69 DBC  -  3.9 K-N (KOPI-)  7/69
M   SD   60(1414.)    (13.0)            LIND      69 HBC  +  9. K+ P(KO PI+) 12/75*
M     1400 1420.0       3.1             AGUILAR1  71 HBC  -  3.9,4.6 K- P    11/71
M  W D 225 1425.        8.0             BARNHAM   71 HBC  + K+ P,KO PI+ P   12/75*
M   S  130(1418.)      (6.)             CLARK     73 HBC  - 3.3 K-P,P PI- KO 12/75*
M           . . . . . . . . .
M   AVG     1420.5      2.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1420.4       2.9      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M   CHARGED ONLY, WITH OTHER FINAL STATES
M      130(1400.0)    (20.0)            BADIER    65 HBC  -  3.  K- P (K*PI) 12/75*
M       20(1440.0)    (20.0)            DUBAL     68 MMS  -  11.5 K- P       12/75*
M  W D 240(1396.)      (6.)             BASSOMPIE 69 HBC  +   5 K+P (K 2PI)  12/75*
M          (1411.)     (7.)             FRIEDMAN  69 HBC  -  2.7 K-P (K 2PI)  2/72

M   CHARGED AND NEUTRAL
M      134(1404.0)    (15.0)            FOCARDI   65 HBC  -0 3.  K- P (K PI) 12/75*
M    D  55(1423.)     (24.0)            ADERHOLZ  68 HBC  -0 10 K- P (K PI)  12/75*

M   NEUTRAL ONLY
M   SD   46(1446.0)    (9.0)            DAHL      67 HBC   0 4.PI- P (KPI)   12/75*
M   S  160(1425.0)    (15.0)            KANG      68 HBC   0 4.6 K- P        12/75*
M   SD   81(1405.0)   (22.0)            SCHWEINGR 68 HBC   0 4.1 K- P (K PI) 12/75*
M   S    97(1397.0)   (19.0)            SCHWEINGR 68 HBC   0 5.5 K- P (K PI) 12/75*
M  WAD 210(1422.)      (8.0)            BASSOMPIE 69 HBC   0 5 K+P (K PI)    12/75*
M     2200 1421.1       2.6             DAVIS     69 HBC   0 12. K+ P(K+PI-)  9/69
M     1800 1419.1       3.7             AGUILAR1  71 HBC   0 3.9,4.6 K- P    11/71
M      600 1416.        6.              CORDS     71 DBC  0 9. K+ N,K+ PI- P  2/72
M     1100 1427.        3.              BUCHNER   72 DBC  0 4.6 K+ N,K+ PI-P 12/72
M    C     1420.1       4.3             LINGLIN   73 HBC  0 2-13 K+P,K+PI-   12/75*
M      800 1421.6       4.2             MCCUBBIN  75 HBC   0 3.6 K-P,K-PI+N  12/75*
M          . . . . . . . . . .
M   AVG     1421.8      1.5      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1421.6       1.7      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M   A   INCLUDED IN LINGLIN 73 WORLD K+P DST
M    C  FROM POLE EXTRAPOLATICN, USING WORLD K+P DST
M  D    ERRORS ENLARGED BY LS TO   GAMMA/SQRT(N). SEE TYPED NCTE.
M   S   DATA WITH MASS ERROR OF 15 MEV OR MORE NOT AVERAGED
M  W    NUMBER OF EVENTS IN PEAK REEAVALUATED BY US

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                     22  K*(1420) WIDTH (MEV)

W   CHARGED ONLY, WITH FINAL STATE K PI
W    D  63    89.       45.              SCHWEINGR 68 HBC   - 5.5 K-P(KO PI-)  12/75*
W   SD 136 (110.0)     (42.0)            BISHOP    69 HBC  +   3.5 K+ P        12/75*
W   SD  60  (96.)      (50.0)            LIND      69 HBC  +   9. K+ P        .12/75*
W     1400    94.7      15.1     12.5    AGUILAR1  71 HBC  -   3.9,4.6 K- P    11/71
W  W D 225   115.       31.0             BARNHAM   71 HBC  + K+ P,KO PI+ P     12/75*
W   S  130   (42.)     (12.)             CLARK     73 HBC  -  3.3 K-P,P PI- KO 12/75*
W          . . . . . . . . . .
W   AVG       97.4      12.1     AVERAGE (ERROR INCLUDES SCALE FACTOR CF 1.0)
W   STUDENT   97.3      13.2     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W   CHARGED ONLY, WITH CTHER FINAL STATES
W    D 130 (105.0)     (37.0)            BADIER    65 HBC  -   3.0 K-P          12/75*
W    D 120 (110.)      (40.0)            BASSOMPIE 69 HBC  +   5 K+P (K 2PI)    12/75*
W           (43.)      (13.)             FRIEDMAN  69 HBC  -   2.7 K-P (K 2PI)   2/72

W   CHARGED AND NEUTRAL
W      134  (92.0)     (32.0)            FOCARDI   65 HBC  -0 3.0 K- P (K PI) 12/75*
W    D  55 (175.)      (94.0)            ADERHOLZ  68 HBC  -0 10 K- P (K PI)  12/75*

W   NEUTRAL ONLY
W   SD  46  (61.0)     (36.0)            DAHL      67 HBC   0 3.8-4.2 PI- P   12/75*
W   SD 160 (116.0)     (37.0)            KANG      68 HBC   0 4.6 K- P        12/75*
W  WAD 210 (110.)      (30.0)            BASSOMPIE 69 HBC   0 5 K+P (K PI)    12/75*
W     2200   101.       10.              DAVIS     69 HBC   0 12. K+ P (K PI)  9/69
W     1800   116.6      10.3     15.5    AGUILAR1  71 HBC   0 3.9,4.6 K- P    11/71
W    D 600   144.       24.0             CORDS     71 CBC  0 9. K+ N,K+ PI- P 12/75*
W    D1100   109.       14.0             BUCHNER   72 DBC  0 4.6 K+ N,K+ PI-P 12/75*
W   C        (61.0)    (14.0)            LINGLIN   73 HBC  0 2-13 K+P,K+PI-    1/74
W      800   116.       18.              MCCUBBIN  75 HBC   0 3.6 K-P,K-PI+N  12/75*
W          . . . . . . . . . .
W   AVG      110.9       6.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT  110.8       7.0     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W   A   INCLUDED IN LINGLIN 73 WORLD K+P CST
W   C   FROM POLE EXTRAPOLATION, USING WORLD K+P DST
W    D  ERRORS ENLARGEC BY LS TO 4*GAMMA/SQRT(N). SEE K* TYPED NOTE.
W   S   DATA WITH MASS ERROR OF 15 MEV OR MORE NOT AVERAGED
W  W    NUMBER OF EVENTS IN PEAK REEAVALUATED BY US

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                     22  K*(1420) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      K*(1420) INTO K PI                                493+ 139
P2      K*(1420) INTO K*(892) PI                          892+ 139
P3      K*(1420) INTO K RHO                               493+ 773
P4      K*(1420) INTO K CMEGA                             493+ 783
P5      K*(1420) INTO K ETA                               493+ 548

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

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          P 1         P 2         P 3         P 4         P 5
 P 1 .5613+-.0263
 P 2   -.3003   .3087+-.0214
 P 3   -.3784     -.1481   .0655+-.0167
 P 4   -.2841     -.3029     -.1163   .0448+-.0169
 P 5   -.4371     -.2957     -.0808     -.0499   .0197+-.0200

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                     22  K*(1420) BRANCHING RATIOS

R1       K*(1420) INTO (K PI)/TOTAL                         (P1)
R1  R          (0.37)   (0.19)          BADIER    65 HBC       3.0 K-P            6/66
R1  R          (0.39)   (0.11)          BASSANO   67 HBC   -  4.6, 5.0 K- P      10/67
R1  R           WE CANNOT USE THIS STATISTICALLY REDUNDANT RATIO. AUTHORS
R1  R           OBTAIN IT MERELY BY SUBTRACTING FROM UNITY THEIR
R1  R           MEASUREMENTS CF OTHER RATIOS.
R1           . . . . . . . . .
R1  FIT         0.561    0.026  FRCM FIT

R2       K*(1420) INTO (K*(892) PI) / TOTAL                 (P2)
R2  Q           (.41)   (0.14)          BADIER    65 HBC       3.0 K-P            6/66
R2  Q          (0.47)   (0.10)          BASSANO   67 HBC   -  4.6, 5.0 K- P      10/67
R2           . . . . . . . . .
R2  FIT         0.3C9    0.021  FRCM FIT

R3       K*(1420) INTO (K RHO)/TOTAL                        (P3)
R3  Q          (0.14)   (0.05)          BADIER    65 HBC       3.0 K-P            6/66
R3  Q          (0.14)   (0.10)          BASSANO   67 HBC    0 4.6, 5.0 K- P      10/67
R3           . . . . . . . . .
R3  FIT         0.065    0.017  FRCM FIT

R4       K*(1420) INTO (K CMEGA)/TOTAL                      (P4)
R4              0.07     0.04           BADIER    65 HBC       3.0 K-P            6/66
R4           . . . . . . . . .
R4  FIT         0.045    0.017  FRCM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5       K*(1420) INTO (K ETA)/TOTAL                        (P5)
R5              0.02     0.02           BADIER    65 HBC       3.0 K-P            6/66
R5             (0.025)OR LESS           BASSCMPIE 69 HBC       5.0 K+ P           9/68
R5           . . . . . . . . .
R5  FIT         0.020    0.020  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6       K*(1420) INTO (K*(892) PI) / (K PI)                (P2)/(P1)
R6        6     0.33     0.33           CHUNG     65 HBC  + 0  3.9-4.2 PI- P    8/66
R6              0.65     0.20           SHEN      66 HBC    0   N* PRODUCED     10/66
R6  Q          (0.63)   (0.20)          SHEN      66 HBC  +     NO N* PRODUCED 10/66
R6              0.52     0.12           SCHWEINGR 68 HBC    0 4.1+5.5 K- P     10/67
R6  Q   84     (0.93)   (0.11)          BISHOP    69 HBC       3.5 K+ P          9/69
R6              0.47     0.08           AGUILAR1  71 HBC       3.9,4.6 K- P     11/71
R6   G          0.91     0.20           CHARRIERE 73 HBC   0 5. K+ P,K P 3PI    1/73
R6   G  REVISED BY GOLDSCHMIDT 75
R6 AQ  150     (0.65)   (0.25)          ANTIPOV   75 ASPK  - 40 K-P,K*- P     .12/75*
R6 A     K* PI SIGNAL FRCM PARTIAL WAVE ANALYSIS OF (K-PI+PI-) SYSTEM
R6              0.54     0.16           DEHM      74 DBC   0 4.6 K+ N          12/75*
R6              0.62     0.19           LAUSCHER  75 HBC    010,16 K-P,K-PI+N 12/75*
R6           . . . . . . . . .
R6  AVG         0.540    0.053   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R6  STUDENT     0.535    0.060   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R6  FIT         0.550    0.052  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
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Mesons

$K^*(1420)$, $K_N(1700)$, $L(1770)$

Data Card Listings

For notation, see key at front of Listings.

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R7       K*(1420) INTO (K CMEGA) / K PI                         (P4)/(P1)
R7              (0.08) OR LESS              SHEN       66 HBC       4.6 K+P         8/66
R7              (0.2)  OR LESS              BASSOMPIE 69 HBC   +    5 K+ P          9/69
R7               0.13      0.07             BASSCMPIE 69 HBC    0 5 K+ P            9/69
R7               0.05      0.04             AGUILAR1  71 HBC      3.9-4.6 K- P     11/71
R7              (0.2)  OR LESS  CL=.95      CHUNG     74 HBC   - 7.3 K-P,K*- P     12/75*
R7                . . . . . . . . .
R7   AVG         0.070     0.035    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R7   STUDENT     0.069     0.039    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R7   FIT         0.080     0.031   FROM FIT (ERRCR INCLUDES SCALE FACTCR CF 1.0)

R8       K*(1420) INTO (K RHO) / (K PI)                         (P3)/(P1)
R8              (0.09) OR LESS              CHUNG      65 HBC   + 0  3.9-4.2 PI- P  8/66
R8               0.26      0.16             SCHWEINGR 68 HBC    0 4.1+5.5 K- P     10/67
R8              (0.2)  OR LESS              BASSONPIE 69 HBC   +    5 K+ P          9/69
R8              (0.3)  OR LESS              BASSCMPIE 69 HBC    0 5 K+ P            9/69
R8   Q    15    (0.11)    (0.06)            BISHOP     69 HBC       3.5 K+ P        9/69
R8               0.16      0.05             AGUILAR1  71 HBC      3.9,4.6 K- P     11/71
R8               0.02      0.10      0.02   DEHM      74 DBC    0 4.6 K+ N         12/75*
R8               0.24      0.14             LAUSCHER  75 HBC    010,16 K-P,K-PI+N 12/75*
R8                . . . . . . . . .
R8   AVG         0.120     0.046    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R8   STUDENT     0.126     0.045    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R8   FIT         0.117     0.032   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R9       K*(1420) INTO (K RHC) / (K*(892) PI)                   (P3)/(P2)
R9              (0.39) OR LESS              BASSOMPIE 67 HBC   +    5. K+ P         9/67
R9              (0.40) OR LESS  CL=.90      FIELD      67 HBC   - 3.8 K- P          6/67
R9 P    130      .13       .09              OTTER      75 HBC    08,10,16 K-P,K* N 12/75*
R9 P      FROM PARTIAL WAVE ANALYSIS OF (KO PI+ PI-) SYSTEM
R9 AN           (0.03)    (0.03)            ANTIPOV    75 ASPK  - 40 K-P,K*- P     12/75*
R9  N     K RHO MODE NOT CBSERVED
R9 A      FROM PARTIAL WAVE ANALYSIS OF (K-PI+PI-) SYSTEM
R9                . . . . . . . . .
R9   FIT         0.212     0.058   FRCM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R10      K*(1420) INTO (K OMEGA) / (K*(892) PI)                 (P4)/(P2)
R10 Q           (0.10)    (0.04)            FIELD      67 HBC   - 3.8 K- P          6/67
R10               . . . . . . . . .
R10 FIT          0.145     0.059   FRCM FIT

R11      K*(1420) INTO (K ETA) / (K*(892) PI)                   (P5)/(P2)
R11 Q           (0.07)    (0.04)            FIELD      67 HBC   - 3.8 K- P          6/67
R11               . . . . . . . . .
R11 FIT          0.064     0.066   FROM FIT

R12      K*(1420) INTO (K ETA) / (K PI)                         (P5)/(P1)
R12             (0.02) OR LESS              BISHOP     69 HBC       3.5 K+ P        9/69
R12             (0.04) OR LESS  CL=.95      AGUILAR1  71 HBC      3.9-4.6 K- P     11/71
R12               . . . . . . . . .
R12 FIT          0.035     0.036   FROM FIT

R    Q    FOLLOWING SUGGESTION BY AGUILAR 70, WE DO NOT MAKE USE OF MEASURE-
R    Q    MENTS WHERE THE (K PI PI) BACKGROUND SUBTRACTION IS DIFFICULT DUE
R    Q    TO THE NEARBY C REGION.
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REFERENCES FOR K*(1420)


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BADIER   65 PL 19 612          BADIER,DEMOULIN,GOLDBERG+(EPOL+SACL+ZEEMAN)
CHUNG    65 PRL  15  325       +DAHL,HARDY,HESS,JACOBS,KIRZ,MILLER    (LRL)
FOCARDI  65 PL 16 351          FCCARDI,MINGUZZI RANZI,SERRA+(BOLOGNA+SACL)

SHEN     66 PRL  17  726       +BUTTERWORTH,FU,GOLDHABERS,TRILLING    (LRL)
    ALSO 66  (PRIVATE COMMUN)GERSCN GOLDHABER                          (LRL)

BASSANO  67 PRL  19  968       +GOLCBERG,GOZ,BARNES,LEITNER+(BNL+SYRACUSE)
BASSOMPI 67 PL 26B 30          BASSCMPIERRE,GOLDSCHMIDT+  (CERN+BRUX+BIRM)IJP
CRENNELL 67 PRL 19  44         +KALBFLEISCH,LAI,SCARR,SCHUMANN        (BNL)
DAHL     67 PR 163 1377        +HARDY+HESS+KIRZ+MILLER                (LRL)
    ALSO 65 PRL 14 401         HARDY,CHUNG,DAHL,HESS,KIRZ,MILLER      (LRL)
DE BAERE 67 NC 51 A 401        +GOLDSCHMIDT-CLERMCNT,HENRI+     (BRUX+CERN)
FIELD    67 PL 24B 638         +HENDRICKS+PICCIONI+YAGER          (LAJOLLA)
GOLDHABE 67 PRL 19  972        G.GOLDHABER,FIRESTCNE,SHEN             (LRL)

ADERHOLZ 68 NP B 5  567        +DEUTSCHMANN+  (AACH+BERL+CERN+LOIC+VIENNA)
    ALSO 66 PL 22 357          BARTSCH,DEUTSCHMANN,MORRISCN+    (ABCL(IC)V)
ANTICH   68 PRL 21 1842       +CALLAHAN,CARSON,COX,DENEGRI,+          (JHU)
DUBAL    68 THESIS    1456     L.DUBAL                             (GENEVE)
KANG     68 PR 176 1587        Y.W.KANG                              (IOWA)
SCHWEING 68 PR 166 1317        SCHWEINGRUBER,DERRICK,FIELDS+     (ANL+NWES)
   ALSO  67  THESIS            F.L.SCHWEINGRUBER   (NORTHWESTERN,EVANSTCN)

BASSOMPI 69 NP  B13 189        BASSOMPIERE,GOLDSCHMIDT-CLERM.+ (CERN+BRUX) JP
BISHOP   69 NP B 9 403         +GOSHAW,ERWIN,WALKER                  (WISC)
CRENNELL 69 PRL 22  487        +KARSHON,LAI,ONEALL,SCARR              (BNL)
DAVIS    69 PRL 23 1071        +DERENZO,FLATTE,ALSTCN,LYNCH,SOLMITZ  (LRL)
DE BAERE 69 NC 61 A 397        +GOLDSCHMIDT-CLERMONT,HENRI,+    (BELG+CERN)
FRIEDMAN 69  UCRL-18860        J.FRIEDMAN,PH.D. THESIS                (LRL)
LIND     69 NP B 14 1          +ALEXANDER,FIRESTONE,FU,GOLDHABER      (LRL) JP

ABRAMS   70 PR D 1 2433        +EISENSTEIN,KIM,MARSHALL,C.HALLORAN,+ (ILL)
AGUILAR  70 PRL 25 1362        AGUILAR-BENITEZ,BASSANO,EISNER,+ (BNL+PURD)
BIRMINGH 70  KIEV CONF.        ASTIER RAPPORTEURS TALK     (BIRM+GLAS+OXF)

AGUILAR1 71 PR D 4 2583        +EISNER,KINSCN                         (BNL)
BARNHAM  71 NP B 28 171        +COLLEY,JOBES,GRIFFITHS,HUGHES,+(BIRM+GLAS)
CORDS    71 PR D 4 1974        +CARMONY,ERWIN,MEIERE,+      (PURD+UCD+IUPU)
SLATTERY 71  UR-875-332(PREP) P.SLATTERY,A REVIEW OF STRANGE MESONS(ROCH)

BUCHNER  72 NP B 45 333        +DEHM,CHARRIERE,CORNET,+   (MPIM+CERN+BRUX)
CRENNELL 72 PR D 6 1220        +GORDON,KWAN-WU LAI,SCARR              (BNL)
DEUTSCHM 72 NP B 36 373        DEUTSCHMANN,+          (ABCLV COLLABORATION)
ENGELMAN 72 PR D 5 2162        ENGELMANN,MUSGRAVE,FORMAN,+        (ANL+EFI)
FRATI    72 PR D 6 2361        +HALPERN,HARGIS,SNAPE,CARNAHAN,+(PENN+CINC)
ROUGE    72 NP B 46 29         +VIDEAU,VOLTE,DE BRION,+          (EPCL+SACL)
TIECKE   72 NP B 39 596        +GRIJNS,HEINEN,DE GROOT,+         (NIJM+ZEEM)

CHARRIER 73 NP B 51 317        CHARRIERE,DRIJARD,DE BAERE,+      (CERN+BELG)
    ALSO 75  (PRIVATE COMMUNICATION) GOLDSCHMIDT-CLERMONT             (CERN)
CLARK    73 NP B 54 432        +LYONS,RADGJICIC                    (OXFORD)
DE JONGH 73 NP B 58 110        +CORNET,CHARRIERE,+   (BRUX+MONS+CERN+MPIM)
LINGLIN  73 NP B 55 408        D.LINGLIN                             (CERN)
WALUCH   73 PR D 8 2837        +FLATTE,FRIEDMAN                       (LBL)

DEHM     74 NP B75 47          +GOEBEL,WITTEK,WCLF,+ (MPIM+BRUX+MONS+CERN)
CHUNG    74 PL 51B 413         +EISNER,PROTOPOPESCU,SAMIOS,STRAND     (BNL)

ANTIPOV  75 NP B86 381         +ASCOLI,BUSNELLC,KIENZLE+   (SERP+CERN+ILL)
LAUSCHER 75 NP B86 189         +CTTER,WIECZOREK,+    (ABCLV COLLABORATION)  JP
MCCUBBIN 75 NP B86 13          N.A.MCCUBBIN,L.LYONS                   (CXF)
OTTER    75 NP B84 333         + (AACH+BERL+CERN+LOIC+VIEN+ATHU+ATEN+LIVP)

BRANDENB 76 PL                 BRANDENBURG,CARNEGIE,CASHMORE,DAVIER+(SLAC)  JP
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$K_N(1700)$

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27  KN(1700, JP=   ) I = 1/2

THIS ENTRY CONTAINS VARIOUS PEAKS IN STRANGE MESON
SYSTEMS REPORTED IN THE 1700 MEV REGION.
EVIDENCE NOT COMPELLING, OMITTED FROM TABLE.

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                    27  KN(1700) MASS (MEV)

M          (1660.0)                     CARMONY   67 HBC  -  3.8 K-P,OMEGA K 11/67
M   J      (1660.0)    (10.0)           JOBES     67 HBC  +  5. K+ P          12/75*
M   J       CLAIMED BY JOBES IN (K PI), (K*(892) PI), AND (K*(1420) PI)
M   J       MODES. K PI BUMP INTERFERES MOSTLY WITH DELTA(1236).
M          (1660.)                      CHARRIERE 73 HBC  0 5. K+ P,K P 3PI    1/73
M        60(1710.)     (15.)            CHUNG     74 HBC  - 7.3K-P,K-CMEGA P 12/75*

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                    27  KN(1700) WIDTH (MEV)

W            (60.0)    (20.0)           JOBES     67 HBC  +  5. K+ P          12/75*
W            (60.)                      CHARRIERE 73 HBC  0 5. K+ P,K P 3PI    1/73
W        60 (110.)     (50.)            CHUNG     74 HBC  - 7.3K-P,K-OMEGA P 12/75*

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                    27  KN(1700) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      KN(1700) INTO K PI                              493+ 139
P2      KN(1700) INTO K PI PI                           493+ 139+ 139
P3      KN(1700) INTO K*(892) PI                        892+ 139
P4      KN(1700) INTO K RHO                             493+ 773
P5      KN(1700) INTO K*(1420) PI                      1421+ 139
P6      KN(1700) INTO K OMEGA                           493+ 783

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                    27  KN(1700) BRANCHING RATIOS

R1      KN(1700) INTO (K PI)/(K OMEGA)                   (P1)/(P6)
R1 N          (0.5)    (0.5)          CHUNG      74 HBC   - 7.3 K-P,KN- P    12/75*
R1 N     NO K PI SIGNAL SEEN IN THIS EXPERIMENT

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REFERENCES FOR KN(1700)


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CARMONY  67 PRL  18  615       D.CARMONY,T.HENDRICKS,L.LANDER   (LA JOLLA)
JOBES    67 PL 26B 49          +BASSOMPIERRE,DE BAERE +   (BIRM+CERN+BRUX)
CHARRIER 73 NP B 51 317        CHARRIERE,DRIJARD,DE BAERE,+      (CERN+BELG)
CHUNG    74 PL 51B 412         +EISNER,PROTOPOPESCU,SAMIOS,STRAND     (BNL)
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$L(1770)$

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23  L(1770, JP=   ) I = 1/2
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The L(1770) is seen as a bump in the diffractive-like process $KN \to (K\pi\pi)N$. BARBARO 69 and FIRESTONE 72 find the decay is consistent with being entirely $K^*(1420)\pi$, whereas AGUILAR 70, BARTSCH 70, COLLEY 71, and DENEGRI 71 present evidence for alternate decay modes. For a review see EISNER 74.

Recent partial-wave analyses (DEUTSCHMANN 74, ANTIPOV 75, OTTER 75) have shown that the situation in the L region is complicated, with many waves contributing. The $2^- K^*(1420)\pi$ S wave is important, but cannot explain the whole L enhancement (DEUTSCHMANN 74). The phase variation of the 2^- wave shows no evidence for any significant resonance contribution with $\Gamma < 300$ MeV (OTTER 75).

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                    23  L MASS (MEV)

M       20(1780.)                       BERLINGHI 67 HBC  +   12.7 K+P            7/67
M         (1760.0)    (15.0)            JOBES     67 HBC  +   5. K+ P             1/73
M          1745.0      20.0             AGUILAR   70 HBC   -  4.6 K- P            6/70
M          1780.0      15.0             BARTSCH   70 HBC   -  10.1 K- P           1/71
M         (1760.0)    (15.0)            LUDLAM    70 HBC   -  12.6 K- P           1/73
M   X      1765.0      40.0             COLLEY    71 HBC  +  10.K+P,K 2PI         1/73
M   X   SYSTEMATIC ERRORS ADDED CORRESP. TO SPREAD OF DIFFERENT FITS.
M         (1740.0)                      DENEGRI   71 DBC   - 12.6 K-D,K 2PI D    5/71
M          1767.        6.              BLIEDEN   72 MMS  -  11.-16. K- P        12/72
M   P   306 1730.      20.              FIRESTONE 72 DBC  +  12. K+ D            1/73
M   P   PRODUCED IN CONJUNCTION WITH D*
M              . . . . . . . . .
M    AVG   1764.6       6.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
M    STUDENT1765.0      5.8     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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Data Card Listings

For notation, see key at front of Listings.

Mesons

L(1770), $K_N(1800)$, $K^*(2200)$

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                         23   L WIDTH (MEV)

W        20  (80.)                            BERLINGHI 67 HBC   +    12.7 K+P           7/67
W            (60.0)    (20.0)                 JOBES     67 HBC   +    5. K+ P            1/73
W            100.0      50.0                  AGUILAR   70 HBC   -    4.6 K- P           6/70
W            138.0      40.0                  BARTSCH   70 HBC   -    10.1 K- P          1/71
W            (50.0)    (40.0)    (20.0)       LUDLAM    70 HBC   -    12.6 K- P          1/73
W   X         90.       70.                   COLLEY    71 HBC   +  10.K+P,K 2PI         1/73
W   X    SYSTEMATIC ERRORS ACDEC CORRESP. TO SPREAD OF DIFFERENT FITS.
W           (130.0)                           DENEGRI   71 DBC   - 12.6 K-D,K 2PI D      5/71
W            100.       26.                   BLIEDEN   72 MMS   -  11.-16. K- P        12/72
W   P   306  210.       30.                   FIRESTONE 72 DBC   +  12. K+ D            12/72
W   P    PRODUCED IN CONJUNCTION WITH D*
W            . . . . . . . . .
W    AVG     137.7      24.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
W    STUDENT 130.7      21.5     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                         23   L PARTIAL DECAY MODES

                                                                  DECAY MASSES
P1       L INTO K PI PI                                         497+ 134+ 134
P2       L INTO K*(1420) PI                                     134+1421
P3       L INTO K PI PI PI                                      497+ 134+ 134+ 134
P4       L INTO K*(892) PI                                      892+ 134
P5       L INTO K*(892) RHO                                     892+ 773
P6       L INTO K*(892) OMEGA                                   892+ 783
P7       L INTO K*(892) PI PI                                   892+ 134+ 134

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                         23   L BRANCHING RATIOS

R1       L INTO (K*(1420) PI) / (K PI PI )                 (P2)/(P1)
R1          LARGE                             DENEGRI   68 DBC   -    12.6 K- D          1/71
R1            (1.0)                           BARBARO   69 HBC   +    12.0 K+ P          1/71
R1             0.2        0.2                 AGUILAR   70 HBC   -    4.6 K- P           1/71
R1          LESS THAN    1.0                  BARTSCH   70 HBC   -    10.1 K- P          1/71
R1          LESS THAN    1.0                  COLLEY    71 HBC      10. K+ P            11/71
R1   P      CONSISTENT WITH 1.                FIRESTONE 72 DBC   +  12. K+ D            12/72
R1   P   PRODUCED IN CONJUNCTION WITH D*                                                12/72
R1    R  LESS THAN 1.0 SEEMS TO BE ESTABLISHED.
R1    R  FOR DISCUSSION OF THE EXPERIMENTAL EVIDENCE ON CTHER DECAY                     11/71
R1    R  MODES SEE HUGHES 71,SLATTERY 71,EISNER 74.

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                              REFERENCES FOR L(1770)

BARTSCH  66 PL 22 357           +DEUTSCHMANN,+     (AACH+BERL+CERN+LOIC+VIEN)

BERLINGH 67 PRL 18 1087         BERLINGHIERI+FARBER+FERBEL+FORMAN+    (ROCH)I
JOBES    67 PL 26B 49           +BASSOMPIERRE,DE BAERE +    (BIRM+CERN+BRUX)

DENEGRI  68 PRL 20 1194         +CALLAHAN+ETTLINGER+GILLESPIE+            (JHU)
BARTSCH  68 NP B8 9             +COCCONI,+         (AACH+BERL+CERN+LOIC+VIEN)

ANDREWS  69 PRL 22 731          +LACH,LUDLAM,SANDWEISS,BERGER,+  (YALE+LRL)
BARBARO  69 PRL 22 1207         BARBARO-GALTIERI,DAVIS,FLATTE,+          (LRL)
COLLEY   69 NC A 59 519         +EASTWOOD,+  (BIRM+GLAS+LOIC+MPIM+OXF+RHEL)

AGUILAR  70 PRL 25 54           AGUILAR-BENITEZ,BARNES,BASSANO,CHUNG,+(BNL)
BARTSCH  70 PL 33 B 186         +DEUTSCHMANN,+     (AACH+BERL+CERN+LOIC+VIEN)
LUDLAM   70 PR D 2 1234         +SANDWEISS,SLAUGHTER                    (YALE)

COLLEY   71 NP B 26 71          +JOBES,KENYON,PATHAK,HUGHES,+     (BIRM+GLAS)
DENEGRI  71 NP B 28 13          +ANTICH,CALLAHAN,CARSON,CHIEN,COX,+    (JHU)   JP
HUGHES   71 BOLOGNA CONF.PROC I.S.HUGHES,TALK AT BOLOGNA CONF.   (GLASGOW)
SLATTERY 71  UR-875-332(PREP) P.SLATTERY,A REVIEW OF STRANGE MESONS(ROCH)

ANDERSON 72 PR D 6 1823         +FRANKLIN,GODDEN,KOPELMAN,LIBBY,TAN   (COLO)
BLIEDEN  72 PL 39 B 668         +FINOCCHIARO,BOWEN,EARLES,+       (STON+NEAS)
FIRESTON 72 PR D 5 505          FIRESTONE,GOLDHABER,LISSAUER,TRILLING (LBL)

BARLOUTA 73 NP B 59 374         +DREVILLON,SHAH,+              (SACL+EPOL+RHEL)
BINGHAM  73 NP B 52 31          +FARWEL,+        (LBL+ORSAY+BNL+SACLAY+MILAN)
CHARRIER 73 NP B 51 317         CHARRIERE,DRIJARD,DE BAERE,+     (CERN+BELG)

DEUTSCHM 74 PL 49B 388          DEUTSCHMANN,+      (AACH+BERL+CERN+LOIC+VIEN)  JP
EISNER   74  BOSTON             R.L.EISNER  REVIEW TALK                  (BNL)

ANTIPOV  75 NP B86 381          +ASCOLI,BUSNELLO,KIENZLE+     (SERP+CERN+ILL)  JP
OTTER    75 NP B93 365          +RUDOLPH,RUMPF+    (AACH+BERL+CERN+LOIC+VIEN)  JP
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$K_N(1800)$ → 60 KN(1800,JP=3-)

This entry includes peaks of low statistical significance seen in the Kπ and Kππ spectra in the region of 1800 MeV (CARMONY 71, AGUILAR 73, SPIRO 76). FIRESTONE 71 and BRANDENBURG 76 observe structure in the Kπ angular distribution, the simplest explanation for which is a rapid rise of the F-wave amplitude around 1800 MeV, interfering strongly with other waves. BRANDENBURG 76 propose the existence of a $J^P=3^-$ resonance, but we prefer to wait for further confirmation before including this entry in the Table.

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                         60   KN(1800) MASS (MEV)

M    C    76(1753.)      (12.)           CARMONY   71 DBC     09 K+N,K+PI-P      11/71
M    C   DISAGREEMENT BETWEEN THE FIT AND CATA ON BOTH SIDES OF THE SIGNAL       11/71
M    I      (1850.)    APPROX.           FIRESTONE 71 DBC     0 12.K+ N,K+ PI-P  11/71
M    I        APPARENT INTERFERENCE WITH OTHER AMPLITUDES PRECLUDES              11/71
M    I        PRECISE DETERMINATION .                                            11/71
M         65(1760.)                      AGUILAR   73 HBC     07.3 K-P,K-PI+N     1/74
M    A      (1776.)      (26.)           BRANDENB  76 ASPK    013 K+-P,K+-PI-+   12/75*
M    A   APPROXIMATE VALUE CNLY, BUT ERROR INCLUDES SOME UNCERTAINTIES
M    A   FROM BACKGROUNC ETC.
M         40(1780.)      (30.)           SPIRO     76 HBC    - 14.3 K-P,KOPI-P   12/75*
M         80(1840.)      (30.)           SPIRO     76 HBC     014.3 K-P,K-PI+N   12/75*

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                         60   KN(1800) WIDTH (MEV)

W    C    76  (60.)      (20.)           CARMCNY   71 DBC     09 K+N,K+PI-P      11/71
W    C   DISAGREEMENT BETWEEN THE FIT AND DATA ON BOTH SIDES OF THE SIGNAL       11/71
W    I       (300.)    APPROX.           FIRESTONE 71 DBC     0 12.K+ N,K+ PI-P  11/71
W    I    SEE NOTE I ABOVE
W         65  (80.)     OR LESS          AGUILAR   73 HBC     07.3 K-P,K-PI+N     1/74
W    A       (270.)      (70.)           BRANDENB  76 ASPK    013 K+-P,K+-PI-+   12/75*
W    A    SEE NOTE A ABOVE
W         40 (120.)      (40.)           SPIRO     76 HBC    - 14.3 K-P,KOPI-P   12/75*
W         80 (100.)      (40.)           SPIRO     76 HBC     014.3 K-P,K-PI+N   12/75*

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                         60   KN(1800) PARTIAL DECAY MODES

                                                               DECAY MASSES
P1       KN(1800) INTO K PI                                  493+ 139
P2       KN(1800) INTO K*(892) PI                            892+ 139
P3       KN(1800) INTO K RHO                                 493+ 773
P4       KN(1800) INTO K*(1420) PI                          1421+ 139
P5       KN(1800) INTO K PI PI                               493+ 139+ 139

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                         60   KN(1800) BRANCHING RATIOS

R1       KN(1800) INTO (K PI)/(K*(892) PI + K RHO)          (P1)/(P2+P3)
R1   ES        (0.40)    (0.10)          CARMONY   71 DBC     0 9. K+ N          11/71
R1    S   STATIST. COMPATIBLE WITH THE WEAK K PI PI SIGNAL OF AGUILAR 73.         1/74

R2       KN(1800) INTO (K*(892) PI)/(K PI PI)               (P2)/(P5)
R2   E         (0.40)    (0.15)          CARMONY   71 DBC     0 9. K+ N          11/71

R3       KN(1800) INTO (K RHO)/(K PI PI)                    (P3)/(P5)
R3   E         (0.60)    (0.25)          CARMCNY   71 DBC     0 9. K+ N          11/71

R4       KN(1800) INTO (K*(892) PI + K RHO)/(K PI PI)       (P2+P3)/(P5)
R4   E         (1.)      (0.12)          CARMONY   71 DBC     0 9. K+ N          11/71

R5       KN(1800) INTO (K*(1420) PI)/(K PI PI)              (P4)/(P5)
R5   E         (0.06) OR LESS            CARMCNY   71 DBC     0 9. K+ N          11/71
R5   E   DIFFICULT BACKGRCUND SUBTRACTION . ERRORS STATISTICAL ONLY .            11/71

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                              REFERENCES FOR KN(1800)

CARMCNY  71 PRL 27 1160         +CORDS,CLOPP,ERWIN,MEIERE,+ (PURD+UCD+IUPU)
FIRESTON 71 PL 36 B 513         FIRESTONE,GOLDHABER,LISSAUER,TRILLING (LBL)
AGUILAR  73 PRL 30 672          +CHUNG,EISNER,PROTOPOPESCU,SAMIOS,+    (BNL)
WALUCH   73 PR D 8 2837         +FLATTE,FRIEDMAN                       (LBL)
BRANDENB 76 PL                  BRANDENBURG,CARNEGIE,CASHMORE,DAVIER+(SLAC)  JP
SPIRO    76 PL                  +BARLOUTAUD,PALER,CHAURAND+(SACL+RHEL+EPOL)  JP
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$K^*(2200)$ → 40 K*(2200,JP=)

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ENHANCEMENT SEEN IN (ANTIHYPERON-NUCLEON) MASS
NEAR THRESHOLD.INTERPRETATION UNCERTAIN.
OMITTED FROM TABLE.

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                         40   K*(2200) MASS (MEV)

M         20 2240.       20.             LISSAUER  70 HBC      9. K+ P           11/71
M    C      (2200.)    APPROX.           SLATTERY  71 RVUE     8-13 K+ P         11/71
M    C   COMPILATION OF (ANTIHYP.-NUCLEON) MASS IN K+ P 8.-13.   GEV/C           11/71

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                         40   K*(2200) WIDTH (MEV)

W         20   80.       20.             LISSAUER  70 HBC      9. K+ P           11/71
W    C      (200.)     APPROX.           SLATTERY  71 RVUE     8-13 K+ P         11/71
W    C   COMPILATION CF (ANTIHYP.-NUCLECN) MASS IN K+ P 8.-13.   GEV/C           11/71

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                              REFERENCES FOR K*(2200)

ALEXANDE 68 PRL 20 755          ALEXANDER,FIRESTONE,GOLDHABER,SHEN     (LRL)
LISSAUER 70 NP B 18 491         +ALEXANDER,FIRESTONE,GOLDHABER         (LBL)

CARMONY  71 PRL 27 1160         +CORDS,CLOPP,ERWIN,MEIERE,+  (PURD+UCD+IND)
SLATTERY 71  UR-875-332(PREP) P.SLATTERY,A REVIEW OF STRANGE MESONS(ROCH)
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Mesons

EXOTICS, NEW HEAVY MESONS

Data Card Listings
For notation, see key at front of Listings.

EXOTIC MESONS

EXOTICS 70 EXOTICS

THE PURPOSE OF THIS ENTRY IS TO PROVIDE A LIST OF REFERENCES FOR EXOTIC MESON SEARCHES (SEE MAIN TEXT, SEC. III AND TABLE I), AS WELL AS THEORETICALLY BASED SUGGESTIONS FOR EXPERIMENTS. NOTE THAT LIPKIN 73 PROPOSES EXPERIMENTS WHICH ARE CONCLUSIVE EVEN IF NEGATIVE RESULTS ARE OBTAINED.

REFERENCES FOR EXOTICS

REPORTS ON SEARCHES

ROSENFEL	68	PHILA.CONF.P.455	A.H.ROSENFELD	(LRL)
DODD	69	PR 177 1991	+JOLDERSMA, PALMER, SAMIOS	(BNL)
CHO	70	PL 32 B 409	+DERRICK,JOHNSON,MUSGRAVE,+	(ANL+NWES+KANS)
GIACOMEL	70	PL 33 B 373	G.GIACOMELLI +	(BGNA+SACL+ZEEM+REHO+EPOL)
LYS	70	PR D 2 2525	J.LYS+	(MICH)
ROSNER	70	EXP.MESON SPECTROSCOPY,ED. C.BALTAY AND A.H.ROSENFELD,P.499		
BUHL	72	NP B 37 421	+CLINE,TERRELL	(WISCONSIN)
COHEN	73	NP B 53 1	+FERBEL,SLATTERY,WERNER	(ROCHESTER)
ALAM	74	PL 53B 207	+BRABSON,GALLOWAY,+	(IND+PURD+SLAC+VAND)
COHEN	74	BOSTON	D.COHEN REVIEW TALK	(COLU)
OREN	74	NP B71 189	+COOPER,FIELDS,RHINES,WHITMORE,+	(ANL+OXF)
BALTAY	75	PL 57B 293	+CAUTIS,COHEN,KALELKAR,PISELLO,+	(COLU+BING)
DAVIS	75	NP B96 426	+AMMAR,KROPAC,YARGER,+	(KANS+CCAC+ANL)

SUGGESTIONS FOR SEARCHES

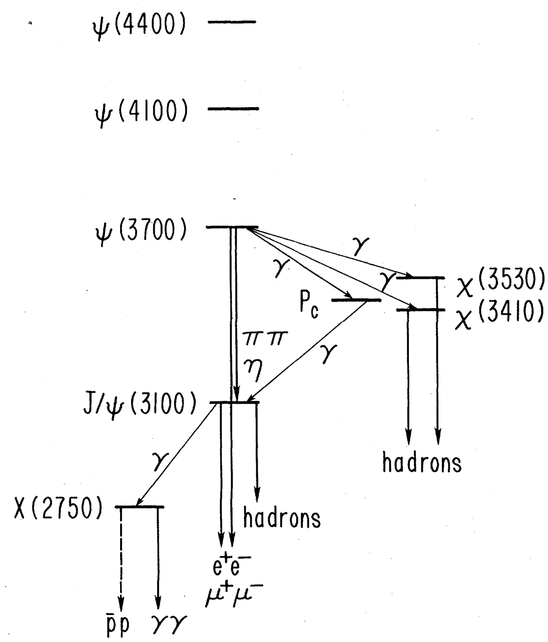
ROSNER	68	PRL 21 950,1468	J.L.ROSNER	(TEL-AVIV)
ROSNER	70	EXP.MESON SPECTROSCOPY,ED. C.BALTAY AND A.H.ROSENFELD,P.499		
FAIMAN	73	PL 43 B 307	D.FAIMAN,G.GOLDHABER,Y.ZARMI	(CERN)
LIPKIN	73	PR D 7 2262	H.J.LIPKIN	(ARGONNE+FNAL)

NEW HEAVY MESONS

The New Heavy Mesons

Since the discovery of the J/ψ(3100) particle in p-Be collisions at the AGS (AUBERT 74), and in e^+e^- collisions at SPEAR (AUGUSTIN 74), the size of the family of "new particles" has increased to at least 8 members, with a complex set of decay modes and mutual transitions; the main features of the experimental situation are illustrated in the figure below.

In the following entries we compile the experimental data as of January 1976, with only a minimum of mini-reviews and footnotes. For detailed discussions of the implications and possible interpretations of the properties of the new particles, see, e.g., the Proceedings of the 1975 International Symposium on Lepton and Photon Interactions at High Energies, Stanford, 1975 [W. T. Kirk (SLAC), editor].



XBL 763 2361

The New Heavy Mesons

Extracting Resonance Widths from e^+e^- Colliding Beam Formation Experiments

In an e^+e^- colliding beam formation experiment, the true shape of an observed resonance is distorted primarily by the effects of (1) soft-photon processes, and (2) beam energy spread due to processes such as quantum fluctuations in emission of synchrotron radiation. The spread in energy due to (2) may usually be approximated by a Gaussian distribution, the effect of which vanishes rapidly at energies sufficiently removed from resonance. The major effect of (1) is a decrease in the effective c.m. energy for some fraction of the collisions, because of the emission of bremsstrahlung by the electron or positron before annihilation. Hence, though the nominal beam energy may be well above the resonance region, a certain fraction of the collisions occur at or near resonance. This gives rise to the well-known high-mass radiative tails of the J/ψ(3100) and ψ(3700) resonances.

Data Card Listings

For notation, see key at front of Listings.

Mesons

NEW HEAVY MESONS, J/ψ(3100)

Because of these effects, the most reliable means for determining resonance widths is to use a method based on the area under the line shape [see, e.g., "Notes from the SLAC Theory Workshop on the ψ", ed. R. Pearson, SLAC-PUB-1515 (1974)] . This method, familiar in nuclear physics, minimizes the sensitivity to the details of the beam energy spread. Corrections for the radiative processes, which depend on the limits of integration of the areas, still need to be made. This discussion assumes the resolution is adequate to allow a reasonable separation of signal from background (which itself is subject to radiative processes).

For formation of a resonance of mass M in e^+e^- collisions, with subsequent decay via channel i,

$$\sigma_i(W) = \sigma_0 \frac{\Gamma_e\Gamma_i/4}{(M-W)^2 + \Gamma^2/4} ,$$

where W is the total center of mass energy; Γ, Γ_e, and Γ_i are the total width and partial widths for coupling to e^+e^- and channel i, respectively; and a Breit-Wigner line shape with energy-independent partial widths is assumed. The quantity σ_0 is given by

$$\sigma_0(W) = \frac{4\pi(2J + 1)}{W^2} ,$$

where J is the spin of the resonance. For a narrow resonance, the area under the resonant line is given by

$$A_i = \frac{\pi}{2} \frac{\Gamma_e\Gamma_i}{\Gamma} \sigma_0(M) ,$$

independent of the energy resolution of the apparatus. Determination of the mass, spin, and integrated channel cross sections, A_i, allows, then, determination of the quantities $\Gamma_e\Gamma_i/\Gamma$, and, assuming there are no undetected decay modes (i.e., in our case $\Gamma = \Gamma_{e^+e^-} + \Gamma_{\mu^+\mu^-} + \Gamma_{hadrons}$), determination of the total and partial widths.

In the Data Card Listings, we tabulate and average the quantity $\Gamma_e\Gamma_i/\Gamma$ only when it was not used to determine the partial widths and/or branching ratios.

J/ψ(3100)

70 J/PSI(3100,JPG=1--) I=0

The J/ψ(3100) was discovered in p-Be collisions at the AGS (AUBERT 74), and in e^+e^- collisions at SPEAR (AUGUSTIN 74), and since then has been extensively investigated in e^+e^- collisions at SPEAR, DORIS, and ADONE, as well as at conventional accelerators with photon and hadron beams.

Evidence bearing on the hadronic nature of the J/ψ(3100) comes from the observation of a large forward photoproduction cross section. Using vector dominance arguments one derives a total cross section for J/ψ(3100) on nucleons over a large energy range of the order of 1 mb (ANDREWS 75, DAKIN 75, KNAPP1 75, MARTIN 75). Although this cross section is an order of magnitude smaller than the corresponding cross sections of the well known vector mesons, it is large enough to suggest that the J/ψ(3100) is probably a hadron. The hadronic interpretation of the J/ψ(3100) is also supported by the apparent conservation of isospin and G-parity in direct hadronic decays (JEAN-MARIE 75). For a detailed discussion of the hadronic nature of J/ψ(3100), see HARARI 75.

The $J^{PC} = 1^{--}$ assignment, suggested by production in s-channel e^+e^- collisions, is confirmed by the observation of an interference between the resonant and QED amplitudes, and by the angular distribution of the lepton pairs in the final state (BOYARSKI 75). The $I^G = 0^-$ assignment was determined by a study of multipion decays (JEAN-MARIE 75). These quantum numbers are compatible with all the data on partial decay widths (non-observation of the γγ mode, observation of the $\Lambda\bar{\Lambda}$ mode, etc.).

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                      70  J/PSI(3100) MASS (MEV)

M         (3100.)                      AUBERT    74 SPEC    28. PP(E+E-)      2/75*
M   L     (3105.)     (3.)             AUGUSTIN  74 SPEAR        E+E-         2/75*
M  O       3095.       4.              BOYARSKI  75 SPEAR        E+E-         3/75*
M  S      (3089.5)                     CRIEGEE   75 DORIS        E+E-         2/75*
M          3098.       6.              PREPOST   75 SPEC    13.-21.GAMMA D    1/76*
M          3103.       6.              BEMPORAD  75 ADONE        E+E-         1/76*
M
M   L   BOYARSKI 75 IS A REEVALUATION OF AUGUSTIN 74 BASED
M   L   ON A RECALIBRATION OF THE SPEAR BEAM ENERGY.
M
M  O    MASS, WIDTH, PARTIAL WIDTHS, AND BRANCHING RATIOS ALL OBTAINED    3/75*
M  O    FROM ONE OVERALL FIT TO DATA OF THIS EXPERIMENT.                  3/75*
M
M  S    ERROR OF ABOUT 1 PER CENT FROM THE UNCERTAINTY IN CALIBRATION OF   2/75*
M  S    THE BEAM ENERGY.                                                  2/75*
M         . . . . . . . . .
M   AVG    3097.6      2.9     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT3097.6      3.3     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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                      70  J/PSI(3100) WIDTH (KEV)

        SEE THE MINI-REVIEW ON EXTRACTING RESONANCE WIDTHS.

W            69.       15.             BOYARSKI  75 SMAG         E+E-         3/75*
W            68.       26.             BALDINI1  75 FRAG         E+E-         1/76*
W            60.       25.             ESPOSITO  75 FRAM         E+E-         1/76*
W         . . . . . . . . .
W   AVG      66.9      11.5    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT  66.9      12.4    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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Mesons

J/ψ(3100)

Data Card Listings

For notation, see key at front of Listings.

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                  70  J/PSI(3100) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      J/PSI(3100) INTO E+ E-                                .5+  .5
P2      J/PSI(3100) INTO MU+ MU-                             105+ 105
P3      J/PSI(3100) INTO HADRCNS
P4      J/PSI(3100) INTO GAMMA INTO HADRONS

P       HADRONIC DECAYS
P       ---------------
P11     J/PSI(3100) INTO PI+ PI-
P12     J/PSI(3100) INTO PI+ PI- PIO
P13     J/PSI(3100) INTO 2(PI+ PI-)
P14     J/PSI(3100) INTO 2(PI+ PI-) PIO
P15     J/PSI(3100) INTO 3(PI+ PI-)
P16     J/PSI(3100) INTO 3(PI+ PI-) PIO
P17     J/PSI(3100) INTO 4(PI+ PI-)
P18     J/PSI(3100) INTO 4(PI+ PI-) PIO
P19     J/PSI(3100) INTO KOS KOL
P20     J/PSI(3100) INTO K+ K-
P21     J/PSI(3100) INTO PI+ PI- K+ K-
P22     J/PSI(3100) INTO 2(PI+ PI-) K+ K-
P23     J/PSI(3100) INTO RHO PI
P24     J/PSI(3100) INTO RHO PI PI PI
P25     J/PSI(3100) INTO OMEGA PI PI
P26     J/PSI(3100) INTO PHI PI PI
P27     J/PSI(3100) INTO K K*(892)
P28     J/PSI(3100) INTO K K*(1420)
P29     J/PSI(3100) INTO K*(892) K*(892)
P30     J/PSI(3100) INTO K*(1420) K*(1420)
P31     J/PSI(3100) INTO K*(892) K*(1420)
P32     J/PSI(3100) INTO PBAR P
P33     J/PSI(3100) INTO LAMBDA ANTILAMBDA
P34     J/PSI(3100) INTO NUCLEON ANTINUCLEON PI
P35     J/PSI(3100) INTO P PBAR PI+ PI-
P36     J/PSI(3100) INTO P PBAR PI+ PI- NEUTRALS

P       RADIATIVE DECAYS
P       ----------------
P51     J/PSI(3100) INTO GAMMA GAMMA
P52     J/PSI(3100) INTO PIO GAMMA
P53     J/PSI(3100) INTO ETA GAMMA
P54     J/PSI(3100) INTO ETA PRIME GAMMA
P55     J/PSI(3100) INTO X(2750) GAMMA                       2750+   0

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                  70  J/PSI(310C) PARTIAL WIDTHS (KEV)

        SEE THE MINI-REVIEW CN EXTRACTING RESONANCE WIDTHS.

W1      J/PSI(3100) INTO E+ E-                        (G1)                2/75*
W1            4.8        0.6          BOYARSKI  75 SMAG        E+E-       3/75*
W1  B        (4.6)      (.8)          BALDINI1  75 FRAG        E+E-       1/76*
W1  B   ASSUMING EQUAL PARTIAL WIDTHS FOR (E+E-) AND (MU+MU-)
W1            4.6        1.0          ESPOSITO  75 FRAM        E+E-       1/76*
W1          . . . . . . . . . .
W1  AVG       4.75       0.51    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W1  STUDENT   4.75       0.55    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W2      J/PSI(3100) INTO MU+ MU-                      (G2)                2/75*
W2            4.8        0.6          BOYARSKI  75 SMAG        E+E-       3/75*
W2            5.0        1.0          ESPOSITO  75 FRAM        E+E-       1/76*
W2          . . . . . . . . . .
W2  AVG       4.85       0.51    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W2  STUDENT   4.85       0.55    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W3      J/PSI(3100) INTO HACRCNS                      (G3)                2/75*
W3           59.        14.           BOYARSKI  75 SMAG        E+E-       3/75*
W3           59.        24.           BALDINI1  75 FRAG        E+E-       1/76*
W3           50.        25.           ESPOSITO  75 FRAM        E+E-       1/76*
W3          . . . . . . . . . .
W3  AVG      57.3       10.9     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W3  STUDENT  57.3       11.7     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W4      J/PSI(3100) INTO GAMMA INTO HADRONS
W4           12.         2.           BOYARSKI  75 SMAG        E+E-       1/76*

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                  70  J/PSI(3100) BRANCHING RATIOS

        FOR THE BRANCHING RATICS R1 - R4, SEE ALSC THE PARTIAL
        WIDTHS ABOVE, AND (PARTIAL WIDTHS)*R1 BELOW.

R1      J/PSI(3100) INTO (E+ E-)/TOTAL                (P1)                3/75*
R1           0.069      0.009         BOYARSKI  75 SMAG        E+E-       3/75*

R2      J/PSI(3100) INTO (MU+ MU-)/TOTAL              (P2)                3/75*
R2           0.069      0.009         BOYARSKI  75 SMAG        E+E-       3/75*

R3      J/PSI(3100) INTO (HADRONS)/TOTAL              (P3)                3/75*
R3           0.86       0.02          BOYARSKI  75 SMAG        E+E-       3/75*

R4      J/PSI(3100) INTO (E+ E-)/(MU+ MU-)            (P1)/(P2)           2/75*
R4           1.00       0.05          BOYARSKI  75 SMAG        E+E-       3/75*
R4           0.93       0.10          FORD      75 SPEC        E+E-       2/75*
R4            .91        .15          ESPOSITO  75 FRAM        E+E-       1/76*
R4          . . . . . . . . . .
R4  AVG      0.980      0.043    AVERAGE (ERRCR INCLUDES SCALE FACTOR OF 1.0)
R4  STUDENT  0.980      0.047    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R5      J/PSI(3100) INTO (GAMMA INTO HADRONS)/TOTAL
R5            .17        .02          BOYARSKI  75 SMAG        E+E-       1/76*


R       HADRONIC DECAYS
R       ---------------

R8      J/PSI(3100) INTO (PI+ PI-)/TOTAL
R8           (.0003)OR LESS CL=.90    WIIK      75 DASP        E+E-       1/76*

R9      J/PSI(3100) INTO (2(PI+ PI-))/TOTAL
R9       76      .004       .001      JEAN-MARI 75 SMAG        E+E-       1/76*

R10     J/PSI(3100) INTO (2(PI+ PI-) PIO)/TCTAL
R10     675      .04        .01       JEAN-MARI 75 SMAG        E+E-       1/76*

R11     J/PSI(3100) INTO (3(PI+ PI-)/TOTAL
R11      32      .004       .002      JEAN-MARI 75 SMAG        E+E-       1/76*

R12     J/PSI(3100) INTO (3(PI+ PI-) PIO)/TCTAL
R12     181      .029       .007      JEAN-MARI 75 SMAG        E+E-       1/76*

R13     J/PSI(3100) INTO (4(PI+ PI-) PIO)/TOTAL
R13      13      .009       .003      JEAN-MARI 75 SMAG        E+E-       1/76*

R14     J/PSI(3100) INTO (PI+ PI- K+ K-)/TOTAL
R14  A   83      .005       .002      ABRAMS4   75 SMAG        E+E-       1/76*
R14  A   INCLUDING CONTRIBUTICN FRCM K*(892)K*(1420)

R15     J/PSI(3100) INTO (2(PI+ PI-) K+ K-)/TOTAL
R15              .003       .001      ABRAMS4   75 SMAG        E+E-       1/76*

R16     J/PSI(3100) INTO (RHO PI)/(PI+ PI- PIO)
R16             (.7)    OR MORE       JEAN-MARI 75 SMAG        E+E-       1/76*

R17     J/PSI(3100) INTO (RHOO PIO)/(RHO+- PI-+)
R17              .59        .17       JEAN-MARI 75 SMAG        E+E-       1/76*

R18     J/PSI(3100) INTO (RHC PI)/TOTAL
R18     153      .013       .003      JEAN-MARI 75 SMAG        E+E-       1/76*

R19     J/PSI(3100) INTO (OMEGA PI PI)/(2(PI+ PI-) PIO)
R19  J          (.2)                  JEAN-MARI 75 SMAG        E+E-       1/76*

R20     J/PSI(3100) INTO (RHC PI PI PI)/(2 (PI+ PI-) PIO)
R20  J          (.3)                  JEAN-MARI 75 SMAG        E+E-       1/76*
R20  J   FINAL STATE  2(PI+PI-)PIO

R21     J/PSI(3100) INTO (PHI PI+ PI-)/(CMEGA PI+ PI-)
R21              .2         .1        ABRAMS4   75 SMAG        E+E-       1/76*

R22     J/PSI(3100) INTO (KOS KOL)/TOTAL
R22          (.0002)OR LESS CL=.90    ABRAMS4   75 SMAG        E+E-       1/76*

R23     J/PSI(3100) INTO (K+ K-)/TOTAL
R23          (.0006)OR LESS CL=.90    WIIK      75 DASP        E+E-       1/76*

R24     J/PSI(3100) INTO (KO K*(892)0)/TOTAL
R24      57      .0024      .0005     ABRAMS4   75 SMAG        E+E-       1/76*

R25     J/PSI(3100) INTO (K+- K*(892)-+)/TOTAL
R25      87      .0031      .0007     ABRAMS4   75 SMAG        E+E-       1/76*
R25        POSSIBLY SEEN              WIIK      75 DASP        E+E-       1/76*

R26     J/PSI(3100) INTC (KO K*(1420)0)/TCTAL
R26          (.0019)OR LESS CL=.90    ABRAMS4   75 SMAG        E+E-       1/76*

R27     J/PSI(3100) INTO (K+- K*(1420-+)/TCTAL
R27          (.0019)OR LESS CL=.90    ABRAMS4   75 SMAG        E+E-       1/76*

R28     J/PSI(3100) INTO (K*(892)0 K*(892)0)/TCTAL
R28          (.0006)OR LESS CL=.90    ABRAMS4   75 SMAG        E+E-       1/76*

R29     J/PSI(3100) INTO (K*(1420)0 K*(1420)0)/TOTAL
R29          (.0018)OR LESS CL=.90    ABRAMS4   75 SMAG        E+E-       1/76*

R30     J/PSI(3100) INTO (K*(892)0 K*(1420)0)/TOTAL
R30      30      .0037      .0010     ABRAMS4   75 SMAG        E+E-       1/76*


R31     J/PSI(3100) INTO (PBAR P)/TOTAL
R31  A 105       .0021      .J004     ABRAMS4   75 SMAG        E+ E-      1/76*
R31  A  40       .0023      .0CC6     WIIK      75 DASP        E+ E-      1/76*
R31  A  ASSUMING ANGULAR DISTRIBUTION (1.+COS(THETA)**2)
R31         . . . . . . . . . .
R31 AVG      0.00216  0.00033  AVERAGE (ERROR INCLUDES SCALE FACTCR OF 1.0)
R31 STUDENT  0.00216  0.00036  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R32     J/PSI(3100) INTO (PBAR P)/(MU+ MU-)
R32  A  20       .051       .02       CRIEGEE   75 PLUT        E+ E-      1/76*
R32  A  ASSUMING ANGULAR DISTRIBUTION (1.+COS(THETA)**2)

R33     J/PSI(3100) INTO (LAMBCA ANTILAMBCA)/TOTAL
R33      19      .0016      .0008     ABRAMS4   75 SMAG        E+ E-      1/76*

R34     J/PSI(3100) INTO (NUCLEON ANTINUCLEON PI)/TOTAL
R34  A  87       .0037      .0019     ABRAMS4   75 SMAG        E+ E-      1/76*
R34  A INCLUDES P PBAR PIO, NBAR P PI- AND N PBAR PI+

R35     J/PSI(3100) INTO (P PBAR PI+PI-)/TCTAL
R35 G   125 SEEN                      GOLDHABER 75 SMAG        E+E-       2/76*
R35 G    INCLUDES LAMBDA ANTILAMBCA

R36     J/PSI(3100) INTO (P PBAR PI+ PI- NEUTRALS)/TOTAL
R36 I    91 SEEN                      GOLDHABER 75 SMAG        E+E-       2/76*
R36 I    INCLUDES SIGMA ANTISIGMA ETC.

R37     J/PSI(3100) INTC (LAMBCA ANTISIGMA)/(LAMBDA ANTILAMBDA)
R37             (.22) OR LESS         GOLDHABER 75 SMAG        E+E-       2/76*


R       RADIATIVE DECAYS
R       ----------------

R51     J/PSI(3100) INTO (2 GAMMA)/(E+ E-)                   (P4)/(P1)    2/75*
R51          (0.050)OR LESS  CL=.90   BRAUNSCH  75 DASP        E+E-       2/75*

R52     J/PSI(3100) INTO (PIO GAMMA)/(E+ E-)                 (P5)/(P1)    2/75*
R52          (0.13) OR LESS  CL=.90   BRAUNSCH  75 DASP        E+E-       2/75*
R52  B       (.06) OR LESS   CL=.90   BACCI     75 FRAG        E+E-       1/76*
R52  B   RE-STATED BY US USING (E+E-)/HADRCNS = .08

R53     J/PSI(3100) INTO (ETA GAMMA)/TOTAL
R53  U         .0014     .0005        WIIK      75 DASP        E+ E-      1/76*
R53  U  USING TOTAL WIDTH (69+-15) KEV
R53           (.016)OR LESS  CL=.90   BACCI     75 FRAG        E+E-       1/76*

R54     J/PSI(3100) INTO (ETA PRIME GAMMA)/(ETA GAMMA)
R54           (5.)    OR LESS  CL=.90 WIIK      75 DASP        E+E-       1/76*
R54            4.0       2.5          HEINTZE   75 DESY        E+E-       1/76*
R54  B       (10.)    OR LESS  CL=.90 BALDINI2  75 FRAG        E+E-       1/76*
R54  B  RE-STATED BY US USING (ETA GAMMA)/TOTAL = .0014

R56     J/PSI(3100) INTO (X(2750) GAMMA)/(ETA GAMMA) FINAL STATE (3 GAMMA)
R56     16     (1.)                   HEINTZE   75 DESY        E+E-       1/76*

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Data Card Listings

For notation, see key at front of Listings.

Mesons

J/ψ(3100), ψ(3700)

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                 70  J/PSI(3100)   G(I)*G(E+E-)/G(TOTAL)  (KEV)

       THIS COMBINATION OF A PARTIAL WIDTH WITH THE PARTIAL WIDTH
       INTO E+E- AND WITH THE TOTAL WIDTH IS OBTAINED FROM THE INTEGRATED
       CROSS-SECTION INTO CHANNEL(I) IN THE E+E- ANNIHILATICN.
       SEE THE MINI-REVIEW ON EXTRACTING RESONANCE WIDTHS.

G1     G(E+E-)*G(E+E-)/G(TOTAL)
G1  S        (.32)    (.07)          BALDINI1  75 FRAG        E+E-         1/76*
G1            .41      .06           DASP1     75 DASP        E+E-         1/76*
G1  S        (.36)    (.10)          FORD      75 SPEC        E+E-
G1            .34      .14           BEMPORAD  75 FRAB        E+E-         1/76*
G1  S        (.34)    (.09)          ESPOSITC  75 FRAM        E+E-         1/76*
G1          . . . . . . . . . .
G1  AVG      0.399    0.055    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
G1  STUDENT  0.399    0.060    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

G2     G(MU+MU-)*G(E+E-)/G(TOTAL)
G2            .51      .09           DASP1     75 DASP        E+E-         1/76*
G2            .31      .09           BEMPORAD  75 FRAB        E+E-         1/76*
G2            .32      .08           CRIEGEE   75 PLUT        E+E-         1/76*
G2  S        (.38)    (.05)          ESPOSITO  75 FRAM        E+E-         1/76*
G2  S        (.46)    (.10)          LIBERMAN  75 SPEC        E+E-         1/76*
G2          . . . . . . . . . .
G2  AVG      0.375    0.063    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
G2  STUDENT  0.369    0.059    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

G3     G(HADRONIC)*G(E+E-)/G(TOTAL)
G3  S        (4.)     (.8)           BALDINI1  75 FRAG        E+E-         1/76*
G3  S        (3.9)    (.8)           ESPOSITO  75 FRAM        E+E-         1/76*

G   S   SEE THE BRANCHING RATIOS AND PARTIAL WIDTHS ABOVE.

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REFERENCES FOR J/PSI(3100)


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CHRISTEN 70 PRL 25 1523        CHRISTENSON,HICKS,LEDERMAN+ (COLU+BNL+CERN)    V70

ABRAMS   74 PRL 33 1453        +BRIGGS,AUGUSTIN,BOYARSKI+        (LBL+SLAC)   V70
ASH      74 NCL 11 705         +ZORN,BARTOLI+     (FRAS+UMD+NAPL+PADO+RCMA)   V70
AUBERT   74 PRL 33 1404        +BECKER,BIGGS,BURGER,CHEN,EVERHART(MIT+BNL)    V70
   ALSO 75  COO-3069-285       AUBERT,BECKER,BIGGS,BURGER,GLENN+ (MIT+BNL)    V7C
AUGUSTIN 74 PRL 33 1406        +BOYARSKI,ABRAMS,BRIGGS+          (SLAC+LBL)   V70
BACCI    74 PRL 33 1408        +BARTOLI,BARBARINO,BARBIELLINI+  (FRASCATI)    V70
   ALSO 74 PRL 33 1649         FCR ERRATA                                     V70
BALDINI- 74 NCL 11 711         BALDINI-CELIO,BACCI+          (FRASCATI+ROMA)  V70
BARBIELL 74 NCL 11 718         BARBIELLINI,BEMPORAD+ (FRAS+NAPO+PISA+ROMA)    V70
BRAUNSCH 74 PL 53B 393         BRAUNSCHWEIG+      (AACHEN+HAMB+MUNICH+TOKYO)  V7C

ABRAMS4  75  STANFORD SYMP.    G.S.ABRAMS                             (LBL)   V70
ANDREWS  75 PRL 34 231         +HARVEY,LOBKOWICZ,MAY,NORDBERG  (ROCH+CORN)    V70
   ALSO 75  UR-518             ANDREWS,HARVEY,LOBKCWICZ,MAY+   (ROCH+CORN)    V70
ANTIPOV  75  IHEP PREP 75-125  +BESSUBOV,BUDANOV,BUSHNIN,DENISOV,+  (IHEP)    V70
AUBERT   75 NP B 89 1                                                         V70
BACCI    75 NCL 12 269         +PENSO,STELLA,BALDINI-CELIC,+    (ROMA+FRAS)   V70
BALDINI1 75 PL 58B 471         BALDINI-CELIO,BOZZO,CAPON,BACCI+(FRAS+ROMA)    V70
BALDINI2 75 PL 58B 475         BALDINI-CELIO,CAPON,DEL FABBRO+ (FRAS+RCMA)    V70
BEMPORAD 75  STANFORD SYMP.    C.BEMPORAD                  (PISA+FRASCATI)    V70
BLANAR   75 PRL 35 346         +BOYER,FAISSLER,GARELICK,GETTNER,+)        )
BOYARSKI 75 PRL 34 1357        +BREIDENBACH,BULOS,FELDMAN,+    (SLAC+LBL)JPC  V70
BRAUNSCH 75 PL 53B 491         BRAUNSCHWEIG+    (AACHEN+HAMB+MUNICH+TOKYO)    V70
CAMERINI 75 PRL 35 483         +LEARNED,PREPOST,ASH,ANDERSON,+ (WISC+SLAC)    V70
CRIEGEE  75 PL 53B 489         +DEHNE,FRANKE,HORLITZ,KRECHLOCK+     (DESY)    V70
CRIEGEE  75  DESY PREP.75/32   +DEHNE,FOX,FRANKE,HORLITZ,KNIES,+    (DESY)    V70
DAKIN    75 PL 56 B 405        +KREISLER,BOLON,HEILE+      (MASA+MIT+SLAC)    V70
DASP1    75 PL 56B 491         BRAUNSCHWEIG,KONIGS,+ (AACH+DESY+MPIM+TOKY)    V70
DASP2    75 PL 57B 297         BRAUNSCHWEIG,KONIGS,+ (AACH+DESY+MPIM+TOKY)    V70
ESPOSITO 75 NCL 14 73          +BARTOLI,BISELLC,+     (FRAS+NAPO+PADO+RCMA)   V70
FORD     75 PRL 34 604         +BERON,HILGER,HOFSTADTER+       (SLAC+PENN)    V70
GITTELMA 75 PRL 35 1616        GITTELMAN+HANSON+LARSCN+LCH+         (CORN)    V70
GOLDHABE 75  LBL-4224          GOLDHABER,JOHNSON,KADYK,+        (LBL+SLAC)    V70
GRECO    75 PL 56B 367         +PANCHERI-SRIVASTAVA,SRIVASTAVA      (FRAS)    V70
HEINTZE  75  STANFORD SYMP.    J.HEINTZE                      (HEIDELBERG)    V70
JACKSON  75 NIM 128 13         J.D.JACKSON,D.SCHARRE                 (LBL)    V70
JEAN-MAR 75 PRL (SLAC-PUB-1681+ABRAMS,BOYARSKI,BREIDENBACH,+  (SLAC+LBL)IG   V70
KNAPP1   75 PRL 34 1040        +LEE,BRONSTEIN+    (COLU+HAWA+CORN+ILL+FNAL)   V70
KNAPP2   75 PRL 34 1044        +LEE,BRONSTEIN+    (COLU+HAWA+CORN+ILL+FNAL)   V70
LIBERMAN 75  STANFORD SYMP.    A.D.LIBERMAN                     (STANFORD)    V70
MARTIN   75 PRL 34 288         +BOLON,DAKIN,FELDMAN,HANSCN+(MIT+MASA+SLAC)    V70
PREPOST  75  STANFORD SYMP.    R.PREPCST                       (WISCONSIN)    V70
SIMPSON  75 PRL 35 699         +BERON,FORD,HILGER,HOFSTADTER,+ (STAN+PENN)    V70
WIIK     75  STANFORD SYMP.    B.H.WIIK                             (DESY)    V70
YENNIE   75 PRL 34 239         D.R.YENNIE                        (CORNELL)    V70
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ψ(3700)

71 PSI(3700,JPG=1--) I=0

The ψ(3700) was discovered in e^+e^- collisions at SPEAR (ABRAMS 74), and since then has been extensively investigated in e^+e^- collisions at SPEAR and DORIS, as well as at conventional accelerators.

The hadronic interpretation of the ψ(3700) is closely related to that of J/ψ(3100), due to the decays $\psi(3700) \to J/\psi(3100)\pi\pi$ and $\psi(3700) \to J/\psi(3100)\eta$. These decays also determine the $I^G = 0^-$ assignment for the ψ(3700) (TANENBAUM 75).

The J^{PC} assignment, suggested by production in s-channel e^+e^- collisions, is confirmed by the observation of an interference between the resonant and QED amplitudes, and by the angular distribution of the lepton pairs in the final state (LÜTH 75). These quantum numbers are compatible with all the data on partial decay widths (the multipion decays mentioned above, the non-observation of $J/\psi(3100)\pi^0$ and $\gamma\gamma$ modes, etc.).

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                71  PSI(3700) MASS (MEV)

M   L    (3695.)     (4.)        ABRAMS   74 SPEAR        E+E-       2/75*
M  S     (3680.3)                CRIEGEE  75 DORIS        E+E-       2/75*
M          3684.       5.        LUTH     75 SPEAR        E+E-       1/76*
M          3684.       9.        PREPOST  75 SPEC    21. GAMMA D     1/76*
M
M   L   LUTH  75 IS A REEVALUATION OF ABRAMS 74 BASED ON A RECALIBRATION    2/75*
M   L   OF THE SPEAR BEAM ENERGY.                                           2/75*
M  S    ERROR OF ABOUT 1 PER CENT FROM THE UNCERTAINTY IN CALIBRATION OF    2/75*
M  S    THE BEAM ENERGY.                                                    2/75*
M          . . . . . . . . . .
M   AVG    3684.0      4.4    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT3684.0      4.7    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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DM              PSI(3700) - J/PSI(3100) MASS CIFFERENCE (MEV)

DM         588.7       .8          LUTH       75 SMAG

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                71  PSI(3700) WIDTH (KEV)

W          228.       56.          LUTH       75 SMAG

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                71  PSI(3700) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      PSI(3700) INTO E+ E-                               .5+  .5
P2      PSI(3700) INTO MU+ MU-                            105+ 105
P3      PSI(3700) INTO HADRCNS
P4      PSI(3700) INTO GAMMA INTO HADRCNS

P       DECAYS INTO J/PSI(3100) + ANYTHING
P       ------------------------------
P11     PSI(3700) INTO J/PSI(3100) + ANYTHING
P12     PSI(3700) INTO J/PSI(3100) + NEUTRALS
P13     PSI(3700) INTO J/PSI(3100) PI+ PI-                 3098+ 139+ 139
P14     PSI(3700) INTO J/PSI(3100) PIO PIO                 3098+ 134+ 134
P15     PSI(3700) INTO J/PSI(3100) ETA                     3098+ 548
P54     PSI(3700) INTO J/PSI(3100) GAMMA GAMMA

P       HADRONIC DECAYS
P       ---------------
P21     PSI(3700) INTO PI+ PI-
P22     PSI(3700) INTO RHCO PIO
P23     PSI(3700) INTO K+ K-
P24     PSI(3700) INTO 2(PI+ PI-) PIO
P25     PSI(3700) INTO PI+ PI- K+ K-
P26     PSI(3700) INTO PBAR P

P       RADIATIVE DECAYS
P       ----------------
P51     PSI(3700) INTO GAMMA GAMMA
P52     PSI(3700) INTO PIO GAMMA
P53     PSI(3700) INTO ETA GAMMA
P55     PSI(3700) INTO ETA PRIME GAMMA
P56     PSI(3700) INTO CHI(3410) GAMMA                     3410+   0
P57     PSI(3700) INTO CHI(3530) GAMMA                     3530+   0
P58     PSI(3700) INTO PC GAMMA
P59     PSI(3700) INTO X(2750) GAMMA

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

	P13	P14	P15	P58	P_{OTHER}
P13	.3307+-.0266				
P14	.5922	.1724+-.0242			
P15	-.0079	-.1453	.0416+-.0070		
P58	.0264	-.2301	-.0065	.0363+-.0066	
P_{OTHER}	-.9108	-.8301	-.0727	-.0370	.4190+-.0450

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                71  PSI(3700) PARTIAL WIDTHS (KEV)

W1      PSI(3700) INTO E+ E-                              (G1)                2/75*
W1           2.1        .3          LUTH      75 SMAG             E+E-        1/76*

W3      PSI(3700) INTO HACRCNS                            (G3)
W3          224.       56.          LUTH      75 SMAG             E+E-        1/76*

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                71  PSI(3700) BRANCHING RATIOS

R1      PSI(3700) INTO (E+ E-)/TOTAL
R1 L          .0093     .0016       LUTH      75 SMAG             E+E-        1/76*
R1 L     FROM AN OVERALL FIT ASSUMING EQUAL PARTIAL WIDTHS FOR (E+E-)
R1 L     AND (MU+MU-). FOR A MEASUREMENT OF THE RATIO SEE THE ENTRY R4 BELOW
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Mesons

ψ(3700)


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R2      PSI(3700) INTO (MU+ MU-)/TOTAL
R2 H          .0084    .0018          HILGER    75 SPEC         E+E-          1/76*
R2 H     RE-STATED BY US USING (J/PSI(3100)+ANYTHING)/TOTAL = .6

R3      PSI(3700) INTO (HADRONS)/TOTAL
R3            .981     .003           LUTH      75 SMAG         E+E-          1/76*

R4      PSI(3700) INTO (MU+ MU-)/(E+ E-)
R4            .89      .16            LUTH1     75 SMAG         E+E-          1/76*

R5      PSI(3700) INTO (GAMMA INTO HADRONS)/TOTAL
R5            .029     .004           LUTH      75 SMAG         E+E-          1/76*


R       DECAYS INTO J/PSI(3100) + ANYTHING
R       --------------------------------

R10     PSI(3700) INTO (J/PSI(3100) + ANYTHING)/TOTAL
R10           .57      .08            ABRAMS4   75 SMAG         E+E-          1/76*
R10         . . . . . . . . .
R10 FIT      0.581    0.045  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R11     PSI(3700) INTO (J/PSI(3100) + NEUTRALS)/(J/PSI(3100) + ANYTHING)
R11  S       (.44)    (.03)           ABRAMS1   75 SMAG         E+E-          1/76*
R11  S   SUPERSEDED BY TANENBAUM 76 (FOOTNOTE 13 OF TANENBA1 75,AND
R11  S   PRIV. COMMUNICATION).
R11           .41      .02            TANENBAUM 76 SMAG         E+E-          2/76*
R11         . . . . . . . . .
R11 FIT      0.410    0.019  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R12     PSI(3700) INTO (J/PSI(3100) PI+ PI-)/TOTAL
R12           .32      .04            ABRAMS1   75 SMAG         E+E-          1/76*
R12           .36      .06            WIIK      75 DASP         E+E-          1/76*
R12         . . . . . . . . .
R12 AVG      0.332    0.033   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R12 STUDENT  0.332    0.036   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R12 FIT      0.331    0.027  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R13     PSI(3700) INTO (J/PSI(3100) PI0 PI0)/TOTAL
R13           .18      .06            WIIK      75 DASP         E+E-          1/76*
R13         . . . . . . . . .
R13 FIT      0.172    0.024  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R14     PSI(3700) INTO (J/PSI(3100) PI0 PI0)/(J/PSI(3100) PI+ PI-)
R14 H        (.64)    (.15)           HILGER    75 SPEC         E+E-          1/76*
R14 H    IGNORING THE (J/PSI ETA) AND (J/PSI GAMMA GAMMA) DECAYS

R15     PSI(3700) INTO (J/PSI(3100) ETA)/TOTAL
R15           .043     .008           TANENBA1  75 SMAG         E+E-          1/76*
R15           .037     .015           WIIK      75 DASP         E+E-          1/76*
R15         . . . . . . . . .
R15 AVG      0.0417   0.0071  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R15 STUDENT  0.0417   0.0076  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R15 FIT      0.0416   0.0070 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R16     PSI(3700) INTO (J/PSI(3100) GAMMA OR J/PSI(3100) PI0)/TOTAL
R16          (.0015)OR LESS CL=.90    TANENBA1  75 SMAG         E+E-          2/76*

R50     PSI(3700) INTO (J/PSI(3100) GAMMA GAMMA)/TOTAL
R50  A  10 SEEN                       DASP3     75 DASP         E+E-          1/76*
R50  B   5 SEEN                       DASP3     75 DASP         E+E-          1/76*
R50  A  15 SEEN                       HEINTZE   75 SPEC         E+E-          1/76*
R50  B 150 SEEN                       TANENBAUM 75 SMAG         E+E-          1/76*
R50 AB  DECAY PROCEEDS VIA INTERMEDIATE STATE PC  (SEE R51) .
R50  A  WITH J/PSI(3100) INTO (E+ E-)
R50  B  WITH J/PSI(3100) INTO (MU+ MU-)

R       HADRONIC DECAYS
R       ---------------

R20     PSI(3700) INTO (PI+ PI-)/TOTAL
R20          (.0009)OR LESS CL=.90    WIIK      75 DASP         E+E-          1/76*
R20         (.00019)OR LESS CL=.90    FELDMAN   75 SMAG         E+E-          1/76*

R21     PSI(3700) INTO (RHO0 PI0)/TOTAL
R21          (.001)OR LESS  CL=.90    ABRAMS4   75 SMAG         E+E-          1/76*

R22     PSI(3700) INTO (2(PI+ PI-) PI0)/TOTAL
R22           .0035    .0015          ABRAMS4   75 SMAG         E+E-          1/76*

R23     PSI(3700) INTO (K+ K-)/TOTAL
R23          (.0016)OR LESS CL=.90    WIIK      75 DASP         E+E-          1/76*
R23         (.00023)OR LESS CL=.90    FELDMAN   75 SMAG         E+E-          1/76*

R24     PSI(3700) INTO (PI+ PI- K+ K-)/TOTAL
R24          (.0005)                  ABRAMS4   75 SMAG         E+E-          1/76*

R25     PSI(3700) INTO (PBAR P)/TOTAL
R25          (.001)OR LESS  CL=.90    WIIK      75 DASP         E+E-          1/76*
R25           .0004    .0002          ABRAMS4   75 SMAG         E+E-          1/76*


R       RADIATIVE DECAYS
R       ----------------

R41     PSI(3700) INTO (GAMMA GAMMA)/TOTAL
R41          (.008)OR LESS  CL=.90    WIIK      75 DASP         E+E-          1/76*
R41  U       (.005)OR LESS  CL=.95    HUGHES    75 SPEC         E+E-          1/76*

R42     PSI(3700) INTO (PI0 GAMMA)/TOTAL
R42          (.01) OR LESS  CL=.90    WIIK      75 DASP         E+E-          1/76*
R42  U       (.007)OR LESS  CL=.95    HUGHES    75 SPEC         E+E-          1/76*

R43     PSI(3700) INTO (ETA GAMMA)/TOTAL
R43          (.0013)OR LESS CL=.90    WIIK      75 DASP         E+E-          1/76*
R43  U       (.024)OR LESS  CL=.95    HUGHES    75 SPEC         E+E-          1/76*
R43  U   RE-STATED BY US USING (MU+MU-)/TOTAL = .01

R44     PSI(3700) INTO (ETA PRIME GAMMA)/TOTAL
R44          (.014)OR LESS  CL=.90    WIIK      75 DASP         E+E-          1/76*

R51     PSI(3700) INTO (PC GAMMA)/TOTAL, PC INTO (J/PSI(3100) GAMMA)
R51           .04      .02            WIIK      75 DASP         E+E-          1/76*
R51           .036     .007           TANENBAUM 75 SMAG         E+E-          1/76*
R51         . . . . . . . . .
R51 AVG      0.0364   0.0066  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R51 STUDENT  0.0364   0.0071  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R51 FIT      0.0363   0.0066 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R52     PSI(3700) INTO (PC GAMMA)/TOTAL, PC INTO (GAMMA GAMMA)
R52        (.000013)OR LESS CL=.90    WIIK      75 DASP         E+E-          1/76*

R53     PSI(3700) INTO (X(2750) GAMMA)/TOTAL,  X(2750) INTO (GAMMA GAMMA)
R53         (.00037)OR LESS CL=.90    WIIK      75 DASP         E+E-          1/76*
R53          (.003)OR LESS  CL=.95    HUGHES    75 SPEC         E+E-          1/76*
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R54     PSI(3700) INTO (CHI(3410) GAMMA)/TOTAL  *10**2
R54
R54 F    FOR DECAY MODES OF THE CHI INDICATED            **********************
R54 F         (.13)     (.05)           FELDMAN   75  CHI INTO (PI+PI-)OR(K+K
R54 F         (.07)                     FELDMAN1  75  CHI INTO (PI+PI-K+K-)
R54 F         (.14)     (.07)           FELDMAN1  75  CHI INTO (2(PI+PI-))
R54 F         (.1)                      FELDMAN1  75  CHI INTO (3(PI+PI-))
R54 F         (.5)  OR LESS  CL=.90     FELDMAN1  75  CHI INTO (J/PSI GAMMA)
R54 F    FOR DECAY MODES OF THE CHI INDICATED            **********************

R55     PSI(3700) INTO (CHI(3530) GAMMA)/TOTAL  *10**2
R55
R55 F    FOR DECAY MODES OF THE CHI INDICATED            **********************
R55 F         (.027)OR LESS  CL=.90     FELDMAN   75  CHI INTO (PI+PI-)OR(K+K
R55 F         (.05)                     FELDMAN1  75  CHI INTO (PI+PI-K+K-)
R55 F         (.2)      (.1)            FELDMAN1  75  CHI INTO (2(PI+PI-))
R55 F         (.2)                      FELDMAN1  75  CHI INTO (3(PI+PI-))
R55 F    FOR DECAY MODES OF THE CHI INDICATED            **********************

R56     PSI(3700) INTO (PC GAMMA)/TOTAL, PC INTO (PI+PI-) OR (K+K-)
R56          (.00027)OR LESS CL=.90     FELDMAN1  75 SMAG         E+E-          1/76*


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                    71  PSI(3700)      G(I)*G(E+E-)/G(TOTAL)  (KEV)


         THIS COMBINATION OF A PARTIAL WIDTH WITH THE PARTIAL WIDTH
         INTO E+E- AND WITH THE TOTAL WIDTH IS OBTAINED FROM THE INTEGRATED
         CROSS-SECTION INTO CHANNEL(I) IN THE E+E- ANNIHILATION.
         SEE THE MINI-REVIEW ON EXTRACTING RESONANCE WIDTHS.


G3      G(HADRONIC)*G(E+E-)/G(TOTAL)
G3            2.2        .4             ABRAMS4   75 SMAG         E+E-          1/76*


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                              REFERENCES FOR PSI(3700)
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ABRAMS    74 PRL 33 1453        +BRIGGS,AUGUSTIN,BOYARSKI+          (LBL+SLAC)     V71

ABRAMS1   75 PRL 34 1181        +BRIGGS,CHINOWSKY,FRIEDBERG,+       (LBL+SLAC)     V71
ABRAMS4   75  STANFORD SYMP.    G.S.ABRAMS                               (LBL)     V71
AUBERT    75 PRL 33 1624        +BECKER,BIGGS,BURGER,GLENN+           (MIT+BNL)     V71
CAMERINI  75 PRL 35 483         +LEARNED,PREPOST,ASH,ANDERSON,+ (WISC+SLAC)     V71
CRIEGEE   75 PL 53B 489         +DEHNE,FRANKE,HORLITZ,KRECHLOCK+        (DESY)     V71
DASP3     75 PL 57B 407         BRAUNSCHWEIG,KONIGS,+ (AACH+DESY+MPIM+TOKY)     V71
FELDMAN   75 PRL 35 821         +JEAN-MARIE,SADOULET,VANNUCCI,+     (LBL+SLAC)     V71
FELDMAN1  75  STANFORD SYMP.    G.J.FELDMAN                             (SLAC)     V71
GRECO     75 PL 56B 367         +PANCHERI-SRIVASTAVA,SRIVASTAVA         (FRAS)     V71
HEINTZE   75  STANFORD SYMP.    J.HEINTZE                         (HEIDELBERG)     V71
JACKSON   75 NIM 128 13         J.D.JACKSON,D.SCHARRE                    (LBL)     V71
HILGER    75 PRL 35 625         +BERON,FORD,HOFSTADTER,HOWELL,+ (STAN+PENN)     V71
HUGHES    75  PREP.HEPL 765     +BERON,CARRINGTON,FORD,HILGER,+ (STAN+PENN)     V71
LUTH      75 PRL 35 1124        +BOYARSKI,LYNCH,BREIDENBACH,+      (SLAC+LBL)JPC V71
LUTH1     75  SLAC-PUB-1599     V.LUTH , PALERMO CONF.PROC.+        (SLAC+LBL)     V71
LIBERMAN  75  STANFORD SYMP.    A.D.LIBERMAN                        (STANFORD)     V71
PREPOST   75  STANFORD SYMP.    R.PREPOST                          (WISCONSIN)     V71
SIMPSON   75 PRL 35 699         +BERON,FORD,HILGER,HOFSTADTER,+ (STAN+PENN)     V71
TANENBAU  75 PRL 35 1323        TANENBAUM,WHITAKER,ABRAMS,+         (LBL+SLAC)     V71
TANENBA1  75 PRL  SLAC-PUB1696 TANENBAUM,ABRAMS,BOYARSKI,+         (SLAC+LBL)     V71
WIIK      75  STANFORD SYMP.    B.H.WIIK                                (DESY)     V71

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Additional States in S-channel e^+e^- Collisions

No evidence for narrow states has been found in the mass intervals 1910-2545 MeV and 2970-3090 MeV (BACCI 75, ESPOSITO 75). Except for the ψ(3700), no additional narrow states have been found in the mass interval 3200-7600 MeV (BOYARSKI 75, SCHWITTERS 75).

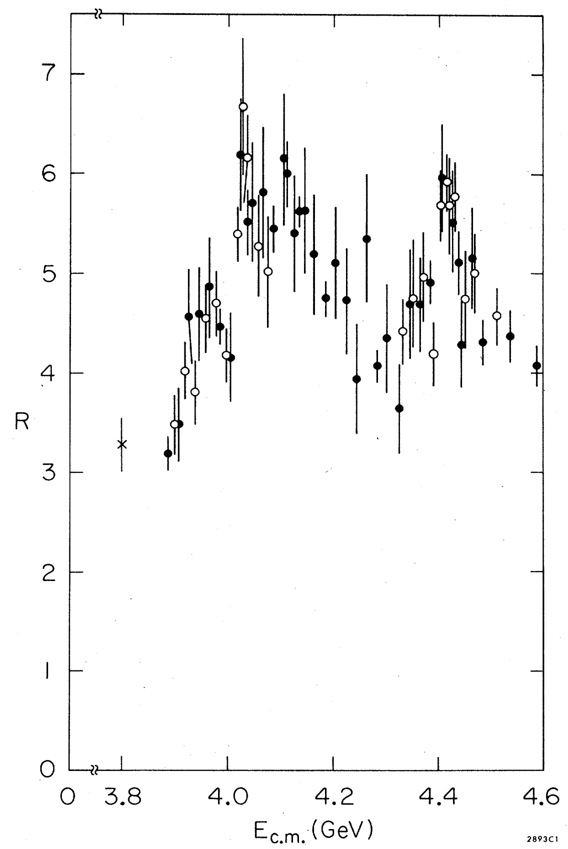
The broad enhancement observed in the e^+e^- total cross section at SPEAR (AUGUSTIN 75) is now resolved into two distinct objects at 4100 and 4400 MeV (SIEGRIST 76), with indications of even more detailed substructure especially at 4100 MeV (see figure). Due to there being very limited information available on the properties of ψ(4100) and ψ(4400), their resonant interpretation is not yet established. If in fact they are resonances, then their relatively large widths suggest that they are hadronic, with $J^{PC} = 1^{--}$.

Data Card Listings

For notation, see key at front of Listings.

Mesons

$\psi(4100)$, $\psi(4400)$, X(2750)



The ratio of cross sections $\frac{\sigma(e^+e^- \to \text{hadrons})}{\sigma(e^+e^- \to \mu^+\mu^-)}$ in the $\psi(4100)$-$\psi(4400)$ region (from SIEGRIST 76).

$\psi(4100)$

72 PSI(4100,JPG=) I=

72 PSI(4100) MASS (MEV)

M	(4150.)	AUGUSTIN	75 SPEAR	2.4-5.0	E+E-	2/75*
M	(4100.)	SCHWITTER	75 SMAG		E+E-	1/76*

REFERENCES FOR PSI(4100)

AUGUSTIN 75 PRL 34 764 +BOYARSKI,ABRAMS,BRIGGS+ (SLAC+LBL) V72
BACCI 75 PL 58B 481 +BIDOLI,PENSO,STELLA,+ (ROMA+FRAS) V72
BOYARSKI 75 PRL 34 762 +BREIDENBACH,ABRAMS,BRIGGS,+ (SLAC+LBL) V72
ESPOSITO 75 PL 58B 478 +FELICETTI,PERUZZI,+ (FRAS+NAPO+PADO+ROMA) V72
SCHWITTE 75 STANFORD SYMP. R.F.SCHWITTERS (SLAC) V72
SIEGRIST 76 SUBM. TO PRL +ABRAMS,BOYARSKI,BREIDENBACH,+ (LBL+SLAC) V72

$\psi(4400)$

73 PSI(4400,JPG=) I=

73 PSI(4400) MASS (MEV)

M	4414.	7.	SIEGRIST	76 SMAG	E+E-	2/76*

73 PSI(4400) WIDTH (MEV)

W	33.	10.	SIEGRIST	76 SMAG	E+E-	2/76*

73 PSI(4400) BRANCHING RATIOS

R1 PSI(4400) INTO (E+ E-)/TOTAL *10**5

R1	1.3	.3	SIEGRIST	76 SMAG	E+E-	2/76*

REFERENCES FOR PSI(4400)

SCHWITTE 75 STANFORD SYMP. R.F.SCHWITTERS (SLAC) V73
SIEGRIST 76 SUBM. TO PRL +ABRAMS,BOYARSKI,BREIDENBACH,+ (LBL+SLAC) V73

X(2750)

54 X(2750,JPG=) I=

→ OBSERVED IN THE SEQUENTIAL RADIATIVE DECAY OF THE J/PSI(3100) INTO X(2750) GAMMA, X(2750) INTO GAMMA GAMMA,AND POSSIBLY PBAR P (HEINTZE 75). THIS SUGGESTS QUANTUM NUMBER ASSIGNMENTS C=+, IG=0+ OR 1-. NEEDS CONFIRMATION. OMITTED FROM TABLE.

54 X(2750) MASS (MEV)

M	(2750.)	HEINTZE	75 DESY	E+E-	1/76*

54 X(2750) PARTIAL DECAY MODES

		DECAY MASSES
P1	X(2750) INTO GAMMA GAMMA	
P2	X(2750) INTO PBAR P	

54 X(2750) BRANCHING RATIOS

R1 X(2750) INTO (PBAR P)/TOTAL

R1	2 POSSIBLY SEEN	WIIK	75 DASP	E+E-	1/76*

REFERENCES FOR X(2750)

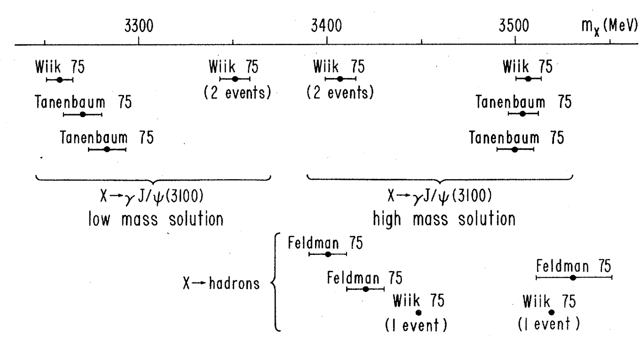
HEINTZE 75 STANFORD SYMP. J.HEINTZE (HEIDELBERG) V54
WIIK 75 STANFORD SYMP. B.H.WIIK (DESY) V54

States Observed in Radiative Decays of $\psi(3700)$

The properties, and even the number, of intermediate states in radiative decay of $\psi(3700)$ are not well known. The main problems are:

1) small statistics in most experiments;
2) ambiguity in the determination of the mass of P_c;
3) it is not known whether the $\chi(3530)$ is a single state, or whether the relatively large observed width is due to a superposition of several narrow states.

The data seem to require the presence of at least 3 states in the mass interval 3250-3550 MeV; the figure summarizes all the present claims.



Claims for intermediate states X in the radiative decay $\psi(3700) \to \gamma X$.

Mesons

P_c(3300 or 3500), χ(3410), χ(3530)

Data Card Listings

For notation, see key at front of Listings.

P_c(3300 or 3500)

55 PC(3300 OR 3500,JPG=) I=

OBSERVED IN THE RADIATIVE SEQUENTIAL DECAY OF THE PSI(3700) INTO PC GAMMA, PC INTO J/PSI(3100) GAMMA (BRAUNSWEIG 75, CONFIRMED BY TANENBAUM 75), THEREFORE C=+. MASS DETERMINATION AMBIGUOUS DUE TO TWO POSSIBLE (GAMMA J/PSI) COMBINATIONS IN THE FINAL STATE (J/PSI GAMMA GAMMA).
NEEDS CLARIFICATION (SEE THE MINIREVIEW ON STATES OBSERVED IN RADIATIVE DECAYS OF PSI(3700). OMITTED FROM TABLE.

55 PC MASS (MEV)

M1 L	LOW MASS SOLUTION						
M1 L W	4(3260.)	(50.)	DASP3	75 DASP	E+E-	1/76*	
M1 L	40 3270.	10.	TANENBAUM	75 SMAG	E+E-	1/76*	
M1 L	7 3283.	10.	TANENBAUM	75 SMAG	E+E-	1/76*	
M1 L W	7 3258.	7.	WIIK	75 DASP	E+E-	1/76*	
M1 L W	2(3351.)	(8.)	WIIK	75 DASP	E+E-	1/76*	
M1	. . . .						
M1	AVG 3267.2	7.3	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)				
M1	STUDENT3267.0	6.2	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT				
M2 H	HIGH MASS SOLUTION						
M2 H W	4(3520.)	(50.)	DASP3	75 DASP	E+E-	1/76*	
M2 H	40 3500.	10.	TANENBAUM	75 SMAG	E+E-	1/76*	
M2 H	7 3504.	8.	TANENBAUM	75 SMAG	E+E-	1/76*	
M2 H W	7 3507.	7.	WIIK	75 DASP	E+E-	1/76*	
M2 H W	2(3407.)	(8.)	WIIK	75 DASP	E+E-	1/76*	
M2 H W	WIIK 75 SUPERSEDES DASP3 75, WITH 3 ADDITIONAL EVENTS FOR THE PC,						
M2 H W	AND 2 EVENTS INDICATING POSSIBLE EXISTENCE OF A PC PRIME.						
M2	. . . .						
M2	AVG 3504.5	4.7	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)				
M2	STUDENT3504.5	5.0	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT				

55 PC PARTIAL DECAY MODES

DECAY MASSES

P1 PC INTO J/PSI(3100) GAMMA
P2 PC INTO PI+ PI-
P3 PC INTO K+ K-
P4 PC INTO GAMMA GAMMA

55 PC BRANCHING RATIOS

R1	PC INTO (J/PSI(3100) GAMMA)/TOTAL					
R1 D	DOMINANT	DASP3	75 DASP	E+E-	1/76*	
R1 D	USING THE UPPER LIMITS OF SIMPSON 75					
R2	PC INTO (PI+PI- OR K+K-)/TOTAL					
R2 F	NOT SEEN	FELDMAN1	75 SMAG	E+E-	1/76*	
R2 F	SEE BRANCHING RATIO R56 OF PSI(3700).					
R3	PC INTO (GAMMA GAMMA)/TOTAL					
R3	(.0032)OR LESS CL=.90	WIIK	75 DASP	E+E-	1/76*	

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REFERENCES FOR PC

DASP3	75 PL 57B 407	BRAUNSCHWEIG,KONIGS,+	(AACH+DESY+MPIM+TOKY)	V55
FELDMAN1	75 STANFORD SYMP.	G.J.FELDMAN	(SLAC)	V55
HEINTZE	75 STANFORD SYMP.	J.HEINTZE	(HEIDELBERG)	V55
SIMPSON	75 PRL 35 699	+BERON,FORD,HILGER,HOFSTADTER,+	(STAN+PENN)	V55
TANENBAU	75 PRL 35 1323	TANENBAUM,WHITAKER,ABRAMS,+	(LBL+SLAC)	V55
WIIK	75 STANFORD SYMP.	B.H.WIIK	(DESY)	V55

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χ(3410)

56 CHI(3410,JPG=) I=

OBSERVED IN THE RADIATIVE DECAY OF PSI(3700) INTO CHI(3410) GAMMA (FELDMAN 75), THEREFORE C=+. THE OBSERVED DECAY INTO (PI+PI-) OR(K+K-) IMPLIES G=+, JP=0+,2+,... . CONFIRMATION OF BOTH (PI+PI-) AND (K+K-) MODES WOULD ESTABLISH I=0.
NEEDS CLARIFICATION (SEE THE MINIREVIEW ON STATES OBSERVED IN RADIATIVE DECAYS OF PSI(3700). OMITTED FROM TABLE.

56 CHI(3410) MASS (MEV)

M	11 3400.	10.	FELDMAN	75 SMAG	E+E-	1/76*
M	50 3410.	10.	FELDMAN	75 SMAG	E+E-	1/76*
M	. . . .					
M	AVG 3405.0	7.1	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)			
M	STUDENT3405.0	7.8	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT			

56 CHI(3410) PARTIAL DECAY MODES

DECAY MASSES

P1 CHI(3410) INTO PI+ PI-
P2 CHI(3410) INTO K+ K-
P3 CHI(3410) INTO 2(PI+ PI-)
P4 CHI(3410) INTO 3(PI+ PI-)
P5 CHI(3410) INTO PI+ PI- K+ K-
P6 CHI(3410) INTO J/PSI(3100) GAMMA

56 CHI(3410) BRANCHING RATIOS

R SEE BRANCHING RATIOS R54 OF PSI(3700)

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REFERENCES FOR CHI(3410)

FELDMAN	75 PRL 35 821	+JEAN-MARIE,SADOULET,VANNUCCI,+	(LBL+SLAC)	V56
ALSO	75 PRL 35 1189	(ERRATA)		
TANENBAU	75 PRL 35 1323	TANENBAUM,WHITAKER,ABRAMS,+	(LBL+SLAC)	V56

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χ(3530)

57 CHI(3530,JPG=) I=

OBSERVED IN RADIATIVE DECAY OF PSI(3700) INTO CHI(3530) GAMMA (FELDMAN 75), THEREFORE C=+. CAN BE INTERPRETED AS A SINGLE (BROAD) STATE, OR AS A SUPERPOSITION OF SEVERAL NARROW STATES.
NEEDS CLARIFICATION (SEE THE MINIREVIEW ON STATES OBSERVED IN RADIATIVE DECAYS OF PSI(3700). OMITTED FROM TABLE.

57 CHI(3530) MASS (MEV)

M	60 3530.	20.	FELDMAN	75 SMAG	E+E-	1/76*

57 CHI(3530) PARTIAL DECAY MODES

DECAY MASSES

P1 CHI(3530) INTO PI+ PI-
P2 CHI(3530) INTO K+ K-
P3 CHI(3530) INTO 2(PI+ PI-)
P4 CHI(3530) INTO 3(PI+ PI-)
P5 CHI(3530) INTO PI+ PI- K+ K-
P6 CHI(3530) INTO J/PSI(3100) GAMMA

57 CHI(3530) BRANCHING RATIOS

R SEE BRANCHING RATIOS R55 OF PSI(3700)

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REFERENCES FOR CHI(3530)

FELDMAN	75 PRL 35 821	+JEAN-MARIE,SADOULET,VANNUCCI,+	(LBL+SLAC)	V57
ALSO	75 PRL 35 1189	(ERRATA)		
TANENBAU	75 PRL 35 1323	TANENBAUM,WHITAKER,ABRAMS,+	(LBL+SLAC)	V57

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Data Card Listings

For notation, see key at front of Listings.

Baryons

N's and Δ's

Note on N's and Δ's

I. Determination of Resonance Parameters

Values of masses, widths, and branching ratios are obtained mainly from phase-shift analyses. In production experiments, in fact, it is seldom clear which of the many states at similar masses is being observed. In addition to a few complete phase-shift analyses, we have other analyses, done by using somewhat incomplete data, by various different groups, but we are quite far from having reliable masses and widths derived therefrom.

There are essentially two problems in obtaining reliable resonance parameters. First there is often disagreement as to just what the values of the partial-wave amplitudes are. This problem is obviously related to the quality and quantity of the data and to the procedures used to determine the amplitudes. Secondly, even if smooth curves were available for the amplitudes, there would still be some parametrization-dependent ambiguity in deciding what the resonance parameters should be. From a theoretical standpoint the most unambiguously defined resonance parameters are the pole position and residue, and it has been found in practice that, given sufficiently precise partial-wave amplitudes, these quantities can be extracted in a stable and parametrization-independent way, in spite of the fact that they require an extrapolation away from the physical region. This point has been discussed in detail with regard to the Δ(1232) in previous editions of this review[1,2]. We list available pole parameter determinations in the Data Card Listings, and many further discussions can be found in the corresponding references, e.g., NOGOVA 73, SPEARMAN 74, BALL 75, LICHTENBERG 75, LONGACRE 75, and VASAN 75.

At the beginning of the Data Card Listings for N's and Δ's, we present a table giving our evaluation of the N and Δ resonances based on information contained in the Listings. In the Table of Particle Properties, we do not quote values and errors for most parameters, but give only ranges for masses and widths in order to emphasize that in some cases these parameters are quite poorly determined.

References for Section I

1. Particle Data Group, Rev. Mod. Phys. 43, S114 (1971).
2. Particle Data Group, Phys. Lett. 39B, 103 (1972).

For other references see the Data Card Listings.

II. $\pi N \to \pi N, \eta N, K\Sigma, K\Lambda$

The most recent available $\pi N \to \pi N$ amplitudes are from the analysis of the Saclay group, AYED 74. Preliminary results of more recent analyses have been discussed at meetings[1,2], but resonance parameters are not yet available. The results of AYED 74 are shown in Figs. II.1-II.6. The figure captions summarize the known resonances in the various partial waves. We restrict our discussion here to mentioning the possible new effects seen in recent analyses. All resonance parameters quoted under AYED 74 derive from energy-dependent fits (Breit-Wigner with background) to the partial-wave amplitudes which were determined in an energy-independent shortest-path analysis.

S''_{31}: In Fig. II.1, the energy-dependent fit of AYED 74 suggests that the broad structure around 2000 MeV is associated with a second resonance with

$$M = 2001 \text{ MeV}, \ \Gamma_{tot} = 307 \text{ MeV}, \ x_{el} = 0.08 \ .$$

There is some additional evidence for such an effect from LANGBEIN 73 and DEANS 75, which are energy-independent and energy-dependent analyses, respectively, of $K\Sigma$ associated production.

P''_{33}: The small dip in the imaginary part of P_{33} and the zero in the real part around 1900 MeV are interpreted in the energy-dependent fit of AYED 74 as a second P_{33} resonance,

$$M = 1904 \text{ MeV}, \ \Gamma_{tot} = 204 \text{ MeV}, \ x_{el} = 0.19$$

ALMEHED 72 found two effects, one at ∿1680 MeV and another at ∿2150 MeV, as did DEANS 75. However, LANGBEIN 73 found evidence for the higher mass effect only. The existence of some sort of effect at ∿2200 MeV seems definitely established

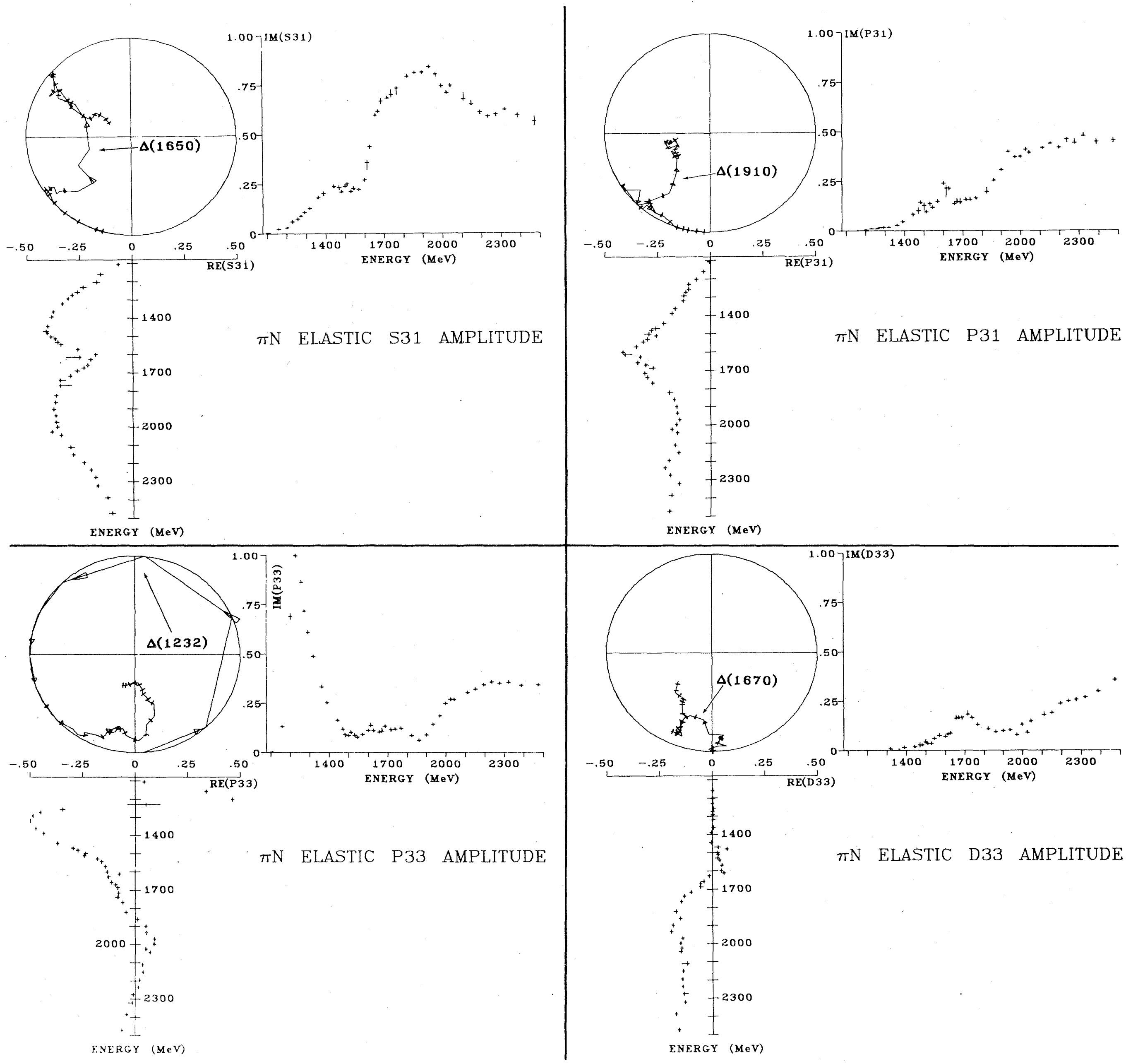

Fig. II.1. Amplitudes for I = 3/2 πN elastic scattering in the J = 1/2 and J = 3/2 waves from AYED 74. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts vs. energy, in alignment with the corresponding Argand plot. In addition, arrows are plotted on the Argand plots with bases positioned at integer multiples of 50 MeV and a base-to-tip length of 5 MeV. All the energy axes run from elastic threshold to 2500 MeV. Established resonances in these waves are the Δ(1650), Δ(1910), Δ(1232), and Δ(1670) in the S_{31}, P_{31}, P_{33}, and D_{33} waves, respectively; these are indicated on the above Argand plots. See the Data Card Listings and the accompanying mini-review for other possible resonances in the S_{31} and P_{33} waves.

Data Card Listings

For notation, see key at front of Listings.

Baryons

N's and Δ's

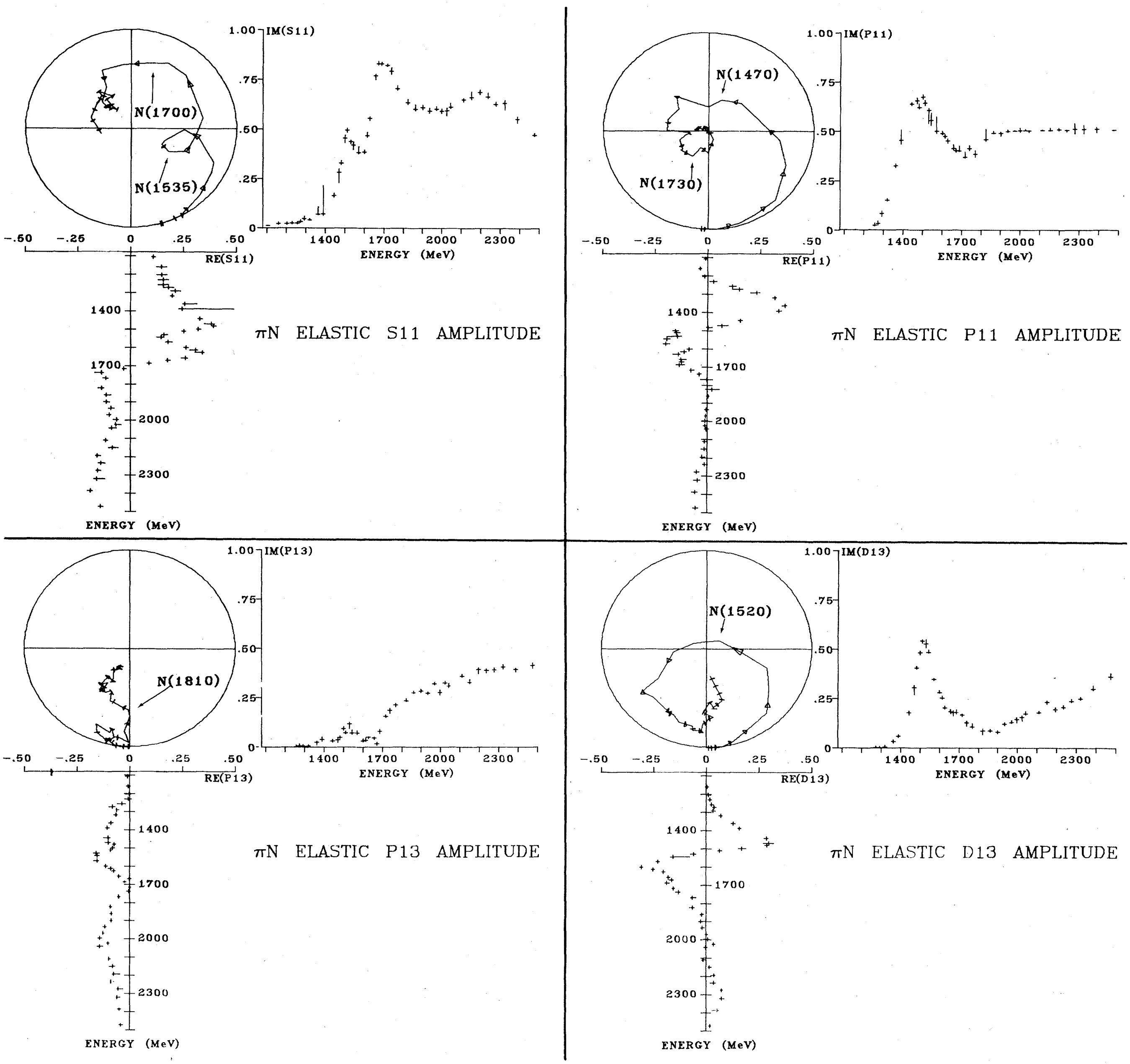

Fig. II.2. Amplitudes for I = 1/2 πN elastic scattering in the J = 1/2 and J = 3/2 waves from AYED 74. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts vs. energy, in alignment with the corresponding Argand plot. In addition, arrows are plotted on the Argand plots with bases positioned at integer multiples of 50 MeV and a base-to-tip length of 5 MeV. All the energy axes run from elastic threshold to 2500 MeV. Established resonances in these waves are the N(1535) and N(1700) in the S_{11} wave, the N(1470) and N(1780) in the P_{11} wave, the N(1810) in the P_{13} wave, and the N(1520) in the D_{13} wave; these are indicated on the above Argand plots. The P_{11} wave also contains the nucleon pole, 138 MeV below threshold. See the Data Card Listings and the accompanying mini-review for other possible resonances in these waves.

Baryons
N's and Δ's

Data Card Listings
For notation, see key at front of Listings.

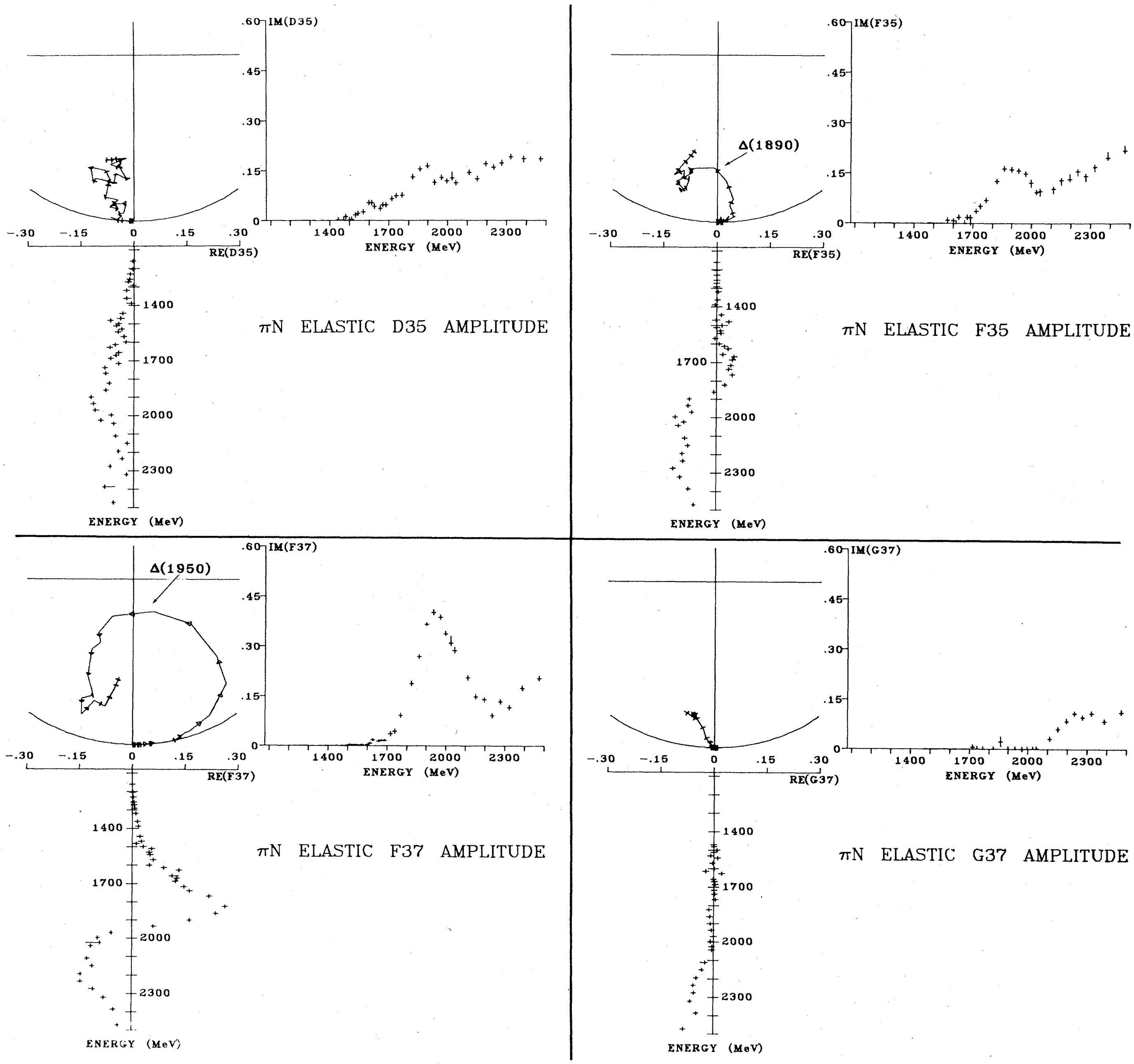

Fig. II.3. Amplitudes for I = 3/2 πN elastic scattering in the J = 5/2 and J = 7/2 waves from AYED 74. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts vs. energy, in alignment with the corresponding Argand plot. In addition, arrows are plotted on the Argand plots with bases positioned at integer multiples of 50 MeV and a base-to-tip length of 5 Mev. All the energy axes run from elastic threshold to 2500 MeV. Established resonances in these waves are the Δ(1890) and Δ(1950) in the F_{35} and F_{37} waves, respectively; these are indicated on the above Argand plots. See the Data Card Listings and the accompanying mini-review for another possible resonance in the D_{35} wave.

Data Card Listings

For notation, see key at front of Listings.

Baryons

N's and Δ's

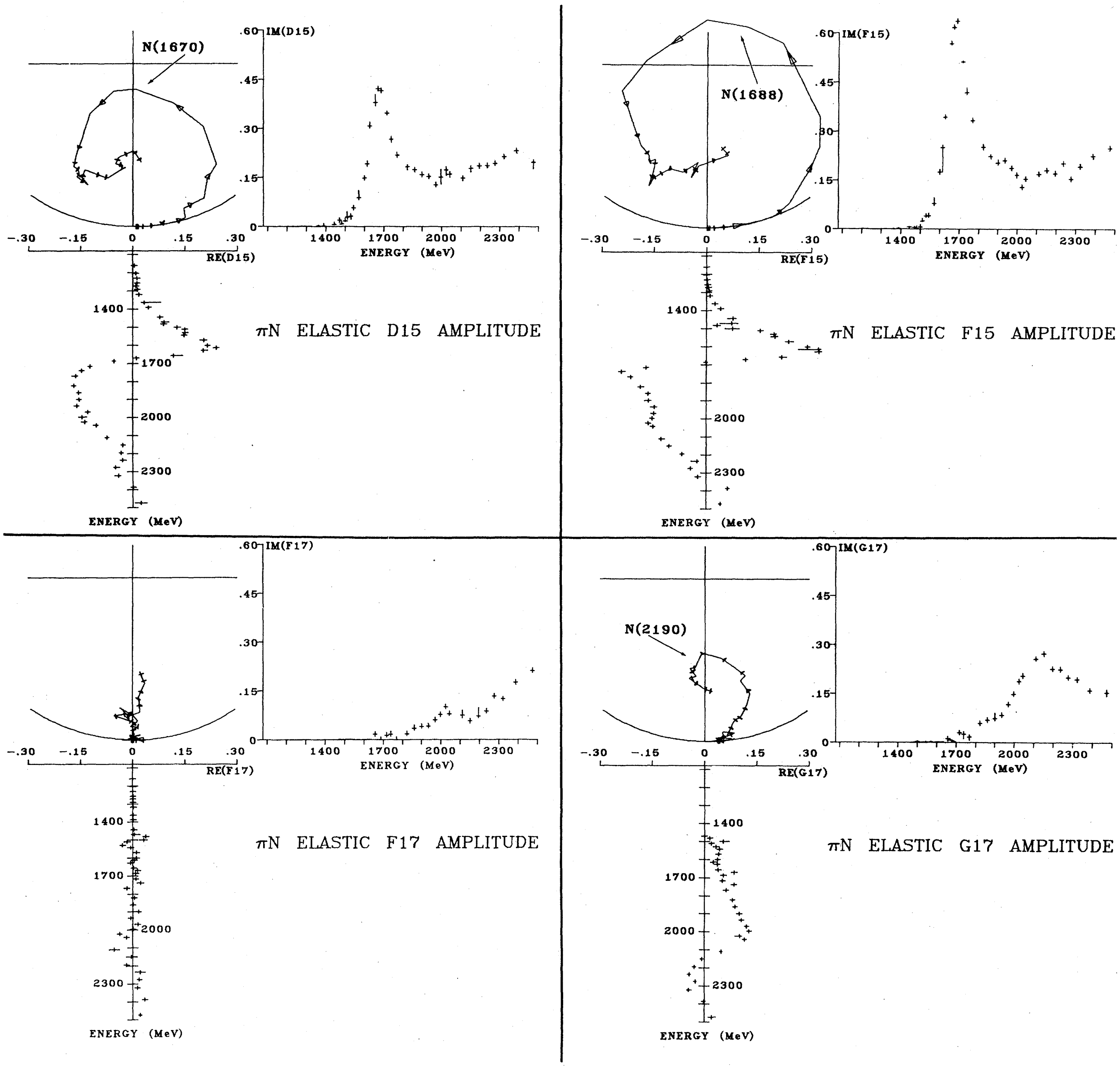

Fig. II.4. Amplitudes for I = 1/2 πN elastic scattering in the J = 5/2 and J = 7/2 waves from AYED 74. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts vs. energy, in alignment with the corresponding Argand plot. In addition, arrows are plotted on the Argand plots with bases positioned at integer multiples of 50 MeV and a base-to-tip length of 5 MeV. All the energy axes run from elastic threshold to 2500 MeV. Established resonances in these waves are the N(1670), N(1688), and N(2190) in the D_{15}, F_{15}, and G_{17} waves, respectively; these are indicated on the above Argand plots. See the Data Card Listings and the accompanying mini-review for other possible resonances in the D_{15}, F_{15}, and F_{17} waves.

Baryons

N's and Δ's

Data Card Listings

For notation, see key at front of Listings.

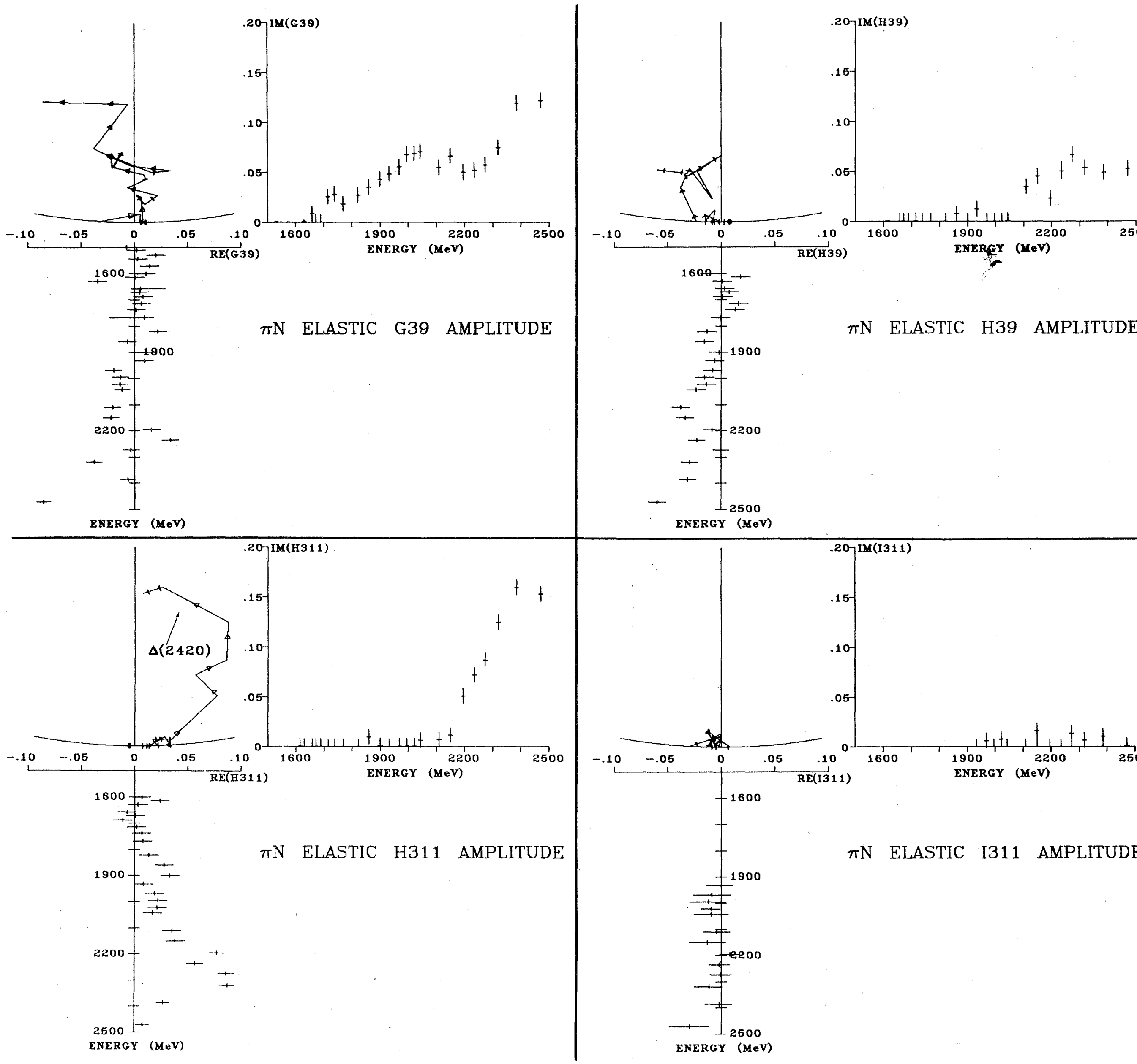

Fig. II.5. Amplitudes for I = 3/2 πN elastic scattering in the J = 9/2 and J = 11/2 waves from AYED 74. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts vs. energy, in alignment with the corresponding Argand plot. In addition, arrows are plotted on the Argand plots with bases positioned at integer multiples of 50 MeV and a base-to-tip length of 5 MeV. All energy axes run from 1500 to 2500 MeV. The only established resonance in these waves is the Δ(2420) in the $H_{3\ 11}$ wave; it is indicated on the above $H_{3\ 11}$ Argand plot. See the Data Card Listings and the accompanying mini-review for another possible resonance in the G_{39} wave.

Data Card Listings

For notation, see key at front of Listings.

Baryons

N's and Δ's

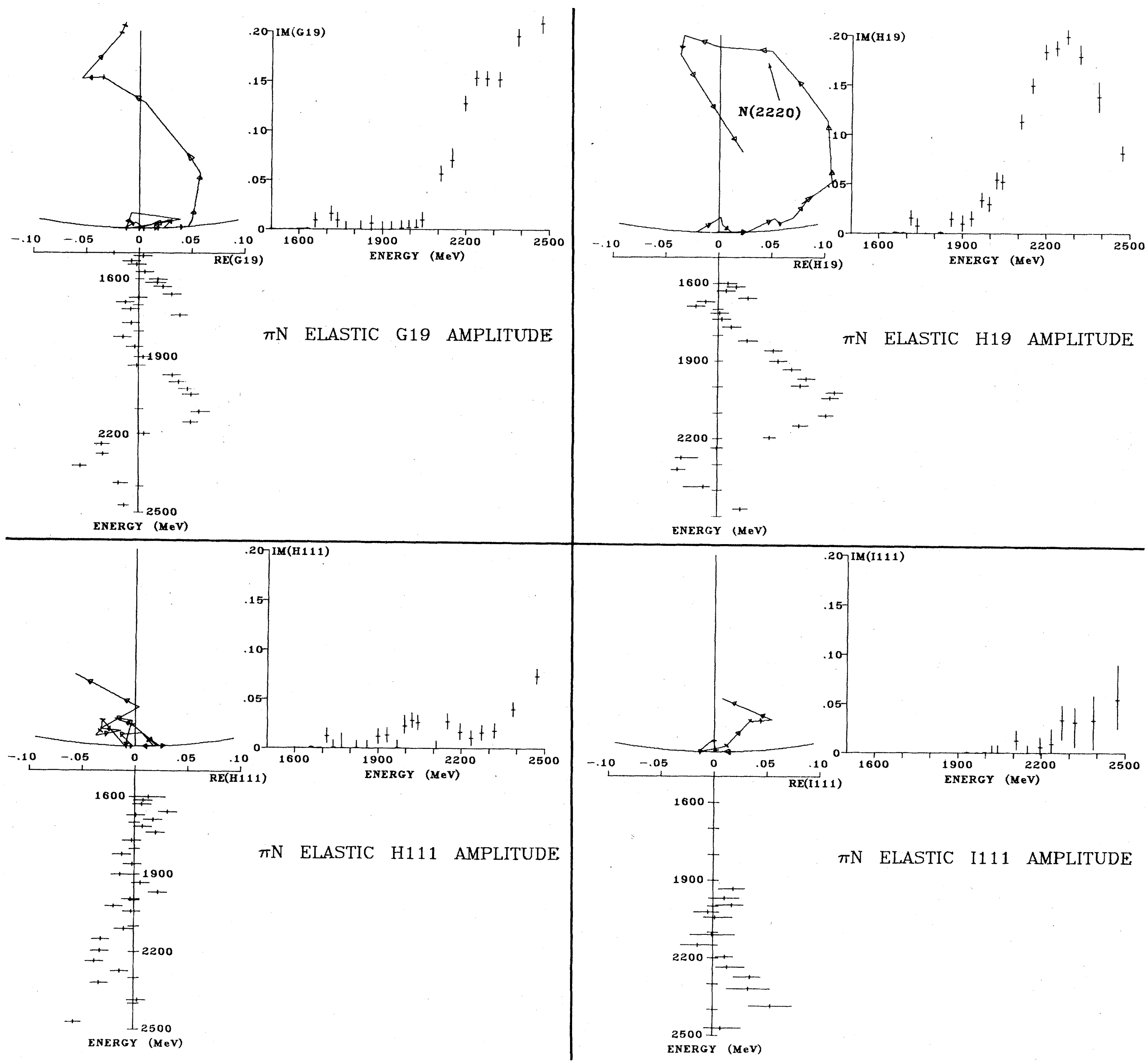

Fig. II.6. Amplitudes for I = 1/2 πN elastic scattering in the J = 9/2 and J = 11/2 waves from AYED 74. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts vs. energy, in alignment with the corresponding Argand plot. In addition, arrows are plotted on the Argand plots with bases positioned at integer multiples of 50 MeV and a base-to-tip length of 5 MeV. All the energy axes run from 1500 to 2500 MeV. The only established resonance in these waves is the N(2220) in the H_{19} wave; it is indicated on the above H_{19} Argand plot. See the Data Card Listings and the accompanying mini-review for another possible resonance in the G_{19} wave.

by the backward π^+p scattering experiment of REY 74, but the quantum numbers are not yet established [see the Listings for Δ(2160)].

$\underline{P_{31}}$: The P_{31} resonance mass quoted by AYED 74 (M = 1786 MeV) is considerably lower than in previous analyses (except AYED 70) which find M in the region 1900 to 1950 MeV.

$\underline{D_{35}}$: AYED 74, LANGBEIN 73, and DEANS 75 all find evidence for a D_{35} state somewhere in the mass range 1900-2000 MeV, ALMEHED 72 found an effect at 2200 MeV, but with such a large width, 600 MeV, that a resonance interpretation is questionable.

$\underline{S_{11}'''}$: In Fig. II.2 are shown the low spin I = 1/2 waves of AYED 74. They associate the broad effect at ∿2300 MeV with a third S_{11} resonance:

$$M = 2283 \text{ MeV}, \ \Gamma_{tot} = 310 \text{ MeV}, \ x_{el} = 0.14 \quad .$$

ALMEHED 72 find a similar effect at 2100 MeV.

$\underline{P_{11}'}$: AYED 74 claim the "Roper" to be split:

$$M_{low} = 1413 \text{ MeV}, \ \Gamma_{tot} = 187 \text{ MeV}, \ x_{el} = 0.55 \ ;$$

$$M_{high} = 1532 \text{ MeV}, \ \Gamma_{tot} = 89 \text{ MeV}, \ x_{el} = 0.12 \quad .$$

While such a splitting might be a natural explanation for the relatively low mass and broad width of the "Roper" as seen in production experiments, the evidence in Fig. II.2, especially the projections, seems only tentative. The new Saclay ηn data and partial-wave analysis of FELTESSE 75 are not inconsistent with the parameters of the high mass state. However, an equally acceptable fit to their data is obtained by introducing a new P_{13} resonance with M = 1530 MeV, Γ = 79 MeV, and $\sqrt{xx'}$ = 0.33.

$\underline{D_{13}''}$: A somewhat larger effect in this wave at ∿1700 MeV is identified by AYED 74 as a second D_{13} resonance:

$$M = 1710 \text{ MeV}, \ \Gamma_{tot} = 100 \text{ MeV}, \ x_{el} = 0.09 \quad .$$

The projections reveal a shoulder in the imaginary part and a small dip in the real part. A similar effect exists in ALMEHED 72, but was not claimed as a resonance. Further evidence for this state is found by LANGBEIN 73, DEANS 75, and KNASEL 75 (KΛ associated production), as well as recent pion photoproduction analyses and the LBL-SLAC ππN analysis (see III and IV below).

$\underline{D_{13}'''}$: Along with ALMEHED 72, AYED 74 find evidence for a D_{13} state at ∿2000 MeV:

$$M = 2029 \text{ MeV}, \ \Gamma_{tot} = 116 \text{ MeV}, \ x_{el} = 0.10 \quad .$$

The evidence in the projections seems less than for the effect at 1700 MeV. Evidence for coupling of this state to the KΣ channel is found by DEANS 75, but not by LANGBEIN 73.

$\underline{D_{15}''}$: The rapid decrease in the real part of this amplitude around 2100 MeV (see Fig. II.4) is associated with a second D_{15} resonance by AYED 74:

$$M = 2100 \text{ MeV}, \ \Gamma_{tot} = 220 \text{ MeV}, \ x_{el} = 0.08 \quad .$$

These parameters are in reasonable agreement with those of ALMEHED 72.

$\underline{F_{15}''}$: The broad shoulder in the real part and dip in the imaginary part are identified with a second F_{15} resonance by AYED 74:

$$M = 1989 \text{ MeV}, \ \Gamma_{tot} = 179 \text{ MeV}, \ x_{el} = 0.08 \quad .$$

ALMEHED 72 find an effect at ∿2200 MeV, and LANGBEIN 73 and DEANS 75 find some evidence for coupling to the KΣ channel at ∿2000 MeV.

Higher Waves. Besides confirming the already accepted $H_{3,11}$ and H_{19}, AYED 74 present evidence for two additional states in the 2200 MeV region:

$$G_{39}: \ M = 2174 \text{ MeV}, \ \Gamma_{tot} = 205 \text{ MeV}, \ x_{el} = 0.04 \ ;$$

$$G_{19}: \ M = 2133 \text{ MeV}, \ \Gamma_{tot} = 193 \text{ MeV}, \ x_{el} = 0.10 \ .$$

The G_{39} effect in Fig. II.5 is not too convincing. Notice that ALMEHED 72 claimed a P_{33} resonance in this same region; see Δ(2160) for further possibilities in this mass region. In contrast, the evidence for G_{19}, Fig. II.6, looks quite good; note, in particular, the behavior of the real part projection in the region 1900-2500 MeV.

References for Section II

1. R. L. Kelly, in New Directions in Hadron Spectroscopy (ANL-HEP-CP-75-58), eds. S. L. Kramer and E. L. Berger, 1975.
2. E. Pietarinen, Universität Karlsruhe Reports TKP 4/75 and TKP 15/75.

For other references see the Data Card Listings.

III. The $N\pi\pi$ Channel

In the isobar model, the amplitude for the reaction $\pi N \rightarrow N\pi\pi$ is written

$$T = \sum \left\{ T^{JILL'}_{\Delta\pi}(E)\, BW_{\Delta}(E_{\pi N})\, X^{JILL'}_{\Delta\pi} + T^{JILL'}_{\rho N}(E)\, BW_{\rho}(E_{\pi\pi})\, X^{JILL'}_{\rho N} + T^{JILL'}_{\varepsilon N}(E)\, BW_{\varepsilon}(E_{\pi\pi})\, X^{JILL'}_{\varepsilon N} \right\} .$$

In this expression the BW's denote either appropriate Breit-Wigner's or the corresponding two-body amplitude. The functions X contain all the angular information; these are well-defined functions depending only on which isobars are used in the model. The partial-wave amplitudes, $T^{JILL'}_{\Delta\pi}$, etc., may be indicated by

$$\Delta\pi, LL'_{2I2J} \qquad \rho N, LL'_{2I2J} \qquad \varepsilon N, LL'_{2I2J}$$

where L is the incoming (πN) angular momentum, and L' is the outgoing angular momentum between the isobar $[\rho, \varepsilon (=\pi\pi\ I = 0,\ S\ \text{wave}), \Delta]$ and the remaining hadron (N or π); as usual I and J are the isospin and total spin ($\vec{J} = \vec{L} + \vec{S} = \vec{L}' + \vec{S}'$), respectively. Often the ρ has a subscript 1 or 3 which denotes twice the ρN total spin. The generalization of the model to include more two-body final-state interactions is obvious, but only the three included above, Δ, ρ, and ε, have actually been used in presently published analyses. It should be noted that one assumes the partial-wave amplitudes depend only on the c.m. energy E and not on the diparticle subenergies, $E_{\pi\pi}$ and $E_{\pi N}$.

The largest isobar analysis to date is that of the LBL-SLAC collaboration, LONGACRE 75 and Ref. 1, which analyzes 200K events of $\pi^- p \rightarrow \pi^-\pi^0 p$, $\pi^+\pi^- n$ and $\pi^+ p \rightarrow \pi^+\pi^0 p$, $\pi^+\pi^+ n$ in the c.m. energy range 1300-2000 MeV. Details of this analysis, particularly the evolution of the preferred solution B, have been discussed in the previous edition of this review[2]. Results from this solution are shown in Fig. III.1. In this edition we list resonance parameters, including pole positions, from LONGACRE 75 in the Data Card Listings. Breit-Wigner masses, widths, and resonance couplings were extracted in two ways by LONGACRE 75, and we list the results of both methods, in addition to the pole positions. Method 1 used Breit-Wigner fitting to individual partial waves, and method 2 used a coupled-channel K-matrix fit to all waves with the same IJP. Among the most interesting results are further evidence for the existence of the $D_{13}(1700)$ and the $P_{33}(1690)$, further evidence for dominantly F-wave decay of the $F_{37}(1950)$ into $\Delta\pi$, and good agreement with quark-model predictions[3].

Some information on isobar couplings is also available from earlier analysis. CHAVANON 74[4] analyzed $\pi^+ p \rightarrow \pi^+\pi^0 p$ in the range 1580-1970 MeV and obtained information on Δ-resonance decays to $\Delta\pi$ and $N\rho$. MEHTANI 72 analyzed the $\Delta\pi$ channel in the region 1820-2090 MeV and found the first evidence for strong F-wave decay of the $F_{37}(1950)$. The analysis of DIEM 70 covered the region 1550-1650 MeV.

In connection with all of these analyses it should be kept in mind that the isobar model is really a model and is not an exact representation of the $\pi N \rightarrow \pi\pi N$ amplitude. There are a number of ways in which the model could seriously fail to represent the physical amplitude. The problem that has received the most attention recently is the assumption that the isobar partial-wave amplitudes do not depend on the diparticle sub-energies, an assumption which is inconsistent with unitarity. For discussion of this problem see Refs. 2, 5, 6, and other references quoted therein.

References for Section III

1. D. J. Herndon et al., Phys. Rev. D11, 3183 (1975).
2. Particle Data Group, Phys. Lett. 50B, No. 1 (1974).
3. R. J. Cashmore et al., Nucl. Phys. B92, 37 (1975).
4. P. Chavanon et al., Nucl. Phys. B76, 157 (1974).
5. R. Aaron et al., Phys. Rev. D12, 1984 (1975).
6. Y. Goradia and T. A. Lasinski, LBL-3626 (1975); submitted to Phys. Rev. D.

For other references see the Data Card Listings.

Baryons

N's and Δ's

Data Card Listings

For notation, see key at front of Listings.

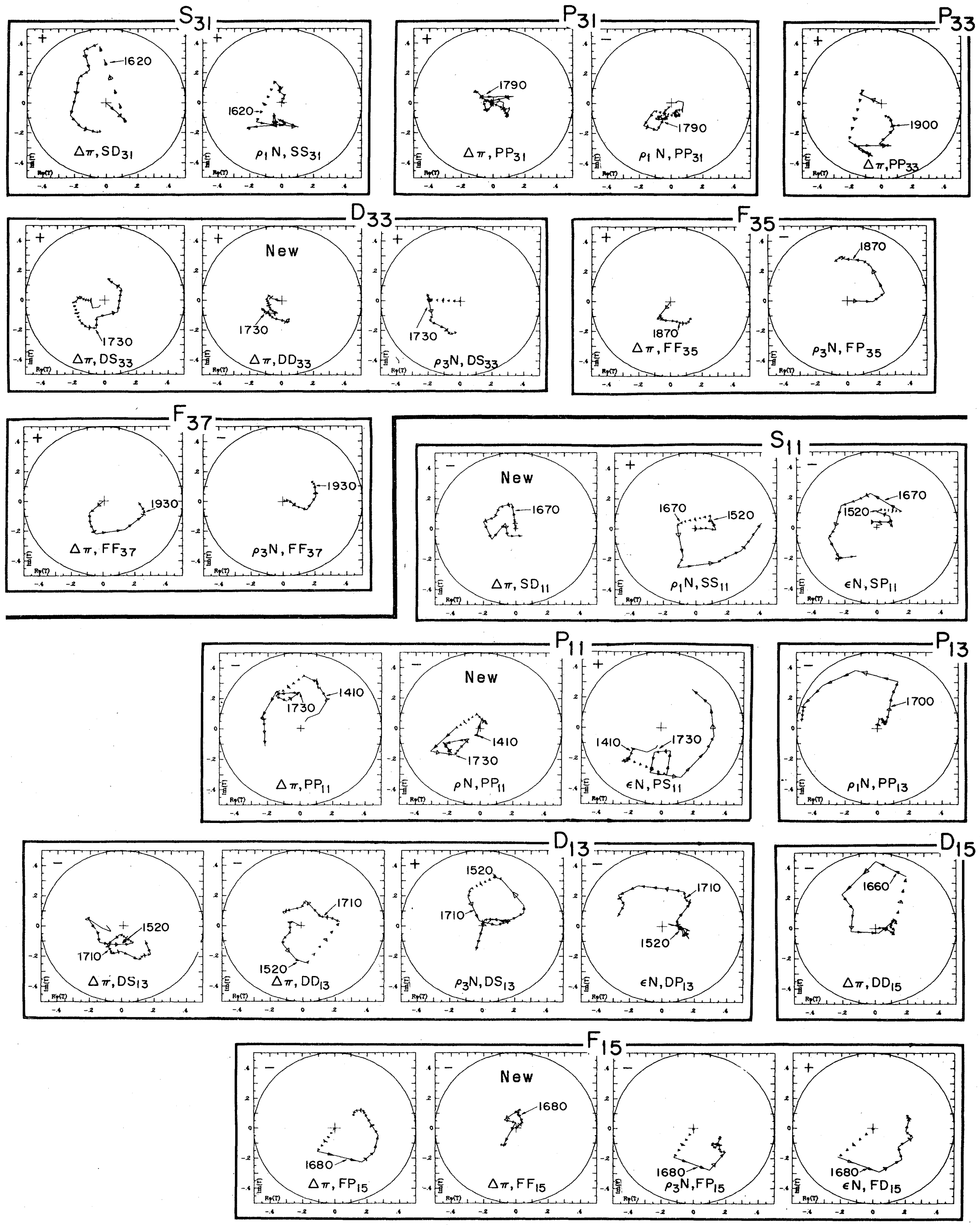

Fig. III.1. Solution B of the LBL-SLAC isobar analysis of $\pi N \to N\pi\pi$. See mini-review for notation. The four waves labeled "New" were not used in earlier solutions. The sign in the upper left-hand corner of each plot indicates how to transform from the sign conventions of this group to that of the "baryon-first" convention. (See main text, Sec. IV B.)

IV. Photon Couplings

(R. L. Crawford and R. G. Moorhouse, Glasgow Univ.)

Photon couplings can be studied in formation reactions like

$$\gamma N \to N^* \to \pi N\ ,\ \eta N\ ,\ K\Lambda\ ,\ \pi\Delta,\ \ldots.$$

A partial-wave analysis of these processes is the standard technique to determine the coupling strengths $g(N^*N\gamma)$. Up to now, almost all results are derived from the analysis of single-pion photoproduction. In the following we, therefore, define the conventions of pion photoproduction in which the results will be quoted.

The process $\gamma N \to N^* \to \pi N$ for a specific intermediate resonance can be symbolically described as

$$\langle \pi N | H_\pi | N^* \rangle \langle N^* | H_\gamma | \gamma N \rangle \quad .$$

The first term is measured in strong interactions, e.g., by partial-wave analysis of elastic πN scattering. A common feature of almost all analyses of pion photoproduction is a strong reliance on the knowledge of resonance parameters from πN partial-wave analyses. Pion photoproduction does not give a particularly accurate method of determining the resonance masses and widths, due partly to a lack of sufficiently precise data at many energies and partly because photoproduction is complicated by the fact that the photon has helicity states ±1 and can react as an isoscalar and isovector particle. Consequently, several couplings for $N^* \to \gamma N$ have to be determined (2 for Δ and 4 for N).

Isospin Decomposition. Ignoring possible isotensor components, the reactions leading to the four possible final charge states are described by three isospin amplitudes. One set of these consists of the amplitudes A^Δ, A^p, and A^n which are respectively the amplitudes for the reaction to proceed by an I = 3/2 state, an I = 1/2 state with charge = +1, and an I = 1/2 state with charge = 0:

$$\begin{aligned} A(\gamma p \to \pi N) &= C^{3/2}_{\pi N} A^\Delta + C^{1/2}_{\pi N} A^p \quad , \\ A(\gamma n \to \pi N) &= C^{3/2}_{\pi N} A^\Delta + C^{1/2}_{\pi N} A^n \quad . \end{aligned} \tag{1}$$

The C-G coefficients, $C^I_{\pi N}$, for the coupling to a specific πN state are given explicitly by

$$\begin{aligned} A(\gamma p \to \pi^+ n) &= -\sqrt{1/3}\ A^\Delta - \sqrt{2/3}\ A^p \quad , \\ A(\gamma p \to \pi^0 p) &= \sqrt{2/3}\ A^\Delta - \sqrt{1/3}\ A^p \quad , \\ A(\gamma n \to \pi^- p) &= \sqrt{1/3}\ A^\Delta - \sqrt{2/3}\ A^n \quad , \\ A(\gamma n \to \pi^0 n) &= \sqrt{2/3}\ A^\Delta + \sqrt{1/3}\ A^n \quad . \end{aligned} \tag{2}$$

Walker's[1] amplitudes, A^{V3}, A^{V1}, and A^S for the production of an isospin eigenstate by the isovector and isoscalar parts of the electromagnetic current and the corresponding CGLN[2] amplitudes $A^{(3)}$, $A^{(1)}$, and $A^{(0)}$ are given by

$$\begin{aligned} A^{V3} &= A^\Delta = \sqrt{3}\ A^{(3)} \quad , \\ A^{V1} &= 1/2(A^n - A^p) = \sqrt{1/3}\ A^{(1)} \quad , \\ A^S &= 1/2(A^n + A^p) = \sqrt{2/3}\ A^{(0)} \quad . \end{aligned} \tag{3}$$

Resonance Couplings. Since we are interested in intermediate resonances, we can approximate the energy dependence of the photoproduction partial waves by a Breit-Wigner form with added background. Using the helicity and parity eigenstates,[3] $C^{\ell\pm}_\lambda(W)$, this gives

$$C^{\ell\pm}_\lambda(W) = \varepsilon \left\{ \frac{\Gamma^\lambda(N^* \to \gamma N)\,\Gamma(N^* \to \pi N)}{kq} \right\}^{1/2} \frac{W}{W^2 - m_R^2 - iW\Gamma} + \text{background} \tag{4}$$

where ε is the sign of the amplitude and k, q are the c.m. momenta of the initial, final states. The resonance energy is m_R and Γ is its total width. In the following discussion of resonance couplings, we use the notation $\tilde{A}$ for the imaginary part of the resonance coupling to an amplitude A(W) evaluated at resonance ($W = m_R$). Thus

$$\tilde{C}^{\ell\pm}_\lambda = \varepsilon \left\{ \frac{\Gamma^\lambda_\gamma \Gamma_\pi}{kq\Gamma^2} \right\}^{1/2} \tag{5}$$

A dominant feature in pion photoproduction is the Born approximation which contains the nucleon pole in the s- and u-channels and the pion pole in the t-channel. It reproduces, for example, the experimentally observed forward peak in charged-pion photoproduction. In partial-wave analyses, the sign factor ε is well determined relative to the Born terms.

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Introducing helicity amplitudes $A_\lambda^{j^P}$ for the decay $N^*(j^P) \to (\gamma N)_\lambda$, where j^P labels the spin and parity of the N^*, we can calculate the radiative width[4], Γ_γ^λ,

$$\Gamma_\gamma^\lambda = \frac{k^2}{\pi}\frac{m_N}{m_R}\frac{1}{2j+1}\left(\tilde{A}_\lambda^{j^P}\right)^2 \quad , \tag{6}$$

where m_N is the nucleon mass. Introducing this expression into Eq. (5) we find

$$\tilde{C}_\lambda^{\ell\pm} = \left\{\frac{1}{(2j+1)\pi}\;\frac{k}{q}\frac{m_N}{m_R}\frac{\Gamma_\pi}{\Gamma^2}\right\}^{1/2} \tilde{A}_\lambda^{j^P} \quad . \tag{7}$$

We quote the results of partial-wave analyses in terms of the amplitudes $\tilde{A}_\lambda^{j^P}$ in units of $GeV^{-1/2}$.

The total radiative width Γ_γ and the corresponding contribution $\sigma_T^{j^P}$ of the partial waves $C_\lambda^{\ell\pm}$ to the total cross section are given by

$$\Gamma_\gamma = \sum_{\lambda=-3/2}^{3/2}\Gamma_\gamma^\lambda = \frac{k^2}{\pi}\frac{m_N}{m_R}\frac{2}{2j+1}\left\{\left(\tilde{A}_{1/2}^{j^P}\right)^2 + \left(\tilde{A}_{3/2}^{j^P}\right)^2\right\}, \tag{8}$$

$$\sigma_T^{j^P} = 2\left(C_{\pi N}^I\right)^2 \frac{m_N}{m_R}\frac{\Gamma_\pi}{\Gamma^2}\left\{\left(\tilde{A}_{1/2}^{j^P}\right)^2 + \left(\tilde{A}_{3/2}^{j^P}\right)^2\right\} \quad . \tag{9}$$

The Hebb-Walker amplitudes[1], $\tilde{A}_{\ell\pm}$, $\tilde{B}_{\ell\pm}$, are related to the $\tilde{A}_\lambda^{j^P}$ by

$$\tilde{A}_{\ell\pm} = \mp\left\{\frac{1}{(2j+1)\pi}\;\frac{k}{q}\frac{m_N}{m_R}\frac{\Gamma_\pi}{\Gamma^2}\right\}^{1/2} C_{\pi N}^I \tilde{A}_{1/2}^{j^P} \quad , \tag{10}$$

$$\tilde{B}_{\ell\pm} = \pm\left\{\frac{1}{(2j+1)\pi}\;\frac{k}{q}\frac{m_N}{m_R}\frac{\Gamma_\pi}{\Gamma^2}\right\}^{1/2} \times \left\{\frac{16}{(2j-1)(2j+3)}\right\}^{1/2} C_{\pi N}^I \tilde{A}_{3/2}^{j^P} \quad . \tag{11}$$

We see from (2), (4), (5) and (7) that, apart from the factor $[16/(2j-1)(2j+3)]^{1/2}$, these are just the imaginary part of the resonance part of the amplitude (2) at resonance. Consequently, they are more directly related to experiment than the $\tilde{A}_\lambda^{j^P}$, which incorporate an additional uncertainty in the partial width $\Gamma(N^* \to \pi N)$.

Methods of Partial-Wave Analysis. (a) Simple Isobar Model: In this method, the partial-wave amplitudes are formulated as in (4) (or similarly), with the resonance or resonances built partly

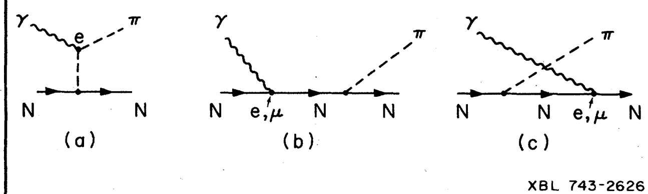

Fig. IV.1. Feynman diagrams for the Born terms in pion photoproduction. The couplings of the photon to the pion and nucleon are indicated by an e to represent a coupling via charge and by a μ for a coupling via anomalous magnetic moment.

using knowledge of m_R, Γ, and $\Gamma(N^* \to \pi N)$ from πN elastic partial-wave analysis. The parametrization of the background is generally author-dependent, as is the detailed form of the resonance term, but the background is generally assumed to vary more slowly than the resonances. When the partial waves of Eq. (4) have been summed to form the angular-dependent helicity amplitudes, the Born amplitudes given by the Feynman diagrams of Fig. IV.1 must be added. [Alternatively, these Born amplitudes may previously have been projected into partial waves and included in the background terms of Eq. (4).]

As indicated in Fig. IV.1, the photon couples to the nucleon through both the electric charge, e, and the anomalous magnetic moment, μ. The minimum gauge invariant form, which includes the pion pole, is given by the pion pole plus the nucleon pole terms with the electric charge interaction only. Generally, only these terms, which we can refer to as the electric Born terms, are included explicitly because they reproduce the forward peak in charged-pion production. The magnetic terms can be assumed to be included in the real parts of the background and resonance terms in Eq. (4). However, this certainly raises problems of principle since some of the electric Born terms might also be subsumed in the background and resonances.

The best values of the resonance couplings, $\Gamma(N^* \to \pi N)$, and background parameters are found as those which give minimum χ^2 for all data within the energy range, in the usual manner for DPWA.

(b) Fixed-t Dispersion Relations (FTDR): The difficulties of principle with the Born approximation in the simple isobar model are among the reasons which have led to the use of FTDR:

$$\mathrm{Re}A_i^{(\pm,0)}(s,t) = B_i^{(\pm,0)}(s,t) + \frac{1}{\pi} P\int_{(m_N+m_\pi)^2}^{\infty} ds' \times \left\{ \frac{\mathrm{Im}A_i^{(\pm,0)}(s',t)}{s'-s} + \xi_i \frac{\mathrm{Im}A_i^{(\mp,0)}(s',t)}{s'-u} \right\} \qquad (12)$$

for the invariant amplitudes $A_i^{(\pm,0)}(s,t)$ (i=1, 2, 3, 4), where $B_i^{(\pm,0)}(s,t)$ are the Born amplitudes[5] of Fig. IV.1, $\xi_1 = \xi_2 = \xi_4 = 1$, $\xi_3 = -1$ and $\pm,0$ denote $\gamma p \to \pi^+ n$, $\gamma n \to \pi^- p$, $\gamma p \to \pi^0 p$ respectively. $A_i^{(\pm,0)}(s,t)$ can be expressed in terms of the helicity amplitudes, and vice versa, by standard formulae[5]. $B_i^{(\pm,0)}(s,t)$ includes both the electric Born and anomalous magnetic moment terms, and thus no ambiguity arises as in the simple isobar model because all the real part (including the "resonant" real part) is manufactured by the unique prescription in Eq. (12).

The $\mathrm{Im}A_i^{(\pm,0)}(s,t)$ are constructed using only the imaginary part of Eq. (4), or alternative formulae[5]. The $\mathrm{Re}A_i^{(\pm,0)}(s,t)$ are obtained from Eq. (12) and minimization of χ^2 in fitting to experimental data to find the unknown parameters of Eq. (4) as is usual in DPWA.

A second advantage of FTDR over the simple isobar model is that the imaginary parts appear to be resonance-dominated[1,5] (but not resonance-saturated), and this is not true of the real parts. The FTDR method only parametrizes the imaginary parts, and the smaller influence therein of background terms, relative to the size of the background in the real parts, is helpful. This advantage is diminished by the need, apparent from Eq. (12), to parametrize $\mathrm{Im}A_i^{(\pm,0)}(s,t)$ outside the energy region of fitting for many analyses, thus effectively adding extra parameters to describe the resulting real background in the energy region being studied. This has been treated in two recent analyses[6,7] by fitting data simultaneously in the resonance region and in the high energy (Regge) region.

Another, and in principle serious, disadvantage is that $\mathrm{Im}A_i^{(\pm,0)}(s,t)$ in Eq. (12) is required for values of t outside the physical range corresponding to s'. Formally, $\mathrm{Im}A_i^{(\pm,0)}(s',t)$ is given by the partial-wave expansion in $\cos\theta$ (θ is the production angle in the center-of-mass system), and this is the method used in practice to calculate the dispersion integrals. While the convergence of this expansion has not been proved for important parts of the unphysical region, Devenish, Lyth, and Rankin[8] have surmised on the basis of the Mandelstam representation that the method is good up to $-t \leqslant 1\ (\mathrm{GeV}/c)^2$ in $\pi^\pm$ production and to $-t \leqslant 1.5\ (\mathrm{GeV}/c)^2$ in π^0 production.

At low energies, the unitarity of the S-matrix imposes a phase condition on the partial-wave amplitudes known as Watson's theorem. It states that in the elastic region the complex phase of each $C_\lambda^{\ell\pm}(W)$ is equal to the scattering phase of the corresponding πN partial wave. This is important across the first resonance region in photoproduction since it imposes a strict phase condition on the two P_{33} partial waves and results in important non-resonant S-wave background in the imaginary parts contributing to the dispersion integrals. However, while the effects of Watson's theorem are significant in the first resonance region, the consequences in a FTDR calculation of ignoring it appear to be slight at higher energies.

The use of FTDR in pion photoproduction has a long history in the first resonance region[9] where their role was envisaged as largely predictive or synthetic. The independently motivated extension by the Berkeley[5,10,11,12], Lancaster[6,13], and Glasgow[7,14] based groups to a larger energy region has changed their role to one that is almost purely analytic.

(c) Energy-Independent Partial-Wave Analyses: Recent improvements in experimental data have allowed Berends and Donnachie[15] to extend the energy-independent analysis of pion photoproduction to beyond the second resonance region. Previous analyses[16] were restricted by the data then available to the first resonance region where Watson's theorem can be used to get a unique

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solution for the partial waves. In general, the energy-independent analyses are in good qualitative agreement with the energy-dependent analyses but there are some qualitative discrepancies. The significance of these is not yet clear.

Definitions of Resonance Parameters and Errors: From analyses which use a form like that of Eq. (4) there are reported in the Data Card Listings and Table IV.1, photonic resonance couplings which are obtained through Eq. (4) from a Breit-Wigner partial width. The FTDR method fits only the imaginary part of Eq. (4) to experimental data. The FTDR method of the Berkeley group[5,10,11,12] uses a K-matrix ansatz for the imaginary part and in these cases it is the corresponding K-matrix pole quantity that is reported. (Regretably, no authors give also partial widths corresponding to T-matrix residues.)

If no errors are assigned, the authors have given a unique result without quoting an error. The Berkeley[5,10,11,12] and Glasgow[7] analyses quote as an error the spread around a central value of a number of solutions. The Lancaster group[6,13] estimate a "real error" for each parameter of a given solution that corresponds to the change in value required to increase "the best possible χ^2" by 1%.

The variation between the central values of the various papers are generally about the same size as or greater than the quoted uncertainties in individual papers. This indicates that the systematic effects of different parametrizations and choices of experimental data are at least as important as statistical effects when estimating the uncertainty in the couplings. This is reflected in the errors given in Table IV.1.

Recent Partial-Wave Analyses: We describe only the most recent analyses by the various groups involved. A description of earlier analyses may be found in the previous edition of this Review.[3]

(a) Simple Isobar Model: The most important of these is still METCALF 74[17] which uses the methods of Walker[1] to analyze data for $\gamma p \to \pi^+ n$, $\pi^0 p$ and $\gamma n \to \pi^- p$ from the first through the fourth resonance regions. The partial waves are parametrized as in Eq. (4) with the background taken to be an independent number at each energy fitted. The electric Born terms are added explicitly.

TABLE IV.1. Photon resonance couplings.

		Helicity Couplings $(\mathrm{GeV})^{-1/2}$ 10^{-3} Analyses Average(1)		Helicity Couplings $(\mathrm{GeV})^{-1/2}$ 10^{-3} Quarks(2)	
State	λ	$\tilde{A}^p_\lambda$	$\tilde{A}^n_\lambda$	$\tilde{A}^p_\lambda$	$\tilde{A}^n_\lambda$
$P'_{11}(1470)$	1/2	−74±15	34±35	27	−18
$D'_{13}(1520)$	1/2	−10±15	−75±15	−34	−31
	3/2	171±15	−129±10	109	−109
$S'_{11}(1535)$	1/2	63±25	−49±35	156	−108
$D'_{15}(1670)$	1/2	16±10	−32±36	0	−38
	3/2	21±12	−62±40	0	−53
$F'_{15}(1688)$	1/2	−5±30	25±10	−10	30
	3/2	127±35	−16±20	60	0
$S''_{11}(1700)$	1/2	43±30	−37±40	0	30
$D''_{13}(1700)$	1/2	−20±45	18±55	0	−10
	3/2	19±45	18±80	0	−40
$P''_{11}(1780)$	1/2	18±40	18±50	−40	10
$P_{13}(1810)$	1/2	−25±50	24±70	100	−30
	3/2	−31±50	−4±60	−30	0
		$\tilde{A}^\Delta_\lambda = \tilde{A}^{V3}_\lambda$		$\tilde{A}^\Delta_\lambda = \tilde{A}^{V3}_\lambda$	
$P'_{33}(1232)$	1/2	−139±5		−108	
	3/2	−256±5		−187	
$S'_{31}(1650)$	1/2	46±36		47	
$D_{33}(1670)$	1/2	72±26		88	
	3/2	72±45		84	
$P''_{33}(1690)$	1/2	−2±40		23	
	3/2	−12±50		39	
$F_{35}(1890)$	1/2	21±30		−20	
	3/2	−10±60		−90	
$P_{31}(1910)$	1/2	−11±20		−30	
$F_{37}(1950)$	1/2	−69±16		−50	
	3/2	−76±20		−70	

(1) Average of the couplings from MOORHOUSE 73, DEVENISH 73, MOORHOUSE 74, METCALF 74, KNIES 74, DEVENISH2 74, CRAWFORD 75, BARBOUR 76, and Ref. 12. The errors given are an estimate that takes into account the errors quoted in these analyses and the differences between the analyses.

(2) The naive, ℓ-excitation, quark model is used in the 4-dimensional oscillator form of Feynman, Kislinger, and Ravndal. The non-relativistic quark model with recoil gives generally very similar results.

Other recent isobar analyses have been on a much smaller scale. KRIVETS 74[18] is an analysis of $\gamma p \to \pi^+ n$, $\pi^0 p$ and $\gamma n \to \pi^- p$ across the first, second, and third resonance regions using a rather small data set consisting only of differential cross-section measurements. Several solutions are given with a large spread in the values of the couplings and those for the resonance couplings to γn are stated to be preliminary. HEMMI1 73[19] is a fit to forward $\gamma p \to \pi^0 p$ differential cross-section data across the second and third resonance regions and evaluates the $\lambda = 1/2$ couplings in this region. HEMMI2 73[20] is an isobar analysis of $\gamma n \to \pi^0 n$ across the second resonance region. ROSSI 73[21] and BENEVENTANO 73[22] are analyses of data for $\gamma n \to \pi^- p$ across the second resonance region. Earlier analyses[1,23] are not included in the Data Card Listings.

(b) Fixed-t Dispersion Relations: MOORHOUSE 73[10] and MOORHOUSE 74[5] are FTDR analyses from threshold through the third resonance region (1160 < W < 1780 MeV) using data for $\gamma p \to \pi^+ n$, $\pi^0 p$ and $\gamma n \to \pi^- p$. The first uses the results of seven fits with a χ^2 per data point ranging from 9.7 with 52 variables to 5.7 with 74. The second uses the average of three solutions with a χ^2 per data point ranging from 4.0 (56 variables) to 3.0 (74 variables). KNIES 74[11] and Ref. 12 extend the energy range of the Berkeley analyses up to a center-of-mass total energy of 2 GeV, and thus include the energy region of the $\Delta(1950)F_{37}$. Several solutions are described with typical values of the χ^2 per data point of between 3.5 and 4.5. In all these analyses, the imaginary parts of the partial waves are parametrized using a K-matrix formalism.

DEVENISH 73[13] analyze data from the first through the third resonance regions and parametrize the imaginary parts of the partial waves as Breit-Wigner forms without background except for the π^0-production S wave. The dispersion integral is cut off at W = 1.9 GeV, but parametrized real background is added to allow for the integrals above 2 GeV. Three solutions are given with χ^2 per data point of 10.5, 3.0, and 4.7 for 37, 68, and 68 free parameters, respectively. DEVENISH2 74[6] treats the problem of the high energy contributions to the dispersion integral by simultaneously fitting data in the resonance region and at high energies and evaluates the couplings for all resonances for $W \leqslant 2$ GeV. It uses data for $\gamma p \to \pi^+ n$, $\pi^0 p$ and $\gamma n \to \pi^- p$ at all available energies and for $|t| < 1$ (GeV/c)^2. A χ^2 per data point of 4.8 is obtained with 48 resonance parameters and 50 high energy parameters.

CRAWFORD 75[14] is an FTDR analysis from the first through the fourth resonance regions of $\gamma p \to \pi^+ n$, $\pi^0 p$ and $\gamma n \to \pi^- p$. Data are fitted for $W \leqslant 2$ GeV and $|t| \leqslant 1.5$ (GeV/c)^2. Three solutions are given with a best χ^2 per data point of 3.1 with 58 free parameters. The masses and widths of all resonances below 1.7 GeV are evaluated. Stable values are obtained that agree well with the values from elastic πN partial-wave analyses. BARBOUR 76[7] is an extension of the previous analysis to include the fitting of high energy data for W > 2.6 GeV. One fit is presented with a χ^2 per data point of 2.6 for the resonance region data and 1.8 for the high energy data. No data are fitted for 2 GeV < W < 2.6 GeV, thus omitting the region of the $H_{3,11}$.

(c) Energy-Independent Analyses: These have now been extended to the second resonance region by Berends and Donnachie[15] as described above. Earlier analyses[16] fitted only in the first resonance region. Resonance couplings have not been quoted in these analyses.

Electroproduction in the Resonance Region: Although single-pion electroproduction can be considered in many ways to be similar to photoproduction[24], a partial-wave analysis of the process is considerably more difficult than in photoproduction. This is due to the less accurate and complete experimental data that are available and because the scalar part of the virtual photon in electroproduction contributes an extra (scalar) coupling for each resonance. The scalar amplitudes uncouple from the T-matrix in the photoproduction limit. Also, it is necessary, in principle, to make an analysis at each value of λ^2, the (virtual photon mass)^2, at which there are

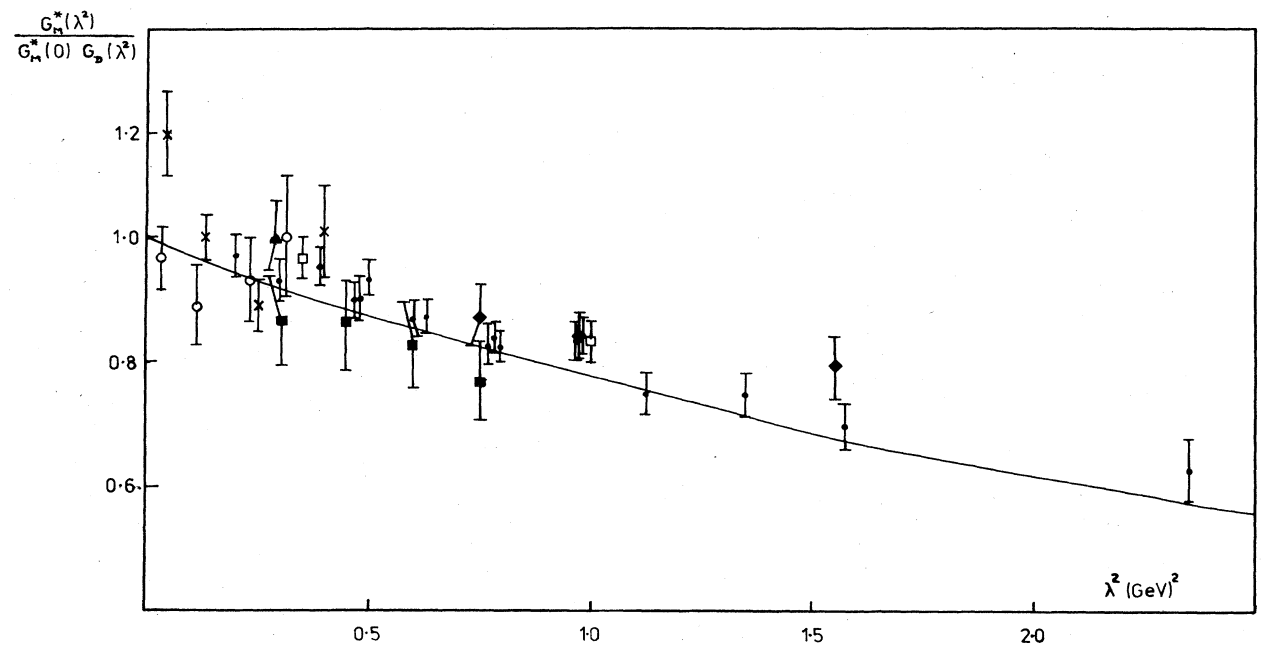

Fig. IV.2. The Δ(1232) magnetic moment form factor, $G_M^*(\lambda^2)$, normalized to $G_M^*(0) = 3$, compared to the nucleon dipole form factor, $G_D(\lambda^2) = (1 + \lambda^2/0.71)^{-2}$. The sources of the data points are ● ref. 25, ○ ref. 27, × ref. 28, ■ ref. 29, □ ref. 30, ◆ ref. 31, ▲ ref. 32, and ◇ ref. 33. The solid line is from Devenish and Lyth[34].

data. The information to be obtained from such an analysis is the size of the scalar couplings to the resonance and the form factors of the scalar transverse couplings, i.e., their λ^2 dependence. This information has been extracted in a number of ways, depending on the experimental data available and the energy range being studied.

(a) Total Cross Sections: In a single-arm experiment, in which only the final electron is detected, it is possible to measure only σ_T and σ_S, the total cross sections for the absorption of transverse and scalar photons. In the first resonance region, due to the dominance of the $M_{1+}^{(3)}$ multipole, σ_T can give the form factor for the magnetic coupling to the $P_{33}(1232)$. There have been many analyses of this type, both the form factors for γp and γn coupling to the $P_{33}(1232)$ having been measured. We quote as examples of these, the analyses of Bartel et al.[25] and of Köbberling et al.[26] Due to the unknown non-resonant scalar background and because the scalar coupling is relatively small, σ_S gives only qualitative information about the scalar coupling to this resonance. Above the second resonance region, due to the large number of resonances, the total cross sections again give little more than qualitative information.

(b) Energy-Independent Analyses: Differential cross-section measurements have been made for π^0 and π^+ electroproduction in a number of coincidence experiments. Although the data are not good enough for a full partial-wave analysis, it is possible, due to the small number of partial waves involved, to use the dominance of the $M_{1+}^{(3)}$ multipole to measure $|M_{1+}|$, Re $E_{1+}^* M_{1+}/|M_{1+}|^2$, and Re $S_{1+}^* M_{1+}/|M_{1+}|^2$ for π^0 production across the first resonance region. This has been done by a number of groups[27–32]. Because $M_{1+}^{(3)}$ is so large and is purely imaginary at the P_{33} mass, these terms can be taken to be respectively Im$M_{1+}^{(3)}$, $E_{1+}^{(3)}/M_{1+}^{(3)}$, and $S_{1+}^{(3)}/M_{1+}^{(3)}$ at the resonance.

(c) Energy-Dependent Analyses: Energy-dependent partial-wave analyses using FTDR have been made for pion electroproduction by Crawford[33]

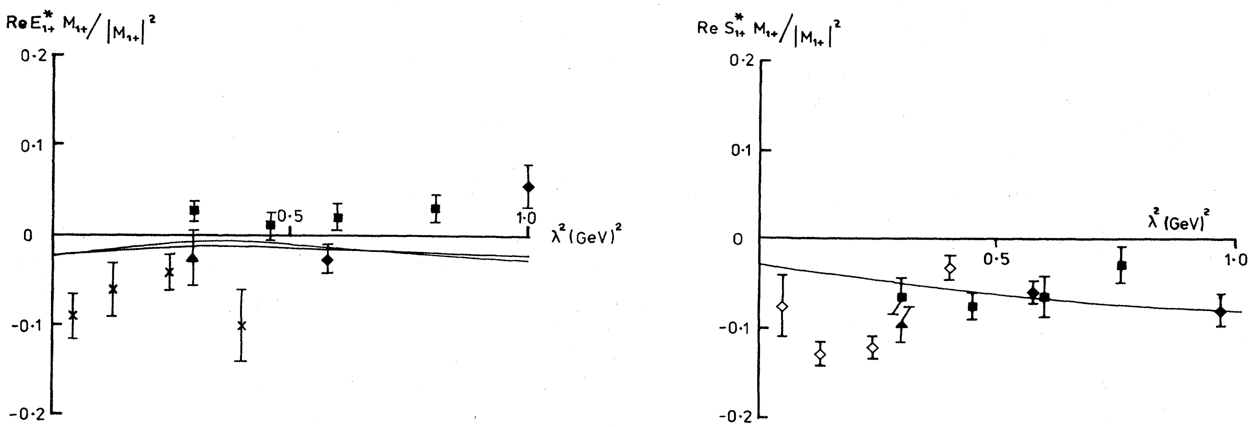

Fig. IV.3. The ratios $\mathrm{Re}(E_{1+}M^*_{1+}/|M_{1+}|^2)$ and $\mathrm{Re}(S_{1+}M^*_{1+}/|M_{1+}|^2)$ for π^0 electroproduction at the Δ(1232). The data points and curves are indicated as in Fig. IV.2. Crawford[33] and Devenish and Lyth[34] give the ratios $E^{(3)}_{1+}/M^{(3)}_{1+}$ and $S^{(3)}_{1+}/M^{(3)}_{1+}$.

and by Devenish and Lyth[34]. The first fitted only in the first resonance region and over a relatively small range of λ^2. The second is an extensive analysis from the first to the fourth resonance regions. Using the results of photoproduction analyses to give a starting point, the form factors for the resonance couplings are given algebraic forms that reflect their analytic structure in the complex λ^2 plane. Data for π^0 and π^+ production and for a range of values of λ^2 are fitted simultaneously and the results of a number of fits are presented. The analysis evaluates the couplings for the $P_{33}(1232)$, $P_{11}(1470)$, $D_{13}(1520)$, $S_{11}(1535)$, $D_{33}(1670)$, $F_{15}(1688)$, $S_{11}(1700)$, $D_{13}(1700)$, $P_{13}(1780)$, $F_{37}(1950)$, and $D_{13}(2040)$ resonances. The results are discussed below.

The couplings and form factors for the $P_{33}(1232)$ are now established for $\lambda^2 < 1\ (\mathrm{GeV})^2$ and there is agreement on all general features between the basic methods of analysis (Figs. IV.2 and IV.3). The λ^2 dependence of $M^{(3)}_{1+}$ is usually expressed in terms of the form factor $G^*_M(\lambda^2)$,[27]

$$G^*_M(\lambda^2) = 2M\left(\frac{3}{2\alpha}\,\frac{|\vec{k}|}{\sin^2\delta_{33}}\,\frac{\Gamma|M_{1+}|^2}{\vec{q}^{\,2}}\right)^{1/2} ,$$

where $\vec{k}$ and $\vec{q}$ are respectively the center-of-mass three-momenta of the pion and the virtual photon.

The behavior of G^*_M for the charge = +1 state, normalized to $G^*_M(0) = 3$, is compared with the nucleon dipole form, $G_D(\lambda^2) = (1 + \lambda^2/0.71)^{-2}$, in Fig. IV.2. It is clearly seen that G^*_M falls off significantly faster with λ^2 than the nucleon dipole. Measurements of G^*_M for the charge = 0 state[26,35] show that it has the same form as for the charge = +1 state. The measurements of the ratios of $E^{(3)}_{1+}$ and $S^{(3)}_{1+}$ to $M^{(3)}_{1+}$ are all consistent with these being small, although the $S^{(3)}_{1+}$ is clearly established as being non-zero with a value of about $-0.06\ M^{(3)}_{1+}$. This is a small violation of the quark model selection rule that predicts that there should be no scalar excitation of the $P_{33}(1232)$[36].

In the second to the fourth resonance regions, Devenish and Lyth obtain definite results for the couplings to the charge = +1 states of the $P_{11}(1470)$, $D_{13}(1520)$, $S_{11}(1535)$, $F_{15}(1688)$, and $F_{37}(1950)$ resonances. These are expressed in terms of the multipole partial waves:

$\underline{P_{11}(1470)}$ The form factor for the magnetic multipole rapidly vanishes and there is no evidence for a scalar coupling.

$\underline{D_{13}(1520)}$ The electric multipole decreases rapidly with λ^2 in an approximate dipole form, but the electric dipole decreases significantly less quickly. There is therefore a rapid change in

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N's and Δ's

Data Card Listings

For notation, see key at front of Listings.

the ratio of the transverse helicity partial waves. The scalar coupling is non-zero at $\lambda^2 = 0$ but decreases rapidly.

$S_{11}(1535)$ The electric multipole decreases slowly with λ^2. The scalar coupling is comparable to the electric one at $\lambda^2 = 0$ but may decrease in an approximately dipole form.

$F_{15}(1688)$ The form factors for the transverse multipoles are similar to those for $D_{13}(1520)$. The scalar coupling decreases rapidly.

$F_{37}(1950)$ The magnetic multipole probably decreases more slowly than the dipole form. The electric multipole is small and its λ^2 behavior is not clearly determined. The scalar multipole is small and decreases rapidly.

The form factors for the $S_{11}(1535)$ can be checked in η electroproduction. This process proceeds mainly through S-wave excitation in the second resonance region and is thus dominated by the $S_{11}(1535)$. The results for the cross section of this process[37] again require that at least one of the form factors should fall off slowly with λ^2.

The rapid change in the ratio of the transverse helicity amplitudes of the $D_{13}(1520)$ and the $F_{15}(1688)$, along with the almost constant value of the ratio for the $P_{33}(1232)$, gives qualitative agreement with quark model calculations[4,38]. However, some quark models find that the form factor for the $S_{11}(1535)$ should decrease rapidly and that the one for the $P_{11}(1470)$ should stay up, and are therefore in conflict with the results above.

Information in this Edition: The Baryon Table contains the branching fractions, Γ_γ/Γ for 14 resonances.

The Data Card Listings contain the photon resonance couplings ($\tilde{A}_\lambda^{jP}$ for p, n, and Δ) from the analyses of Moorhouse and Oberlack[10] (MOORHOUSE 73), Moorhouse, Oberlack, and Rosenfeld[5] (MOORHOUSE 74), Knies, Moorhouse, and Oberlack[11] (KNIES 74), Devenish, Lyth, and Rankin[13,6] (DEVENISH 73 and DEVENISH2 74), Crawford[14] (CRAWFORD 75), Barbour and Crawford[7] (BARBOUR 76), Metcalf and Walker[17] (METCALF 74), Hemmi et al.[19] (HEMMI1 73), Hemmi et al.[20] (HEMMI2 73), Rossi et al.[21] (ROSSI 73), and Beneventano et al.[22] (BENEVENTANO 73).

The average of the listed results along with an estimate of the uncertainty in each from the spread of results is given in Table IV.1. We give results from a naive (ℓ-excitation) quark model for comparison.

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Data Card Listings

For notation, see key at front of Listings.

Baryons

N's and Δ's, p, n

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STATUS OF N* RESONANCES

THOSE WITH AN OVERALL STATUS OF *** OR **** ARE INCLUDED IN THE MAIN BARYCN TABLE. THE OTHERS AWAIT CONFIRMATION.

				STATUS AS SEEN IN --						
PARTICLE	LIJ	OVERALL STATUS	TOTAL≠ CR.S.	PI N	ETA N	K LAM	K SIG	PI DE	GAM N	OTHER CHANN.
N(940)	P11	****								
N*(1470)	P11	****		****				***	**	EPS N
N*(1520)	D13	****	****	****	*			***	***	RHC N
N*(1535)	S11	****		****	***				***	RHO N
N*(1670)	D15	****	***	****	*	*		***	*	
N*(1688)	F15	****	***	****	*	*		***	**	RHC N
N*(1700)	S11	****		****	*	***			**	EPS N
N*(1700)	D13	**		**		*	*	*	*	EPS N
N*(1780)	P11	***		***	*	**		***	*	EPS N
N*(1810)	P13	***		***	*	**			*	RHO N
N*(1990)	F17	**		**	*	*	*		*	
N*(2000)	F15	*		*		*	*		*	
N*(2040)	D13	**		**	*	*			*	
N*(2100)	S11	*		*						
N*(2100)	D15	*		*						
N*(2190)	G17	***	***	***		*			*	
N*(2220)	H19	***	***	***						
N*(2650)		***	***	*						
N*(3030)		***	***	*						
N*(3245)		*	*							
N*(3690)		*	*							
N*(3755)		*	*							
DE(1232)	P33	****	****	****	F				****	
DE(1650)	S31	****	**	****	O			**	**	RHO N
DE(1670)	D33	***	***	***	R			**	*	
DE(1690)	P33	*		*	B			**	*	
DE(1890)	F35	***	*	***	I		*	*	*	RHC N
DE(1900)	S31	*	*	*			*			
DE(1910)	P31	***	*	***		D	*	*	*	RHC N
DE(1950)	F37	****	***	****		D	*	**	*	RHO N
DE(1960)	D35	**	*	*		E	*	*		
DE(2160)		**		***		N	*			
DE(2420)	H311	***	***	***	F					
DE(2850)		***	***	**	O					
DE(3230)		***	***	*	R					

**** GOOD, CLEAR, AND UNMISTAKABLE.
*** GOOD, BUT IN NEED OF CLARIFICATION CR NOT ABSOLUTELY CERTAIN.
** NEEDS CONFIRMATION.
* WEAK.
≠ ATTRIBUTED TO THE STATE CLOSEST TO WHERE THE CROSS SECTION PEAKS.

****** ********* ********* ********* ********* ********* ********* ********
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S=0 I=1/2 NUCLEON STATES (N)

****** ********* ********* ********* ********* ********* ********* ********
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p 16 PROTCN(938, J=1/2) I=1/2

SEE STABLE PARTICLE DATA CARD LISTINGS

****** ********* ********* ********* ********* ********* ********* ********
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n 17 NEUTRCN(939, J=1/2) I=1/2

SEE STABLE PARTICLE CATA CARC LISTINGS

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Baryons
N(1470)

Data Card Listings
For notation, see key at front of Listings.

N(1470) P'_{11}

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61  N*1/2(1470, JP=1/2+) I=1/2

MASS AND WIDTH ARE BEST DETERMINED FROM PARTIAL WAVE
ANALYSES.  WE LIST PRODUCTION EXPERIMENTS SEPARATELY --
SEE BELOW.

AYED 74 CLAIM TWO P11 STATES IN THE 1500 MEV REGION.
WE TENTATIVELY LIST BOTH HERE.

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               61  N*1/2(1470) MASS (MEV)

M          (1370.0)                 BRANDSEN  65 RVUE   PHASE-SHIFT ANAL   9/66
M          (1380.0)                 ROPER     65 RVUE   PHASE-SHIFT ANAL   9/66
M    1     (1470.0)                 BAREYRE   68 RVUE   PHASE-SHIFT ANAL  11/67
M    1           WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3     (1466.0)                 DONNACH1  68 RVUE   PHASE-SHIFT ANAL   6/68
M    6     (1461.0)                 AYED      70 IPWA                      1/71
M    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4     (1462.0)                 DAVIES    70 RVUE   P-S ANAL  SCL A    8/69
M    7     (1470.)                  ALMEHED   72 IPWA                      2/72
M    2     (1413.)                  AYED      74 IPWA                      2/74
M    2     (1532.)                  AYED      74 IPWA                      2/74
M    2   AYED 74 FIND 2 DIFFERENT P11 RESONANCES IN THIS REGION IN CONTRAST 2/74
M    2   TO ALL PREVIOUS PWAS. WE LIST BOTH TOGETHER HERE UNTIL THE         2/74
M    2   SITUATION IS FURTHER CLARIFIED.                                    2/74
M          1405. TO 1420.           CRAWFORD  75 DPWA   PI N PHOTO-PROD   1/76*
M     L    1415. OR 1390.           LONGACRE  75 IPWA   PI N TO 2PI N    11/75*
M     L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75. 11/75*
M          (1404.)                  BARBOUR   76 DPWA   PI N PHOTO-PROD   1/76*

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               61  N*1/2(1470) WIDTH (MEV)

W    1      (255.0)                 BAREYRE   68 RVUE                     11/67
W    3      (211.0)                 DONNACH1  68 RVUE                      6/68
W    6      (164.0)                 AYED      70 IPWA                      1/71
W    4      (391.)                  DAVIES    70 RVUE   P-S ANAL  SOL A    8/69
W    7      (220.)                  ALMEHED   72 IPWA                      2/72
W    2      (187.)   (SMALLER MASS) AYED      74 IPWA                      2/74
W    2       (89.)   (LARGER MASS)  AYED      74 IPWA                      2/74
W            255. TO  396.          CRAWFORD  75 DPWA   PI N PHOTO-PROD   1/76*
W     L      180. OR  200.          LONGACRE  75 IPWA   PI N TO 2PI N    11/75*
W           (330.)                  BARBOUR   76 DPWA   PI N PHOTO-PROD   1/76*
      SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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               61  N*1/2(1470) REAL PART OF POLE POSITION (MEV)         1/74
RE         (1375.)    (5.)          LEE       73        FIT TO ALMEHED72  1/74
RE         (1381.)                  LONGACRE  75 IPWA   PI N TO 2PI N    11/75*

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               61  N*1/2(1470) 2*IMAG PART OF POLE POSITION (MEV)       1/74
IM          (216.)    (10.)         LEE       73        FIT TO ALMEHED72  1/74
IM          (209.)                  LONGACRE  75 IPWA   PI N TO 2PI N    11/75*

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               61  N*1/2(1470) ABSOLUTE VALUE OF POLE RESIDUE (MEV)     1/74
ABS          (74.)    (5.)          LEE       73        FIT TO ALMEHED72  1/74

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               61  N*1/2(1470) PHASE OF POLE RESIDUE (RADIANS)          1/74
PH          (-1.4)                  LEE       73        FIT TO ALMEHED72  1/74

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               61  N*1/2(1470) PARTIAL DECAY MODES

                                                      DECAY MASSES
P1     N*1/2(1470) INTO PI N                         139+ 938
P2     N*1/2(1470) INTO N EPSILON                    938+1200
P3     N*1/2(1470) INTO N*3/2(1232) PI              1232+ 139
P4     N*1/2(1470) INTO N PI PI                      938+ 139+ 139
P5     N*1/2(1470) INTO GAMMA N                        0+ 938
P6     N*1/2(1470) INTO N RHO                        938+ 773
P7     N*1/2(1470) INTO GAM P, HELICITY=1/2            0+ 938
P8     N*1/2(1470) INTO GAM N, HELICITY=1/2            0+ 939
P9     N*1/2(1470) INTO ETA N                        939+ 548
P10    N*1/2(1470) INTO K LAMBDA                     497+1115
P11    N*1/2(1470) INTO N RHO,S=1/2,P-WAVE           938+ 773

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               61  N*1/2(1470) BRANCHING RATIOS

R1     N*1/2(1470) INTO (PI N)/TOTAL                        (P1)
R1  1        (0.68)                 BAREYRE   68 RVUE                     11/67
R1  3        (0.658)                DONNACH1  68 RVUE                      6/68
R1  6        (0.564)                AYED      70 IPWA                      1/71
R1  4        (0.49)                 DAVIES    70 RVUE   P-S ANAL  SOL A    8/69
R1  A        (0.67)   (0.18)        SAXON     70 HBC    AT 1400 MEV        6/70
R1  B        (0.58)   (0.09)        SAXON     70 HBC                       6/70
R1  7        (0.65)                 ALMEHED   72 IPWA                      2/72
R1  2         (.549)(SMALLER MASS)  AYED      74 IPWA                      2/74
R1  2         (.123)(LARGER MASS)   AYED      74 IPWA                      2/74
R1  A A AND B CORRESPOND TO THE 2 BEST SOLUTIONS.  ANALYSIS IS DONE ON THRE
R1  B BODY DECAYS, ASSUMING ONLY P1, P2 AND P3 DECAYS PRESENT.
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

R2     N*1/2(1470) INTO (N EPSILON)/TOTAL                   (P2)
R2          DOMINANT INELASTIC DECAY  THURNAUER 65 RVUE -                 11/67
R2          DOMINANT INELASTIC DECAY  NAMYSLOWS 66 RVUE -                 11/67
R2          DOMINANT INELASTIC DECAY  ROSENFELD 67 RVUE -                 11/67
R2          DOMINANT INELASTIC DECAY  MORGAN    68 RVUE   ISOBAR MODEL     6/68
R2  D        (0.16)                 DIEM      70 IPWA   3 BODY ANALYSIS    1/71
R2  D       ASSUMING  R1= 0.61
R2  A        (0.30)   (0.20)        SAXON     70 HBC                       6/70
R2  B        (0.20)   (0.12)        SAXON     70 HBC                       6/70
R2  A AND B CORRESPOND TO THE 2 BEST SOLUTIONS, SEE NOTE IN R1.

R3     N*1/2(1470) INTO (N*3/2(1232) PI)/TOTAL              (P3)
R3  D        (0.17)                 DIEM      70 IPWA   3 BODY ANALYSIS    1/71
R3  D       ASSUMING  R1= 0.61
R3  A        (0.03)   (0.20)        SAXON     70 HBC                       6/70
R3  B        (0.22)   (0.12)        SAXON     70 HBC                       6/70
R3  A AND B CORRESPOND TO THE 2 BEST SOLUTIONS, SEE NOTE IN R1.
R3  R        (0.20)                 MAKAROV   71 IPWA  0 PI- P TO PI PI N  3/72
R3  R   ASSUMES R1=0.6. MAXIMUM CM ENERGY ANALYZED WAS 1435 MEV.

R4     N*1/2(1470) INTO (GAMMA N)/(PI N)                    (P5)/(P1)
R4  F       STRONG INDICATION       ROSSI     73 DBC   0 GAM N TO PI-P   . 2/73
R4  F  DISAGREES WITH OTHER DATA                                           2/73

R5     N*1/2(1470) INTO (N RHO )/TOTAL                      (P6)
R5  D        (0.07)                 DIEM      70 IPWA   3 BODY ANALYSIS    1/71
R5  D       ASSUMING  R1= 0.61

R6     N*1/2(1470) INTO (GAMMA N)/TOTAL                     (P5)
R6  E        (.0006)                MICKENS   71          THEORETICAL EST. 10/71
R6  E  TOTAL WIDTH TAKEN AS 250 MEV.

R7     N*1/2(1470) FROM PI N INTO ETA N                     SQRT(P1*P9)        2/74
R7           (+.23)                 LEMOIGNE  73 DPWA     1488 TO 1685 MEV   2/74
R7  9        (+.328)                FELTESSE  75 DPWA   0 1488 TO 1745 MEV 11/75*
R7  9  SUPERCEDES LEMOIGNE 73, USES M AND W OF AYED 74 (LARGER MASS).      11/75*
R7  9  AN ALTERNATIVE WHICH CAN NOT BE DISTINGUISHED FROM THIS IS TO HAVE  11/75*
R7  9  A P13 RESONANCE WITH M=1530, W=79, AND COUPLING=+.271               11/75*

R8     N*1/2(1470) FROM PI N TO K LAMBDA                    SQRT(P1*P10)       4/75*
R8 C         -.296      .068        DEVENISH  74          0 FIXED T DISP REL 4/75*
R8 C   EXTRAPOLATION OF PARAMETRIZED AMPLITUDE BELOW THRESHOLD.             4/75*

R9     N*1/2(1470) FROM PI N TO N*3/2(1232) PI              SQRT(P1*P3)       11/75*
R9   L       (-.30)OR  -.37         LONGACRE  75 IPWA     PI N TO 2PI N    11/75*

R10    N*1/2(1470) FROM PI N TO N RHO,S=1/2,P-WAVE          SQRT(P1*P11)      11/75*
R10  L       (0.0) OR  -.23         LONGACRE  75 IPWA     PI N TO 2PI N    11/75*

R11    N*1/2(1470) FROM PI N TO N EPSILON                   SQRT(P1*P2)       11/75*
R11  L       (.18)OR  +.23          LONGACRE  75 IPWA     PI N TO 2PI N    11/75*

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               61  N*1/2(1470) PHOTON DECAY AMPL(GEV**-1/2)

       FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
     REVIEW PRECEDING THE BARYON LISTINGS.

A1     N*1/2(1470) INTO GAM P, HELICITY=1/2 (GEV**-1/2)
A1          -.096      .022         DEVENISH  73 DPWA     PI N PHOTO PROD    2/74
A1         (-.080)                  HEMMI1    73        + FWD PIO PHTOPROD   2/74
A1          -.055      .028         MOORHOUS  73 DPWA     PI N PHOTO-PROD    2/73
A1          -.079      .012         DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A1          -.066      .013         KNIES     74 DPWA     PI N PHOTO PROD    2/74
A1          -.070     .023          METCALF   74 DPWA     PI N PHOTO-PROD    2/74
A1          -.087      .002         MOORHOUS  74 DPWA     PI N PHOTO-PROD    2/74
A1          -.070      .040         CRAWFORD  75 DPWA     PI N PHOTO-PROD    1/76*
A1         (-.053)                  BARBOUR   76 DPWA     PI N PHOTO-PROD    1/76*
A1           . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.2)

A2     N*1/2(1470) INTO GAM N, HELICITY=1/2 (GEV**-1/2)
A2           .089      .056         DEVENISH  73 DPWA     PI N PHOTO PROD    2/74
A2 8       (-.001)                  HEMMI2    73        0 GAM N TO PIO N     4/75*
A2 8   CONVERTED TO OUR CONVENTIONS USING M AND W FROM WALKER69 AND X=.55    4/75*
A2          +.002      .025         MOORHOUS  73 DPWA     PI N PHOTO-PROD    2/73
A2 F         .117      .011         ROSSI     73 DPWA   0 GAM N TO PI- P     4/75*
A2 F   CONVERTED TO OUR CONVENTIONS USING M AND W FROM ROSSI73 AND X=.55     4/75*
A2 5        (.083)                  BENEVENT  74 DPWA   0 GAM N TO PI- P     4/75*
A2 5   CONVERTED TO OUR CONVENTIONS USING M=1470 MEV, W=230 MEV, X=.55       4/75*
A2           .041      .025         DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A2           .000      .013         KNIES     74 DPWA     PI N PHOTO PROD    2/74
A2           .043      .035         METCALF   74 DPWA     PI N PHOTO-PROD    2/74
A2           .033      .013         MOORHOUS  74 DPWA     PI N PHOTO-PROD    2/74
A2          +.044      .007         CRAWFORD  75 DPWA     PI N PHOTO-PROD    1/76*
A2         (+.058)                  BARBOUR   76 DPWA     PI N PHOTO-PROD    1/76*
A2           . . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 3.1)

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REFERENCES FOR N*1/2(1470)


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BRANDSEN 65 PR 139 B1566      +ODONNELL, MOORHOUSE          (DURHAM, RHEL)IJP
ROPER    65 PR 138 B190       LD ROPER,RM WRIGHT,BT FELD    (LRL-LVMR,MIT)IJP
THURNAUE 65 PRL 14 985        P G THURNAUER                          (ROCH)

NAMYSLOW 66 PR 157 1328       NAMYSLOWSKI,RAZMI,ROBERTS  (STAN,EDIN,LOIC)

ROSENFEL 67 IRVINE CONF       A H ROSENFELD, P SODING                 (LRL)

BAREYRE  68 PR 165 1731       P BAREYRE, C BRICMAN, G VILLET    (SACLAY)IJP
DONNACH1 68 PL 26B 161        A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139        DONNACHIE  RAPPORTEUR.S TALK           (GLAS)
    ALSO 68 THESIS            R G KIRSOPP                            (EDIN)
MORGAN   68 PR 166 1731       D MORGAN                               (RHEL)

AYED     70 KIEV CONF         R AYED,P BAREYRE, G VILLET          (SACL)IJP
DAVIES   70 NP B21 359        A DAVIES                               (GLAS)
DIEM     70 KIEV CONF.        + SMADJA, CHAVANON, DELER, DOLBEAU+  (SACL)
SAXON    70 PR D2 1790        SAXON, MULVEY, CHINOWSKY            (OXF,LRL)

MAKAROV  71 SJNP 13 510       ,GASILOVA,NELYUBIN,++         (IOFFE INST)IJP
MICKENS  71 LNC  1  707       R E MICKENS                            (FISK)
ALMEHED  72 NP B40 157        +LOVELACE                      (LUND,RUTG)IJP

DEVENISH 73 PL 47B 53         DEVENISH,RANKIN,LYTH        (LOUC+BONN+LANC)IJP
HEMMI1   73 PL 43B 79         HEMMI,INAGAKI+         (KYOTO+SAGA+KEK+TOKY)IJP
HEMMI2   73 NP B55 333        +INAGAKI,KIKUCHI,MAKI,MIYAKE+ (KYOTO,TOKYO)IJP
LEE      73 PRL 31 1029       LEE,SHAW         (UCI+ROYAL HOLLOWAY COLLEGE)IJP
LEMOIGNE 73 PURDUE CONF. 93   +GRANET,MARTY,AYED,BAREYRE,BORGEAUD,+(SACL)IJP
MOORHOUS 73 PL 43B 44         MOORHOUSE, OBERLACK                (GLAS+LBL)IJP
ROSSI    73 NC 13A 59         +PIAZZA,SUSINNO,+      (ROMA,FRAS,NAPL,PAVIA)IJP
    ALSO 71 LNC 2 1183        CARBONARA,FIORE,+      (NAPL,FRAS,PAVIA,ROMA)IJP

AYED     74 PRIVATE COMMCTN.  AYED,BAREYRE                         (SACL)IJP
    ALSO 73 AIX CONFERENCE    AYED,BAREYRE                         (SACL)IJP
BENEVENT 74 NC 19A 529        BENEVENTANO,DANGELO,NOTARISTEFANI,+  (RCMA)IJP
DEVENISH 74 NP B81 330        DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227        DEVENISH,LYTH,RANKIN         (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680        KNIES,MOORHOUSE,OBERLACK           (LBL,GLAS)IJP
METCALF  74 NP B76 253        W J METCALF,R L WALKER                  (CIT)IJP
MOORHOUS 74 PRD 9 1           MOORHOUSE,OBERLACK,ROSENFELD       (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125        R L CRAWFORD                           (GLAS)IJP
FELTESSE 75 NP B93 242        +AYED,BAREYRE,BORGEAUD,DAVID,ERNWEIN+(SACL)IJP
LONGACRE 75 PL 55B 415        +ROSENFELD,LASINSKI,SMADJA+        (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP      I. M. BARBOUR,R. L. CRAWFORD           (GLAS)IJP
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Data Card Listings

For notation, see key at front of Listings.

Baryons

N(1470), N(1520)

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                              PAPERS NOT REFERRED TO IN CATA CARDS.

BAREYRE  64 PL 8 137              +BRICMAN,VALLADAS,VILLET, +   (SACLAY,CAEN) IJ
BAREYRE  65 PL 18 342             +BRICMAN, STIRLING, VILLET         (SACLAY)IJP
DALITZ   65 PL 14 159             R H DALITZ, R G MOCRHOUSE        (OXF,RHEL)
JOHNSON  67 UCRL-17683 THESIS     C H JOHNSON                         (LRL)
DONNACHI 69 NP 108 433            A DONNACHIE, R KIRSOPP          (GLAS+EDIN)
WALKER   69 PR 182 1729           R L WALKER                     (CAL TECH)IJP
AYED     70 PL 31B 598            +BAREYRE,VILLET                   (SACLAY)
BERARDO  70 PRL 24 419            +HADDOCK,NEFKENS,...,PARSONS+..   (UCLA+LRL)
AYED     72 BATAVIA CONF          R AYED,P BAREYRE, Y LEMOIGNE        (SACL)

      THE FOLLOWING ARE THEORETICAL PAPERS CONCERNING THE N*1/2(1470) --
RESNICK  66 PR 150 1292           L RESNICK                      (NIELS BOHR)
SCHWARZ  66 PR 152 1325           J H SCHWARZ                         (LRL)
BALL     67 PR 155 1725           JS BALL, GL SHAW, DY WONG   (UCLA,UCI,UCSD)
GOLDBERG 67 PR 154 1558           H GOLDBERG                      (CORNELL)

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1470 MEV REGION – PRODUCTION EXPERIMENTS

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                91  N*1/2(1470, JP=      ) I=1/2    PRODUCTICN EXPERIMENTS

                THE BUMP SEEN IN PRODUCTION EXPERIMENTS AT LOW INVARIAN
                MASS MOST LIKELY CORRESPONDS TO THE P11 (SEE ABOVE)
                RESONANT STATE, IF ANY.  THE HBC EXPERIMENTS SEE
                ENHANCEMENTS MAINLY IN THE P PI PI MASS PLOT.  FOR ZERO
                CHARGE EXCHANGE, SUCH FINAL STATES ARE KNOWN TO HAVE
    LARGE DECK-TYPE BACKGROUND.  THIS FACT COMPLICATES THE INTERPRETATION
    OF THIS BUMP AS A RESCNANCE.

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                91  N*1/2(1470) MASS (MEV) (PROD.EXP.)

M         (1400.)    APPROX                COCCCNI    64 CNTR +  PP 3.6-12 GEV/C
M         (1425.)    APPROX                ADELMAN    65 HBC  +  K-P 1.45 GEV/C     7/66
M         (1430.)    APPROX                ANKENBRAN  65 CNTR +  PP 7.1 GEV/C       7/66
M         (1400.)    APPROX                BELLETTIN  65 SPRK +  PP,D 10-26 GEV/C   7/66
M         (1405.)     (15.)                ANDERSON   66 SPRK +  PP, 6-30 GEV/C     7/66
M         (1410.)     (15.)                BLAIR      66 CNTR +  PP 2.8-7.9 GEV/C   7/66
M         (1400.)     (30.)                FOLEY      67 CNTR    PI+- P AND PP     11/67
M         (1450.)     (17.)                ALMEIDA    68 HBC  +  PP-P2PI ,10GEV/C  10/69
M         (1420.)    APPROX                BELL       68 HBC     PI+- P, 6 GEV/C    6/68
M         (1400.)    APPROX                LAMSA      68 HBC     PI-P , 8 GEV/C     6/68
M    S 175(1446.)     (11.)                SHAPIRA    68 CBC     INTO PPI,PN 7.0   10/69
M    S    (1390.)     (20.)                TAN        68 HBC     PP TO PIP, 6.1    10/69
M      120(1443.)     (15.)                RHODE      69 HBC     PP 22 GEV/C       10/69
M         (1410.)     (13.)                ANDERSON   70 MMS  -  PI- P TO PI- MMS   2/71
M         (1430.)     (20.)                BALLAM     71 HBC  +- PI+-P AT 16GEV     2/72
M         (1460.)                          BEKETOV    71 HBC  +  PI- P 4.45GEV/C    3/72
M         (1461.)     (10.)                BOESEBEC   71 RVUE    PP,PI-P,K-P PROD   3/72
M      120(1462.0)     (6.0)    120/80     MA         71 HBC  +  P P TO P N PI     10/71
M          1460. TO 1510.                  MORSE      71 HBC  +0 PI-P,  7 GEV/C     3/72
M         (1510.0)    (20.0)               MORSE      71 HBC  +  PI-P, 25 GEV/C     3/72
M         (1425.)     (25.)                RUSHBROOKE71 HBC  +  PP TO P2PI 16GEV    2/72
M         (1411.0)    (10.0)               EDELSTEIN  72 MMS  +  PP 6 TO 30 GEV     1/73
M       64(1410.0)    (33.0)               GAGE       72        0 PD  5.9GEV/C     12/72
M         (1464.0)     (7.0)     45/45     KARSHON    72 DBC  +  PD--PD2PI 7 GEV   12/72
M         (1440.)     (15.)                RONAT      72  HBC    PI+P TO 3PI P      2/73
M         (1479.)      (8.)                LICHTMAN   74 HBC  +  PI+P TO 3PI P      4/75*
M         (1430.)      (8.)                LICHTMAN   74 HBC  +  PI-P TO 3PI P      4/75*
M    1    (1450.)                          BLOBEL     75 HBC  +  PP TO P(PI+PI-P)   1/76*
M    1   PWA INDICATES PI+PI-P ENHANCEMENT IS PRIMARILY AN                          1/76*
M    1   S-WAVE DELTA++PI- SYSTEM WITH I,JP=1/2,3/2-.                               1/76*
M         (1450.)     (16.)                CAVALLI    75 SPEC +  PP TO 2N*,W=23GV   1/76*
M         (1462.)     (11.)                CAVALLI    75 SPEC +  PP TO 2N*,W=31GV   1/76*
M         (1466.)     (28.)                CAVALLI    75 SPEC +  PP TO 2N*,W=53GV   1/76*
M         (1390.)     (10.)                MUSGRAVE   75 HBC     K+ P TO K PI N    11/75*
M          1350. TO 1400.                  STRACHMA   75 BC      NBAR (N PI)        1/76*
M    S   TAN 68, SHAPIRA 68, AND GAGE 72 ARE ONLY PRODUCTION EXPERIMENTS TO
M    S   SEE PPI DECAY.  HOWEVER THE EFFECT OF SHAPIRA 68, WITH MUCH IMPROVE
M    S   DATA, HAS ALMST DISAPPEARED (YEKUTIEL1 72).
M    B    (1250.)                          BERLAND    74 HBC  +0 ISOSPIN ANALYSIS 10/74*
M    B    (1230.)                          BRAUN2     75  BC     PBAR P AND D,5.7 11/75*
M    B    (1230.)                          STRACHMA   75  BC     NBAR (N PI)        1/76*
M    B   THE EFFECT SEEN BY BERLAND 74 IN A PRISM PLOT ANALYSIS, BY BRAUN2          1/76*
M    B   75 IN A DALITZ PLOT FIT, AND BY STRACHMAN 75 IN AN AMPLITUDE               1/76*
M    B   ANALYSIS IS PROBABLY NOT CONNECTED WITH THE N*(1470).  WE                  1/76*
M    B   TEMPORARILY LIST THE MASS HERE UNTIL THE SITUATICN IS FURTHER              1/76*
M    B   CLARIFIED.  SEE ALSO COOPER 74.                                            1/76*

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                91  N*1/2(1470) WIDTH (MEV) (PRCD. EXP.)

W          (100.)                          BELL       68 HBC     PI+- P AND PP      6/68
W    S 175 (198.)     (40.)                SHAPIRA    68 CBC                       10/69
W    S     (150.)     (60.)                TAN        68 HBC  +                    10/69
W      120 (100.)     (15.)                RHODE      69 HBC     PP 22 GEV/C       10/69
W          (210.)     (15.)                ANDERSON   70 MMS  -  PI- P TO PI- MMS   2/71
W          (150.)     (40.)                BALLAM     71 HBC  +- PI+-P AT 16GEV     2/72
W          (100.)                          BEKETOV    71 HBC  +  P PI+ PI- MASS     3/72
W           (60.)     (20.)                BOESEBEC   71 RVUE    PP,PI-P,K-P PROD   3/72
W    T 120  (54.0)    (12.0)    120/80     MA         71 HBC  +  P P TO P N PI     10/71
W    T   NARROW WIDTH SUGGESTS THIS IS NOT THE USUAL N*(1470).                     10/71
W           80. TO   120.                  MORSE      71 HBC  +  PI-P,  7 GEV/C     3/72
W         (100.0)     (30.0)               MORSE      71 HBC  +  PI-P, 25 GEV/C     3/72
W          (125.)     (25.)                RUSHBROOKE71 HBC  +  PP TO P2PI 16GEV    2/72
W         (188.0)     (38.0)               EDELSTEIN  72 MMS  +  PP 6 TO 30 GEV     1/73
W         (212.0)     (62.0)               GAGE       72 DBC  0 PD  5.9GEV/C       12/72
W         (124.0)     (20.0)               KARSHON    72 DBC  +  PD--PD2PI 7 GEV   12/72
W          (100.)     (30.)                RONAT      72  HBC    PI+P TO 3PI P      2/73
W           (50.)     (25.)                LICHTMAN   74 HBC  +  PI+P TO 3PI P      4/75*
W           (62.)     (18.)                LICHTMAN   74 HBC  +  PI-P TO 3PI P      4/75*
W          (250.)     (95.)                CAVALLI    75 SPEC +  PP TO 2N*,W=23GV   1/76*
W          (249.)     (90.)                CAVALLI    75 SPEC +  PP TO 2N*,W=31GV   1/76*
W          (205.)    (105.)                CAVALLI    75 SPEC +  PP TO 2N*,W=53GV   1/76*
W          (145.)     (35.)                MUSGRAVE   75 HBC     K+ P TO K PI N    11/75*

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                91  N*1/2(1470) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1      N*1/2(1470) INTO PI N                            139+ 938
P2      N*1/2(1470) INTO N PIPI(J,I=0)                   938+ 139+ 139
P3      N*1/2(1470) INTO N*3/2(1232) PI                 1232+ 139
P4      N*1/2(1470) INTO N PI PI                         938+ 139+ 139
P5      N*1/2(1470) INTO GAMMA N                           0+ 938
P6      N*1/2(1470) INTO N RHO                           938+ 773

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                91  N*1/2(1470) BRANCHING RATIOS (PRCD. EXP.)

R1      N*1/2(1470) INTO (PI N)/TOTAL                          (P1)
R1              (.66)                     TAN       68 HBC     PP TO PIP, 6.1    10/69

R2      N*1/2(1470) INTO (N*3/2(1232) PI)/TCTAL                (P3)
R2            PROBABLY SEEN               JESPERSEN 68 HBC     PP 22 BEV/C       11/68
R2            PROBABLY SEEN               LAMSA     68 HBC     PI-P 8 BEV/C      11/68

R3      N*1/2(1470) INTO (N PIPI(J,I=0))/TCTAL                 (P2)
R3            MAIN DECAY MODE             MORSE     71 HBC  +  PI-P 7,25 GEV/C    3/72

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                                 REFERENCES FOR N*1/2(1470) (PROD. EXP.)

COCCCNI  64 PL    8 134           +LILLETHUN,SCANLON,STAHLBRANCT, +     (CERN)
ADELMAN  65 PRL 14 1043           S L ADELMAN               (CAMBRIDGE(CERN))
ANKENBRA 65 NC  35 1052           ANKENBRANDT,CLYDE,CORK,KEEFE,KERTH+    (LRL)
BELLETTI 65 PL   18 167           BELLETTINI,COCCONI,DIDDENS +          (CERN)
ANDERSON 66 PRL 16  855           +BLESER,CCLLINS,FUJII,+           (BNL,CARN)
BLAIR    66 PRL 17  789           +TAYLOR,CHAPMAN,+  (HARWELL,QUEENMARY,RHEL)

FOLEY    67 PRL 19  397           +JONES,LINDENBAUM,LOVE,OZAKI+          (BNL)
ALMEIDA  68 PR 174 1638           +RUSHBROOKE,SCHARENGUIVEL+       (CAVE,DESY)
BELL     68 PRL 20  164           +CRENNELL,HOUGH,KARSHON,LAI+      (BNL,CUNY)
JESPERSE 68 PRL 21 1368           JESPERSEN,KANG,KERNAN+          (IOWA STATE)
LAMSA    68 PR 166 1395           +CASON,BISWAS,DERADO,GROVES,+  (NOTRE DAME)
SHAPIRA  68 PRL 21 1835           +BENARY,EISENBERG,RONAT,YAFFE+        (REHO)
TAN      68 PL 28B 195            TAN,PERL,MARTIN,VHINOWSKU +  (SLAC+LRL+UCI)
RHODE    69 PR 187 1844           RHODE, LEACOCK, KERNAN, JESPERSEN,+   (ISU)
ANDERSON 70 PRL 25 699            +BLESER,BLIEDEN,COLLINS++         (BNL,CARN)

BALLAM   71 PR D4 1946            +CHADWICK,GUIRAGOSSIAN,JOHNSON,++    (SLAC) I
BEKETOV  71 SJNP 13 605           ,ZCMBKOVSKII,KONOVALOV,KRUCHININ,++  (ITEP)IJ
BOESEBEC 71 NP B33 445            BOESEBECK,GRAESSLER,KRAUS,+++      (ABBCHLV) I
MA       71 PRL  26  333          +COLTON                           (MSU+LBL)I
MORSE    71 PR D4 133             +CH,WALKER,CARRCLL,LYNCH +       (WISC+TNTO)IJ
RUSHBROO 71 PR D4 3273            RUSHBROOKE,WILLIAMS+BAREFORD++  (CAVE,LOIC) IJ

EDELSTEI 72 PR D5 1073            EDELSTEIN,CARRIGAN,HIEN,MCMAHON,+(CARN+BNL)
GAGE     72 NP B46 21             W GAGE,E COLTON,W CHINOWSKI            (LBL)
KARSHCN  72 NP B37 371            +YEKUTIELI,YAFFE,SHAPIRA,RONAT,+     (REHO) I
RONAT    72 NP B38 20             +EISENBERG,LYCNS,SHAPIRA,TOAFF+       (REHO)
YEKUTIEL 72 NP B40 77             YEKUTIELI,YAFFE,SHAPIRA,RCNAT +       (REHO)

BERLAND  74 NP B75 93             BERLAND,HABER,HODOLS,HULSIZER,+       (MIT)I
    ALSO 74 PL 51B 187            BERLAND,HABER,HODOUS,HULSIZER,+       (MIT)I
LICHTMAN 74 NP B81 31             LICHTMAN,BISWAS,CASON,KENNEY,MCGAHAN+(NDAM)I

BLOBEL   75 NP B97 201            +ESKREYS,FESEFELDT,FRANZ+  (BONN+HAMB+MPIM)IJP
BRAUN2   75 NP B95 503            +GERBER,MAURER,MICHALON,SCHIBY+ STBRB,LPNP I
CAVALLI  75 LNC 14 353            CAVALLI-SFORZA,CONTA+            (PAVIA+PRIN)
    ALSO 75 LNC 14 345+359        CAVALLI-SFORZA,CONTA+            (PAVIA+PRIN)
MUSGRAVE 75 NP B87 365            +PEETERS,SCREINER,WHITMORE,YUTA        (ANL)
STRACHMA 75 NP B98 120            STRACHMAN,BRAUN,GERBER,MAURER+  (LPNP+STRB)I

                                  PAPERS NOT REFERRED TO IN CATA CARDS

GELLERT  66 PRL 17 884            +SMITH,WOJCICKI,COLTON,SCHLEIN + (LRL,UCLA)
ALBERI   68 PR 176 1631           +APPEL,BUDNITZ,CHEN,DUNNING,GOITEIN+ (HARV)
WALKER   68 PRL 20 133            +THOMPSCN,ROBERTSON,OH,LEE,HARTUNG,+ (WISC)
CLEGG    69 NP B13 222            CLEGG                                 (LANC)
ALEXANDE 73 NP B52 221            ALEXANDER,BENARY+(TEL-AVIV+HEIDELBERG+DESY)
ANSORGE  73 NP B63 93             ANSORGE,MADEN,NEALE,RUSHBROOKE        (CAVE)
BEAUPRE  73 NP B66 93                 (AACH+BERL+BONN+CERN+NDAM+PENN+TOHO)I
COOPER   74 NP B79 259            COOPER,SEIDL,VANDERVELDE             (MICH)IJP
DEUTSCHM 75 NP B99 397            DEUTSCHMANN+(AACH+BONN+BERL+CERN+CRAC+HEID)

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N(1520)

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                62  N*1/2(1520, JP=3/2-) I=1/2        D'13
                THE EXISTENCE OF THIS RESCNANCE IS WELL ESTABLISHED.

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                62  N*1/2(1520) MASS (MEV)

M         (1530.0)                         BRANDSEN  65 RVUE    PHASE-SHIFT ANAL  9/66
M         (1536.0)                         ROPER     65 RVUE    PHASE-SHIFT ANAL  9/66
M    1    (1510.0)                         BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
M    1            WHERE CROSS SECTICN IS GREATEST - EYEBALL FIT
M    3    (1541.0)                         DCNNACH1  68 RVUE    PHASE-SHIFT ANAL  6/68
M    6    (1523.0)                         AYED      70 IPWA                      1/71
M    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4    (1512.0)                         DAVIES    70 RVUE    P-S ANAL   SOL A  8/69
M    7    (1520.)                          ALMEHED   72 IPWA                      2/72
M         (1525.)                          AYED      74 IPWA                      2/74
M          1501. TO 1503.                  CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
M     L    1524. OR 1520.                  LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
M     L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.       11/75*
M         (1503.)                          BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*

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                62  N*1/2(1520) WIDTH (MEV)

W    1     (125.0)                         BAREYRE   68 RVUE                     11/67
W    3     (149.0)                         DCNNACH1  68 RVUE                      6/68
W    6     (131.0)                         AYED      70 IPWA                      1/71
W    4     (106.0)                         DAVIES    70 RVUE    P-S ANAL   SOL A
W    7     (120.)                          ALMEHED   72 IPWA                      2/72
W          (122.)                          AYED      74 IPWA                      2/74
W           115. TO  150.                  CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
W     L     120. OR  150.                  LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
W          (137.)                          BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*
       SEE THE NOTES ACCOMPANYING THE MASSES CUOTEC.

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                62  N*1/2(1520) REAL PART OF POLE PCSITICN (MEV)               11/75*

RE         (1514.)                         LCNGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                62  N*1/2(1520) 2*IMAG PART CF POLE POSITICN (MEV)             11/75*

IM         (146.)                          LCNGACRE  75 IPWA    PI N TO 2PI N    11/75*

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Baryons
N(1520)

Data Card Listings
For notation, see key at front of Listings.

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                 62  N*1/2(1520) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      N*1/2(1520) INTO PI N                                 139+ 938
P2      N*1/2(1520) INTO N*3/2(1232) PI                      1232+ 139
P3      N*1/2(1520) INTO N PI PI                              938+ 139+ 139
P4      N*1/2(1520)+ INTO NEUTRON PI+                         939+ 139
P5      N*1/2(1520)+ INTO PROTON PI+ PI-                      938+ 139+ 139
P6      N*1/2(1520) INTO N ETA                                939+ 548
P7      N*1/2(1520) INTO N EPSILON                            938+1200
P8      N*1/2(1520) INTO N RHO                                938+ 773
P9      N*1/2(1520) INTO GAM P, HELICITY=1/2                    0+ 938
P10     N*1/2(1520) INTO GAM P, HELICITY=3/2                    0+ 938
P11     N*1/2(1520) INTO GAM N, HELICITY=1/2                    0+ 939
P12     N*1/2(1520) INTO GAM N, HELICITY=3/2                    0+ 939
P13     N*1/2(1520) INTO K LAMBDA                             497+1115
P14     N*1/2(1520) INTO N*3/2(1232) PI,S-WAVE               1232+ 139
P15     N*1/2(1520) INTO N*3/2(1232) PI,D-WAVE               1232+ 139
P16     N*1/2(1520) INTO N RHO,S=3/2,S-WAVE                   938+ 773

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                 62  N*1/2(1520) BRANCHING RATIOS

R1      N*1/2(1520) INTO (PI N)/TOTAL                        (P1)
R1  1        (0.54)                  BAREYRE    68 RVUE                          11/67
R1  3        (0.509)                 DONNACH1   68 RVUE                           6/68
R1  6        (0.593)                 AYED       70 IPWA                           1/71
R1  4        (0.45)                  DAVIES     70 RVUE    P-S ANAL   SOL A       8/69
R1  7        (0.58)                  ALMEHED    72 IPWA                           2/72
R1            (.558)                 AYED       74 IPWA                           2/74
R1      SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
R1
R1  ALMOST THE ENTIRE INELASTICITY IS IN N PI PI (CNLY N ETA COULD COMPETE,
R1  AND IT DOESNT).  THE N PI PI SEEMS TO BE MAINLY N*3/2(1232) PI, IN BCTH
R1  S AND D WAVES.

R2      N*1/2(1520) INTO (N*3/2(1232) PI)/TOTAL              (P4)
R2             0.20      0.05        KIRZ       66 HBC   0 ASSUMING R1=0.72   9/66
R2             DOMINANT INEL DECAY   OLSSON     66 RVUE    PI P TO PI PI N    9/66
R2  D        (0.40)                  DIEM       70 IPWA    3 BODY ANALYSIS    1/71
R2  D      ASSUMING  R1= 0.5

R3      N*1/2(1520) INTO (N*3/2(1232) PI)/(N PI PI)          (P2)/(P3)
R3              LARGE                THURNAUER 65 RVUE -                     11/67
R3              LARGE                NAMYSLOWS 66 RVUE -                     11/67
R3              LARGE                ROBERTS    67 RVUE -                     11/67
R3              LARGE                ROSENFELD 67 RVUE -                     11/67
R3              LARGE                MORGAN     68 RVUE    ISOBAR MODEL       6/68

R4      N*1/2(1520) INTO (N EPSILCN)/TCTAL                   (P7)
R4            PROBABLY PRESENT       MORGAN     68 RVUE    ISOBAR MODEL       6/68
R4  D        (0.02)                  DIEM       70 IPWA    3 BODY ANALYSIS    1/71
R4  D      ASSUMING  R1= 0.5

R5      N*1/2(1520) INTO (N ETA)/TOTAL                       (P6)
R5  D        (0.006)   APPROX        DAVIES     67 RVUE                      11/67
R5   CAVIES 67 GIVES SEVERAL VALUES DEPENDING ON INPUT DATA.  ALL ARE SMALL
R5  B        (0.014)                 BOTKE      69 MPWA    T POLE+ RESON.    10/69
R5  B        (0.003)  (0.001)        DEANS      69 MPWA    T POLE+ RESCN.     5/70
R5  B        (0.002)OR 0.004         CARRERAS   70 MPWA    T POLE+ RESCN.     5/70
R5  B    PARAMETRIZATION USEC COULD BE IN DANGER OF DOUBLE COUNTING
R5             SEEN                  LEMOIGNE   73 DPWA    1488 TC 1685 MEV   2/74

R6      N*1/2(1520) INTO (N RHO )/TOTAL                      (P8)
R6  D        (0.07)                  DIEM       70 IPWA    3 BODY ANALYSIS    1/71
R6  D      ASSUMING  R1= 0.5

R7      N*1/2(1520) FROM PI N TO K LAMBDA                    SQRT(P1*P13)        4/75*
R7 C          -.076      .032        DEVENISH   74          0 FIXED T DISP REL   4/75*
R7 C     EXTRAPOLATION OF PARAMETRIZED AMPLITUDE BELOW THRESHOLD.                4/75*

R8      N*1/2(1520) FRCM PI N INTC N EPSILON                 SQRT(P1*P7)         11/75*
R8   L       (0.0) OR  +.17          LONGACRE   75 IPWA    PI N TO 2PI N     11/75*

R9      N*1/2(1520) FROM PI N TO N*3/2(1232) PI,S-WAVE       SQRT(P1*P14)        11/75*
R9   L       (+.27)OR  +.24          LONGACRE   75 IPWA    PI N TO 2PI N     11/75*

R10     N*1/2(1520) FROM PI N TO N*3/2(1232) PI,D-WAVE       SQRT(P1*P15         11/75*
R10  L       (+.24)OR  +.30          LONGACRE   75 IPWA    PI N TO 2PI N     11/75*

R11     N*1/2(1520) FROM PI N TO N RHO,S=3/2,S-WAVE          SQRT(P1*P16)        11/75*
R11  L       (+.32)OR  +.24          LONGACRE   75 IPWA    PI N TO 2PI N     11/75*

R12     N*1/2(1520) FROM PI N TC ETA N                       SQRT(P1*P6)          1/76*
R12  9       (-.011)OR +.058         FELTESSE   75 DPWA  0 1488 TO 1745 MEV   1/76*
R12  9   SUPERCEDES LEMOIGNE 73, USES M AND W OF AYED 74.                        1/76*

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                 62  N*1/2(1520) PHOTCN DECAY AMPL(GEV**-1/2)

     FOR DEFINITICN OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
   REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*1/2(1520) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1            .010      .022         DEVENISH  73 DPWA    PI N PHOTO PROD     2/74
A1          (-.026)                  HEMMI1    73       + FWD PIO PHTOPRCD    2/74
A1           -.026      .015         MOORHOUS  73 DPWA    PI N PHOTO-PROD     2/73
A1           -.008      .015         DEVENIS2  74 DPWA    PI N PHOTC-PRCD     4/75*
A1           -.019      .008         KNIES     74 DPWA    PI N PHOTC PROD     2/74
A1           -.006      .006         METCALF   74 DPWA    PI N PHOTO-PROD     2/74
A1            .000      .006         MOORHOUS  74 DPWA    PI N PHOTO-PROD     2/74
A1           -.009      .004         CRAWFORD  75 DPWA    PI N PHOTO-PROD     1/76*
A1          (-.012)                  BARBOUR   76 DPWA    PI N PHOTO-PROD     1/76*
A1            . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A2      N*1/2(1520) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2            .180      .017         DEVENISH  73 DPWA    PI N PHOTO PROD     2/74
A2           +.194      .031         MOORHOUS  73 DPWA    PI N PHOTO-PRCD     2/73
A2            .171      .012         DEVENIS2  74 DPWA    PI N PHOTO-PROD     4/75*
A2            .169      .012         KNIES     74 DPWA    PI N PHOTC PROD     2/74
A2           +.165      .011         METCALF   74 DPWA    PI N PHOTO-PRCD     2/74
A2            .174      .006         MOORHOUS  74 DPWA    PI N PHOTO-PRCD     2/74
A2           +.162      .004         CRAWFORD  75 DPWA    PI N PHOTO-PROD     1/76*
A2          (+.158)                  BARBOUR   76 DPWA    PI N PHOTC-PRCD     1/76*
A2            . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A3      N*1/2(1520) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3           -.075      .037         DEVENISH  73 DPWA    PI N PHOTO PROD     2/74
A3           -.085      .014         MOORHOUS  73 DPWA    PI N PHOTO-PROD     2/73
A3 2         +.037      .012         ROSSI     73 CPWA  0 GAM N TO PI- P      4/75*
A3 2   CONVERTED TO OUR CONVENTIONS USING M AND W FROM ROSSI73 AND X=.56      4/75*
A3          (0.)                     BENEVENT  74 DPWA  0 GAM N TO PI- P      4/75*
A3           -.089      .019         DEVENIS2  74 DPWA    PI N PHOTO-PROD     4/75*
A3           -.077      .005         KNIES     74 DPWA    PI N PHOTO PRCD     2/74
A3           -.066      .010         METCALF   74 DPWA    PI N PHOTO-PROD     2/74
A3           -.088      .007         MOORHOUS  74 DPWA    PI N PHOTO-PROD     2/74
A3           -.067      .004         CRAWFORD  75 DPWA    PI N PHOTO-PRCD     1/76*
A3          (-.056)                  BARBOUR   76 DPWA    PI N PHOTO-PROD     1/76*
A3            . . . . . . . . .
A3  AVERAGE MEANINGLESS (SCALE FACTOR = 3.9)

A4      N*1/2(1520) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4           -.126      .028         DEVENISH  73 DPWA    PI N PHOTO PRCD     2/74
A4 8        (-.087)                  HEMMI2    73       0 GAM N TO PIO N      4/75*
A4 8   CONVERTED TO OUR CONVENTIONS USING M AND W FROM WALKER69 AND X=.56     4/75*
A4 2         -.016      .016     .018 ROSSI    73 CPWA  0 GAM N TO PI- P      4/75*
A4           -.124      .013         MOORHOUS  73 DPWA    PI N PHOTO-PROD     2/73
A4 5        (-.035)                  BENEVENT  74 CPWA  0 GAM N TO PI- P      4/75*
A4 5   CONVERTED TO OUR CONVENTIONS USING M=1520 MEV, W=120 MEV, X=.56        4/75*
A4           -.155      .019         DEVENIS2  74 DPWA    PI N PHOTO-PROD     4/75*
A4           -.120      .010         KNIES     74 DPWA    PI N PHOTO PROD     2/74
A4           -.118      .013         METCALF   74 DPWA    PI N PHOTO-PRCD     2/74
A4           -.119      .025         MOORHOUS  74 DPWA    PI N PHOTO-PROD     2/74
A4           -.133      .003         CRAWFORD  75 DPWA    PI N PHOTO-PROD     1/76*
A4          (-.136)                  BARBOUR   76 DPWA    PI N PHOTO-PRCD     1/76*
A4            . . . . . . . . .
A4  AVERAGE MEANINGLESS (SCALE FACTOR = 3.1)

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                        REFERENCES FOR N*1/2(1520)

        SEE A PREVIOUS EDITICN (RMP 37, 633, 1965) FOR EARLIER REFERENCES.

BRANDSEN 65 PR 139 B1566      +ODCNNELL, MCORHOUSE          (DURHAM, RHEL)IJP
ROPER    65 PR 138 B190       LD ROPER,RM WRIGHT,BT FELD   (LRL-LVMR,MIT)IJP
THURNAUE 65 PRL 14 985        P G THURNAUER                         (ROCH)

KIRZ     66 PRIVATE COMM      J KIRZ                                 (LRL)
    NUMBER EXTRACTED FRCM CATA DISCUSSED IN KIRZ 63. Z 63.
NAMYSLOW 66 PR 157 1328       NAMYSLOWSKI,RAZMI,ROBERTS  (STAN,EDIN,LOIC)
OLSSON   66 PR 145 1309       M G OLSSON, G B YODH                (WISC,UMD)

DAVIES   67 NC 52A 1112       A T DAVIES, R G MOORHOUSE  (GLASGOW, RHEL)
ROBERTS  67 PREPRINT          R G ROBERTS                         (DURHAM)
ROSENFEL 67 IRVINE CONF       A H ROSENFELD, P SODING                (LRL)

BAREYRE  68 PR 165 1731       P BAREYRE, C BRICMAN, G VILLET     (SACLAY)IJP
DONNACH1 68 PL 26B 161        A DCNNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139        DONNACHIE  RAPPORTEUR.S TALK          (GLAS)
    ALSO 68 THESIS            R G KIRSOPP                           (EDIN)
MORGAN   68 PR 166 1731       D MCRGAN                              (RHEL)

BOTKE    69 PR 180 1417       J C BOTKE                             (UCSB)
DEANS    69 PR 185 1797       S DEANS, J WOOTEN          (UNIV S FLORICA)

AYED     70 KIEV CONF         R AYED,P BAREYRE, G VILLET          (SACL)IJP
CARRERAS 70 NP 16B 35         B CARRERAS, A DONNACHIE         (DARE,MCHS)
DAVIES   70 NP B21 359        A DAVIES                              (GLAS)
DIEM     70 KIEV CONF.        + SMADJA, CHAVANON, DELER, DOLBEAU+  (SACL)
ALMEHED  72 NP B40 157        +LOVELACE                      (LUND,RUTG)IJP

DEVENISH 73 PL 47B 53         DEVENISH,RANKIN,LYTH      (LOUC+BONN+LANC)IJP
HEMMI1   73 PL 43B 79         HEMMI,INAGAKI+        (KYOTO+SAGA+KEK+TOKY)IJP
HEMMI2   73 NP B55 333        +INAGAKI,KIKUCHI,MAKI,MIYAKE+ (KYOTO,TOKYO)IJP
LEMOIGNE 73 PURDUE CONF. 93   +GRANET,MARTY,AYED,BAREYRE,BORGEAUD,+(SACL)IJP
MCORHOUS 73 PL 43B 44         MOORHOUSE, OBERLACK             (GLAS+LBL)IJP
ROSSI    73 NC 13A 59         +PIAZZA,SUSINNO,+     (ROMA,FRAS,NAPL,PAVIA)IJP
    ALSO 71 LNC 2 1183        CARBONARA,FIORE,+     (NAPL,FRAS,PAVIA,ROMA)IJP

AYED     74 PRIVATE COMMCTN.  AYED,BAREYRE                        (SACL)IJP
    ALSO 73 AIX CONFERENCE    AYED,BAREYRE                        (SACL)IJP
BENEVENT 74 NC 19A 529        BENEVENTANO,DANGELO,NOTARISTEFANI,+ (RCMA)IJP
DEVENISH 74 NP B81 330        DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227        DEVENISH,LYTH,RANKIN       (DESY,LANC,BCNN)IJP
KNIES    74 PRD 9 2680        KNIES,MOORHOUSE,OBERLACK        (LBL,GLAS)IJP
METCALF  74 NP B76 253        W J METCALF,R L WALKER               (CIT)IJP
MOORHOUS 74 PRD 9 1           MOORHOUSE,OBERLACK,RCSENFELD    (GLAS+LBL)IJP

CRAWFCRD 75 NP B97 125        R L CRAWFORD                        (GLAS)IJP
FELTESSE 75 NP B93 242        +AYED,BAREYRE,BORGEAUD,DAVID,ERNWEIN+(SACL)IJP
LONGACRE 75 PL 55B 415        +ROSENFELD,LASINSKI,SMADJA+     (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP      I. M. BARBOUR,R. L. CRAWFCRD        (GLAS)IJP

                              PAPERS NOT REFERREC TO IN CATA CARDS.

KIRZ     63 PR 130 2481       J KIRZ, J SCHWARTZ, R D TRIPP          (LRL)
BAREYRE  65 PL 18 342         + BRICMAN, STIRLING, VILLET        (SACLAY)IJP
CROUCH   65 DESY CONF II 21   +   (BROWN,CEA,HARVARD,MIT,PADOVA,WEIZMANN)
DERADO   65 ATHENS CONF 244   +KENNEY,LAMSA, +       (NOTRE DAME,KENTUCKY)
MERLO    66 P ROY SOC 289 489 J P MERLO, G VALLACAS               (SACLAY)
    THE ABOVE PAPERS DISCUSS INELASTIC CHANNELS NEAR THE REONANCE.
JOHNSON  67 UCRL-17683 THESIS C H JOHNSCN                            (LRL)
DEANS    69 PRL 177 2623      S R DEANS                  (UNIV S FLORIDA)
DCNNACHI 69 NP 10B 433        A DONNACHIE, R KIRSOPP           (GLAS+EDIN)
WALKER   69 PR 182 1729       R L WALKER                      (CAL TECH)IJP
AYED     70 PL 31B 598        +BAREYRE+VILLET                     (SACLAY)

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Data Card Listings

For notation, see key at front of Listings.

Baryons
N(1535)

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N(1535)   63  N*1/2(1535, JP=1/2-) I=1/2   S'11

              THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.
              IT IS STRONGLY ASSOCIATED WITH THE ETA N CHANNEL.

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                  63  N*1/2(1535) MASS (MEV)

M          (1519.0)                   HENDRY    65 RVUE   ETA N + S11 PI N  9/66
M          (1570.0)                   MICHAEL   66 RVUE   FITS BAREYRE S11  7/66
M    N     (1557.0) OR  1565.0        UCHIYAMA- 66 RVUE   FITS N ETA DATA   9/66
M    N      FITTING GIVES TWO SOLUTIONS.  PROBLEMS MATCHING PI P PHASE SHIFT
M    1     (1535.0)                   BAREYRE   68 RVUE   PHASE-SHIFT ANAL 11/67
M    1            WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3     (1591.0)                   DONNACH1  68 RVUE   PHASE-SHIFT ANAL  6/68
M          (1535.0)    (10.0)         DELCOURT  69 CNTR   PHOTOPRODUCT.     8/69
M    6     (1534.0)                   AYED      70 IPWA                     1/71
M    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4     (1502.0)                   DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
M    7     (1500.)                    ALMEHED   72 IPWA                     2/72
M     2    (1551.)                    HICKS     73 MPWA   GAM P-ETA P       9/73
M     2  ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUDED IN LISTINGS.    9/73
M     2  M AND W ARE FROM SOLUTION C2,BR=SQRT(G)/W WITH G FROM TABLE VII.   9/73
M          (1520.)                    AYED      74 IPWA                     2/74
M           1507. TO 1530.            CRAWFORD  75 DPWA   PI N PHOTO-PROD   1/76*
M     L     1520. OR 1510.            LONGACRE  75 IPWA   PI N TO 2PI N    11/75*
M     L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.  11/75*
M          (1501.)                    BARBOUR   76 DPWA   PI N PHOTO-PROD   1/76*

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                  63  N*1/2(1535) WIDTH (MEV)

W           (130.0)                   HENDRY    65 RVUE                     9/66
W           (130.0)                   MICHAEL   66 RVUE                     7/66
W    N      (156.0) OR  144.0         UCHIYAMA- 66 RVUE   SEE NOTE ON MASS  9/66
W    1      (155.0)                   BAREYRE   68 RVUE                    11/67
W    3      (268.0)     APPROX        DONNACH1  68 RVUE                     6/68
W           (120.0)                   DELCOURT  69 CNTR   PHOTOPRODUCT.     8/69
W    6       (96.0)                   AYED      70 IPWA                     1/71
W    4       (36.0)                   DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
W    7       (50.)                    ALMEHED   72 IPWA                     2/72
W     2     (134.)                    HICKS     73 MPWA   GAM P-ETA P       9/73
W            (80.)                    AYED      74 IPWA                     2/74
W            114. TC  167.            CRAWFORD  75 DPWA   PI N PHOTO-PROD   1/76*
W     L       75. OR  100.            LONGACRE  75 IPWA   PI N TO 2PI N    11/75*
W           (128.)                    BARBOUR   76 DPWA   PI N PHOTO-PROD   1/76*
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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                  63  N*1/2(1535) REAL PART OF POLE PCSITION (MEV)         11/75*

RE        (1496.)                     LONGACRE  75 IPWA   PI N TO 2PI N    11/75*

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                  63  N*1/2(1535) 2*IMAG PART OF POLE POSITICN (MEV)       11/75*

IM        (103.)                      LONGACRE  75 IPWA   PI N TC 2PI N    11/75*

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                  63  N*1/2(1535) PARTIAL DECAY MODES

                                                     DECAY MASSES
P1      N*1/2(1535) INTO PI N                       139+ 938
P2      N*1/2(1535) INTC N ETA                      939+ 548
P3      N*1/2(1535) INTO N PI PI                    938+ 139+ 139
P4      N*1/2(1535) INTO N EPSILCN                  938+1200
P5      N*1/2(1535) INTO N*3/2(1232) PI            1232+ 139
P6      N*1/2(1535) INTO N RHO                      938+ 773
P7      N*1/2(1535) INTO GAM P, HELICITY=1/2          0+ 938
P8      N*1/2(1535) INTO GAM N, HELICITY=1/2          0+ 939
P9      N*1/2(1535) INTO K LAMDBA                   497+1115
P10     N*1/2(1535) INTO N RHO,S=1/2,S-WAVE         938+ 773

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                  63  N*1/2(1535) BRANCHING RATICS

R1      N*1/2(1535) INTO (PI N)/TOTAL                     (P1)
R1           (0.69)                 HENDRY    65 RVUE                       9/66
R1           (0.32)                 MICHAEL   66 RVUE                       9/66
R1   N       (0.71) OR  0.28        UCHIYAMA- 66 RVUE   SEE NOTE ON MASS    9/66
R1           (0.31) OR  0.43        DAVIES    67 RVUE   PIP TO N ETA,B,C   11/67
R1   3       (0.696)                DONNACH1  68 RVUE                       6/68
R1           (0.33)                 DELCOURT  69 CNTR                       8/69
R1   6       (0.397)                AYED      70 IPWA                       1/71
R1   4       (0.36)                 DAVIES    70 RVUE   P-S ANAL  SCL A     8/69
R1   7       (0.25)                 ALMEHED   72 IPWA                       2/72
R1            (.36)                 AYED      74 IPWA                       2/74

R2      N*1/2(1535) INTO (N ETA)/TOTAL                    (P2)
R2            DOMINANT INEL DECAY   HENDRY    65 RVUE                       9/66
R2           (0.68)                 MICHAEL   66 RVUE                       9/66
R2   N       (0.29) OR  0.71        UCHIYAMA- 66 RVUE   SEE NOTE CN MASS    9/66
R2           (0.69) OR  0.45        DAVIES    67 RVUE   PIP TO N ETA,B,C   11/67
R2   B       (0.4)     (0.1)        DEANS     69 MPWA   T POLE+ RESON.      5/70
R2           (0.66)                 DELCOURT  69 MPWA                       8/69
R2   B       (0.69) OR  0.696       CARRERAS  70 MPWA   T POLE+ RESCN.      5/70
R2   B    PARAMETRIZATION USEC COULD BE IN DANGER OF DOUBLE COUNTING
R2      THE VALUES OF R2 LISTED ABOVE ARE INCOMPATIBLE WITH THE RESULTS
R2      OF DIEM ET AL. (70)

R3      N*1/2(1535) INTO (N*3/2(1232) PI)/TOTAL           (P5)
R3   D       (0.07)                 DIEM      70 IPWA    3 BODY ANALYSIS    1/71
R3   D     ASSUMING  R1= 0.34

R4      N*1/2(1535) INTC (N EPSILCN)/TCTAL                (P4)
R4   D       (0.26)                 DIEM      70 IPWA    3 BODY ANALYSIS    1/71
R4   D     ASSUMING  R1= 0.34

R5      N*1/2(1535) INTO (N RHO )/TOTAL                   (P6)
R5   D       (0.20)                 DIEM      70 IPWA    3 BODY ANALYSIS    1/71
R5   D     ASSUMING  R1= 0.34

R6      N*1/2(1535) INTO GAMMA PROTCN/TOTAL                    (P7)          9/73
R6   5        .0042     .0014        DEANS     72 MPWA    P ETA PHOTOPROD.   9/73
R6   5  BR=(DEANS72 RADIATIVE WIDTH)/(NOMINAL FULL WIDTH=100 MEV)           9/73
R6   5  THE HICKS73 ENTRY UNDER R7 IS A MORE RECENT RESULT BY SAME GROUP.   9/73

R7      N*1/2(1535) FROM GAMMA PROTON TO ETA PROTON       SQRT(P2*P7)        9/73
R7   2        (.0366)                HICKS     73 MPWA    GAM P-ETA P        9/73

R8      N*1/2(1535) FROM PI N INTO ETA N                  SQRT(P1*P2)        2/74
R8         (+.43)                    LEMOIGNE  73 CPWA    1488 TC 1685 MEV   2/74
R8   A     (+.48)                    FELTESSE  75 DPWA  0 1488 TO 1745 MEV  11/75*
R8   A  SUPERCEDES LEMOIGNE 73, USES M AND W OF AYED 74.                    11/75*

R9      N*1/2(1535) FROM PI N TO K LAMBDA                 SQRT(P1*P9)        4/75*
R9 C        -.691      .214          DEVENISH  74         0 FIXED T DISP REL 4/75*
R9 C    EXTRAPOLATION OF PARAMETRIZED AMPLITUCE BELOW THRESHOLD.             4/75*

R10     N*1/2(1535) FROM PI N TO N*3/2(1232) PI           SQRT(P1*P5)       11/75*
R10  L      (0.0) OR  -.06           LCNGACRE  75 IPWA    PI N TO 2PI N     11/75*

R11     N*1/2(1535) FROM PI N TO N RHO,S=1/2,S-WAVE       SQRT(P1*P10)      11/75*
R11  L      (+.12)OR  +.09           LCNGACRE  75 IPWA    PI N TO 2PI N     11/75*

R12     N*1/2(1535) FROM PI N TO N EPSILON                SQRT(P1*P4)       11/75*
R12  L      (.1) OR  -.09            LCNGACRE  75 IPWA    PI N TO 2PI N     11/75*

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                  63  N*1/2(1535) PHOTON DECAY AMPL(GEV**-1/2)

        FOR DEFINITION OF GAMMA-NUCLECN DECAY AMPLITUDES, SEE MINI-
       REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*1/2(1535) INTO GAM P, HELICITY=1/2 (GEV**-1/2)
A1             .042       .023       DEVENISH  73 DPWA    PI N PHOTO PRCD    2/74
A1            (.015)                 HEMMI1    73       + FWD PIO PHTOPROD   2/74
A1            +.053       .020       MOORHOUS  73 DPWA    PI N PHOTO-PRCD    2/73
A1             .078       .020       DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A1             .056       .020       KNIES     74 DPWA    PI N PHOTO PROD    2/74
A1            +.063       .013       METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A1             .036       .002       MOORHOUS  74 DPWA    PI N PHOTC-PROD    2/74
A1            +.082       .007       CRAWFORD  75 DPWA    PI N PHOTO-PROD    1/76*
A1           (+.063)                 BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A1                . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 4.6)

A2      N*1/2(1535) INTO GAM N, HELICITY=1/2 (GEV**-1/2)
A2            -.026       .029       DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A2            -.048       .021       MOORHCUS  73 DPWA    PI N PHOTO-PROD    2/73
A2 8          -.031       .024       ROSSI     73 DPWA  0 GAM N TO PI- P     4/75*
A2 8    CCNVERTED TO OUR CONVENTIONS USING M AND W FROM ROSSI73 AND X=.36    4/75*
A2 9          (-.078)                BENEVENT  74 DPWA  0 GAM N TO PI- P     4/75*
A2 9    CONVERTED TO OUR CONVENTIONS USING M=1520 MEV, W=80 MEV, X=.36       4/75*
A2            -.037       .023       DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A2            -.052       .005       KNIES     74 CPWA    PI N PHOTO PRCD    2/74
A2            -.051       .021       METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A2            -.027       .009       MOORHOUS  74 DPWA    PI N PHOTO-PROD    2/74
A2            -.088       .011       CRAWFORD  75 DPWA    PI N PHOTO-PROD    1/76*
A2           (-.109)                 BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A2                . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)

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                           REFERENCES FOR N*1/2(1535)
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HENDRY    65 PL 18 171         A W HENDRY, R G MOORHOUSE             (RHEL)
    REVIEWS EARLY PHASE-SHEFT-ANALYSIS RESULTS AND PI- P TO ETA N
    EXPERIMENTS. WE TAKE NUMBERS FROM THE SOLUTION USING BRANDSEN 65.
MICHAEL   66 PL 21 93          C MICHAEL                              (OXF)
UCHIYAMA  66 PR 149 1220       F UCHIYAMA-CAMPBELL, R K LCGAN      (ILL)IJP
DAVIES    67 NC 52A 1112       A T DAVIES, R G MOORHOUSE     (GLASGOW,RHEL)

BAREYRE   68 PR 165 1731       P BAREYRE, C BRICMAN, G VILLET    (SACLAY)IJP
DONNACH1  68 PL 26B 161        A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO  68 VIENNA 139        DONNACHIE  RAPPORTEUR.S TALK          (GLAS)
    ALSO  68 THESIS            R G KIRSOPP                           (EDIN)
DEANS     69 PR 185 1797       S DEANS, J WOCTEN            (UNIV S FLORIDA)
DELCCURT  69 PL 29B 75         DELCOURT,LEFRANCOIS,PEREZ-Y-JORBA,+  (ORSA)

AYED      70 KIEV CONF         R AYED,P BAREYRE, G VILLET          (SACL)IJP
CARRERAS  70 NP 16B 35         B CARRERAS, A DONNACHIE         (DARE,MCHS)
DAVIES    70 NP B21 359        A DAVIES                              (GLAS)
DIEM      70 KIEV CONF.        + SMADJA, CHAVANON, DELER, DOLBEAU+  (SACL)

ALMEHED   72 NP B40 157        +LOVELACE                      (LUND,RUTG)IJP
DEANS     72 PN 3 217          +JACOBS, LYONS, HICKS   (U S FL TAMPA+CARN)
DEVENISH  73 PL 47B 53         DEVENISH,RANKIN,LYTH        (LOUC+BONN+LANC)IJP
HEMMI1    73 PL 43B 79         HEMMI,INAGAKI+         (KYOTO+SAGA+KEK+TOKY)IJP
HICKS     73 PRD 7 2614        +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP
LEMOIGNE  73 PURDUE CONF. 93   +GRANET,MARTY,AYED,BAREYRE,BORGEAUD,+(SACL)IJP
MOORHOUS  73 PL 43B 44         MOORHOUSE, OBERLACK               (GLAS+LBL)IJP
ROSSI     73 NC 13A 59         +PIAZZA,SUSINNO,+      (ROMA,FRAS,NAPL,PAVIA)IJP
    ALSO  71 LNC 2 1183        CARBONARA,FIORE,+      (NAPL,FRAS,PAVIA,ROMA)IJP

AYED      74 PRIVATE COMMCTN.  AYED,BAREYRE                          (SACL)IJP
    ALSO  73 AIX CONFERENCE    AYED,BAREYRE                          (SACL)IJP
BENEVENT  74 NC 19A 529        BENEVENTANO,DANGELO,NOTARISTEFANI,+  (ROMA)IJP
DEVENISH  74 NP B81 330        DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2  74 PL 52B 227        DEVENISH,LYTH,RANKIN        (DESY,LANC,BONN)IJP
KNIES     74 PRD 9 2680        KNIES,MOORHOUSE,OBERLACK          (LBL,GLAS)IJP
METCALF   74 NP B76 253        W J METCALF,R L WALKER                 (CIT)IJP
MOORHOUS  74 PRD 9 1           MCORHOUSE,OBERLACK,RCSENFELD      (GLAS+LBL)IJP

CRAWFORD  75 NP B97 125        R L CRAWFORD                          (GLAS)IJP
FELTESSE  75 NP B93 242        +AYED,BAREYRE,BORGEAUD,DAVID,ERNWEIN+(SACL)IJP
LONGACRE  75 PL 55B 415        +ROSENFELD,LASINSKI,SMADJA+       (LBL,SLAC)IJP

BARBOUR   76 SBMTD. TO NP      I. M. BARBOUR,R. L. CRAWFORD          (GLAS)IJP

                               PAPERS NCT REFERRED TO IN CATA CARDS.

BAREYRE   65 PL 18 342         + BRICMAN, STIRLING, VILLET        (SACLAY)IJP
BRANDSEN  65 PR 139 B1566      +ODONNELL, MCORHOUSE           (DURHAM, RHEL)IJP
    BASIS OF NUMBERS WE QUOTE FROM HENDRY 65.
JOHNSON   67 UCRL-17683 THESIS C H JOHNSON                            (LRL)
LOVELACE  67 HEIDELBERG C. 79  C LOVELACE                            (CERN)IJP
DONNACHI  69 NP 10B 433        A DONNACHIE, R KIRSOPP             (GLAS+EDIN)
AYED      70 PL 31B 598        +BAREYRE+VILLET                       (SACLAY)
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Baryons
N(1535), N(1670)

Data Card Listings
For notation, see key at front of Listings.

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     THE FOLLOWING ARTICLES DEAL WITH THE REACTIONS PI- P TO ETA N
     AND GAMMA P TO ETA P NEAR THRESHOLD. THE DATA AND THE THEORETICAL
     ARTICLES ARE USEFUL IN UNDERSTANDING THE BEHAVIOR OF THE S11 AMPLI-
     TUDE AS DETERMINED IN PI P PHASE-SHIFT ANALYSES. FURTHER REFERENCES
     MAY BE FOUND IN THEM.
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     MAINLY EXPERIMENTAL --
BULOS    64 PRL 13 486     +        (BROWN,BRANDEIS,HARVARD,MIT,PADOVA) I
BACCI    66 NC 45A 983     +PENSO,SALVINI,MENCUCCINI,+ (ROMA,FRASCATI)IJP
JONES    66 PL 23 597      +BINNIE,DUANE,HORSEY,MASON,+       (LOIC,RHEL)
RICHARDS 66 PRL 16 1221    +CHIU,EANDI,HELMHOLZ,KENNEY,+ (LRL,HAWAII) IJ
PREPOST  67 PRL 18 82      R PREPOST, D LUNDQUIST, D QUINN    (STANFORD)
BLOCM    68 PRL 21 1100    +HEUSCH, PRESCOTT, ROCHESTER            (CIT)
BULOS    69 PR 187 1827    +LANOU,BORDNER,BASTIEN+(BOST+HARV+MIT+PENN)
HEUSCH   70 PRL 25 1381    +PRESCOTT,ROCHESTER,WINSTEIN            (CIT)
BINNIE   73 PRD 8 2789     +CAMILLERI,DEBENHAM,DUANE,+       (LOIC,SHMP)
     MAINLY THEORETICAL --
BALL     66 PR 149 1191    J S BALL                               (UCLA)
DOBSCN   66 PR 146 1022    P N DOBSON                           (HAWAII)
MINAMI   66 PR 147 1123    S MINAMI                              (OSAKA)
DEANS    67 PR 161 1466    S R DEANS, W G HOLLADAY         (VANDERBILT)
LOGAN    67 PR 153 1634    R K LOGAN, F UCHIYAMA-CAMPBELL          (ILL)
MENCUCCI 67 NC 48A 579     C MENCUCCINI, A REALE              (FRASCATI)
MINAMI   67 PR 162 1619    S MINAMI                              (OSAKA)
MOSS     67 PR 163 1785    T A MOSS                                (LSU)
DEANS    68 PR 165 1886    S R DEANS, W G HOLLADAY         (VANDERBILT)
PAL      68 PR 167 1350    B K PAL                          (NPL NEW DELHI)
BALL     69 PR 177 2257    +GARG+SHAW                         (UCLA+UCI)
LEFIEVRE 70 NC 66A 349     +LERUSTE                               (CDEF)
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1520 MEV REGION – PRODUCTION EXPERIMENTS

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          8  N*1/2(1520, JP=     ) I=1/2    PRODUCTION EXPERIMENTS

          THIS INFORMATION REFERS TO EITHER THE D13 OR THE S11
          STATE SEEN AT THIS MASS.  FOR SPIN-PARITY ANALYSIS OF
          THIS MASS REGION, SEE JOHNSTAD 72.
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          8  N*1/2(1520) MASS (MEV) (PROD. EXP.)

M        1507.0     6.0          A-BORELLI 67 HBC   0 PBAR P 5.7 GEV   10/71
M        1503.      6.           ANDERSON  70 MMS  -  PI- P TO PI- MMS  2/71
M        1500.0    10.0          AMALDI    71 CNTR    P P AT 24 GEV    10/71
M        1512.0     2.0          ELLIS     71 CNTR    MMS PP 3.7 GEV/C 10/71
M        1501.0     5.7          EDELSTEIN 72 MMS  +  PP 6 TO 30 GEV    1/73
M   1   (1500.)                  OH        72 DBC   0 PI-N TO PI-P-P    2/73
M   1  DETERMINE J=3/2,D13 PROBABLE                                     2/73
M        1515.     11.           COOPER    74 HBC   0 D P CEX          4/75*
M       (1490.)                  BRAUN1    75 HBC     PBAR P 5.7 GEV  11/75*
M        1510.      7.           MUSGRAVE  75 HBC     K+ P TO K PI N  11/75*
M       (1500.)                  STRACHMA  75  BC     NBAR (N PI)      1/76*
M        1500.      8.           WEBB      75 ISR  +  P P TO P N*      1/76*
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          8  N*1/2(1520) WIDTH (MEV) (PROD. EXP.)

W          55.0    15.0          A-BORELLI 67 HBC   0 PBAR P 5.7 GEV   10/71
W         120.     10.           ANDERSON  70 MMS  -  PI- P TO PI- MMS  2/71
W         118.0    20.0          AMALDI    71 CNTR    P P AT 24 GEV    10/71
W          88.0     2.0          ELLIS     71 CNTR    MMS PP 3.7 GEV/C 10/71
W         140.0    43.0          EDELSTEIN 72 MMS  +  PP 6 TO 30 GEV    1/73
W         106.     39.     33.   COOPER    74 HBC   0 D P CEX          4/75*
W        (200.)                  BRAUN1    75 HBC     PBAR P 5.7 GEV  11/75*
W         101.     26.           MUSGRAVE  75 HBC     K+ P TO K PI N  11/75*
W         150.     50.           WEBB      75 ISR  +  P P TO P N*      1/76*
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          8  N*1/2(1520) PARTIAL DECAY MODES (PROD. EXP.)

                                                     DECAY MASSES
P1    N*1/2(1520) INTO PI N                          139+ 938
P2    N*1/2(1520) INTO N*3/2(1232) PI               1232+ 139
P3    N*1/2(1520) INTO N PI PI                       938+ 139+ 139
P4    N*1/2(1520)+ INTO NEUTRON PI+                  939+ 139
P5    N*1/2(1520)+ INTO PROTON PI+ PI-               938+ 139+ 139
P6    N*1/2(1520) INTO N ETA                         939+ 548
P7    N*1/2(1520) INTO N PIPI(J,I=0)                 939+ 139+ 139
P8    N*1/2(1520) INTO N RHO                         938+ 773
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          8  N*1/2(1520) BRANCHING RATIOS (PROD. EXP.)

R1    N*1/2(1520) INTO (N PI)/TOTAL                 (P1)
R1       N*(1520)  INTO   (N PI)/TOTAL    PRODUCTION EXPERIMENTS
R1         0.78     0.24            BASSOMPIE 67 HBC  +  K+P TO K* N*   11/68

R2    N*1/2(1520) INTO (NEUTRON PI+)/(P PI+ PI-)    (P4)/(P5)
R2         0.77     0.45            ALEXANDER 67 HBC  +  PP 5.5 BEV/C    9/66

R3    N*1/2(1520) INTO (N PI)/(N PI PI)             (P1)/(P3)
R3         1.25     0.44     0.71  A-BORELLI 67 HBC   0 PBAR P 5.7 BEV/C  9/66

R4    N*1/2(1520) INTO (N*3/2(1232) PI)/(N PI PI)   (P2)/(P3)
R4         0.00     0.09            A-BORELLI 67 HBC                     9/66

R5    N*1/2(1520) INTO (N PI PI)/TOTAL              (P3)
R5       (0.08) OR LESS             BASSOMPIE 67 HBC  +  K+P TO K* N*   11/68

R6    N*1/2(1520) INTO (N ETA)/TOTAL                (P6)
R6         0.22     0.14            BASSOMPIE 67 HBC  +  K+P TO K* N*   11/68

R7    N*1/2(1520) INTO (PI N)/(PI N*3/2(1232))      (P1)/(P2)
R7       (0.42) OR LESS             LEE       67 HBC     PI-P 3.6  GEV/C 11/67
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               - REFERENCES FOR N*1/2(1520) (PROD. EXP.)
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A-BORELL 67 NC 47 232      ALLES-BORELLI,FRENCH,FRISK,MICHEJDA  (CERN)
ALEXANDE 67 PR 154 1284    ALEXANDER,BENARY,CZAPEK,+  (WEIZMANN(CERN))
BASSOMPI 67 PL 25B 440     BASSOMPIERRE, +            (CERN,BRUXELLES)
LEE      67 PR 159 1156    +MOEBS,ROE,SINCLAIR,VANDER VELDE     (MICH)

ANDERSON 70 PRL 25 699     +BLESER,BLIEDEN,COLLINS++       (BNL,CARN)

AMALDI   71 PL 34B 435     +BIANCASTELLI,BOSIO,+  (I SANITA ROMA+CERN)
ELLIS    71 PRL 27 442     +MAGLICH,NOREM,SANNES,SILVERMAN     (RUTG)

EDELSTEI 72 PR D5 1073     EDELSTEIN,CARRIGAN,HIEN,MCMAHON,+(CARN+BNL)
JOHNSTAD 72 NP B42 588     +MOLLERUD+...+JACOBSEN(BOHR,HELS,OSLO,STOH)IJP
OH       72 PL 42B 497     +FUNG,KERNAN,POE,SCHALK,SHEN        (UCR)IJP

COOPER   74 NP B79 259     COOPER,SEIDL,VANDERVELDE              (MICH)

BRAUN1   75 NP B95 481     +GERBER,MAURER,MICHALON,SCHIBY+ (STRB,LPNP)I
MUSGRAVE 75 NP B87 365     +PEETERS,SCREINER,WHITMORE,YUTA        (ANL)
STRACHMA 75 NP B98 120     STRACHMAN,BRAUN,GERBER,MAURER+  (LPNP+STRB)I
WEBB     75 PL 55B 331     +TRILLING,TELEGDI+       (AACH+UCLA+UCR+CERN)
   ALSO  75 PL 55B 336     +TRILLING,TELEGDI+       (AACH+UCLA+UCR+CERN)
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N(1670) — D'_{15}

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          64  N*1/2(1670, JP=5/2-) I=1/2
          THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.

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          64  N*1/2(1670) MASS (MEV)

M         (1650.0)       APPROX       BRANDSEN  65 RVUE    PHASE-SHIFT ANAL  7/66
M    1    (1680.0)                    BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
M    1          WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3    (1678.0)                    DONNACH1  68 RVUE    PHASE-SHIFT ANAL  6/68
M         (1674.0)                    DUKE      68 CNTR    PI-P EL + POL     6/68
M    6    (1675.0)                    AYED      70 IPWA                      1/71
M    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4    (1669.0)                    DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M    7    (1683.)                     ALMEHED   72 IPWA                      2/72
M         (1660.)                     AYED      74 IPWA                      2/74
M          1652.  TO 1687.            CRAWFORD  75 DPWA    PI N PHOTO-PROD  1/76*
M    L     1660. OR 1660.             LONGACRE  75 IPWA    PI N TO 2PI N   11/75*
M    L   THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.  11/75*
M         (1687.)                     BARBOUR   76 DPWA    PI N PHOTO-PROD  1/76*
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          64  N*1/2(1670) WIDTH (MEV)

W    1    (135.0)                     BAREYRE   68 RVUE                     11/67
W    3    (173.0)                     DONNACH1  68 RVUE                      6/68
W    6    (143.0)                     AYED      70 IPWA                      1/71
W    4    (115.0)                     DAVIES    70 RVUE    SOL A AND B       8/69
W    7    (150.)                      ALMEHED   72 IPWA                      2/72
W         (146.)                      AYED      74 IPWA                      2/74
W          165.  TO  185.             CRAWFORD  75 DPWA    PI N PHOTO-PROD  1/76*
W    L     145.  OR  150.             LONGACRE  75 IPWA    PI N TO 2PI N   11/75*
W         (172.)                      BARBOUR   76 DPWA    PI N PHOTO-PROD  1/76*
     SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
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          64  N*1/2(1670) REAL PART OF POLE POSITION (MEV)             11/75*

RE        (1663.)                     LONGACRE  75 IPWA    PI N TO 2PI N   11/75*
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          64  N*1/2(1670) 2*IMAG PART OF POLE POSITION (MEV)           11/75*

IM        (146.)                      LONGACRE  75 IPWA    PI N TO 2PI N   11/75*
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          64  N*1/2(1670) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1    N*1/2(1670) INTO PI N                                 139+ 938
P2    N*1/2(1670) INTO N ETA                                939+ 548
P3    N*1/2(1670) INTO LAMBDA K                            1115+ 497
P4    N*1/2(1670) INTO N*3/2(1232) PI                      1232+ 139
P5    N*1/2(1670) INTO N PI PI                              938+ 139+ 139
P6    N*1/2(1670) INTO GAM P, HELICITY=1/2                    0+ 938
P7    N*1/2(1670) INTO GAM P, HELICITY=3/2                    0+ 938
P8    N*1/2(1670) INTO GAM N, HELICITY=1/2                    0+ 939
P9    N*1/2(1670) INTO GAM N, HELICITY=3/2                    0+ 939
P10   N*1/2(1670) INTO SIGMA K                             493+1189
P11   N*1/2(1670) INTO N*3/2(1232) PI,D-WAVE               1232+ 139
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          64  N*1/2(1670) BRANCHING RATIOS

R1    N*1/2(1670) INTO (PI N)/TOTAL                     (P1)
R1  1       (0.41)                    BAREYRE   68 RVUE                     11/67
R1  3       (0.391)                   DONNACH1  68 RVUE                      6/68
R1  6       (0.392)                   AYED      70 IPWA                      1/71
R1  4       (0.50)                    DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
R1  7       (0.45)                    ALMEHED   72 IPWA                      2/72
R1          (.415)                    AYED      74 IPWA                      2/74
     SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

R2    N*1/2(1670) INTO (N ETA)/TOTAL                    (P2)
R2          (0.02) OR LESS            TRIPP     67 RVUE                      8/67
R2  B       (0.018)                   BOTKE     69 MPWA     T POLE + RESCN. 10/69
R2  B       (0.006)  (0.004)          DEANS     69 MPWA     T POLE + RESON.  5/70
R2  B       (0.006)OR 0.012           CARRERAS  70 MPWA     T POLE + RESON.  5/70
R2  B    PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R3    N*1/2(1670) INTO (LAMBDA K)/TOTAL                 (P3)
R3          (0.016)OR LESS            TRIPP     67 RVUE                      8/67
R3  B       (0.001)OR LESS            RUSH      68 MPWA     T POLE + RESON.  8/69
R3  B    PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING
R3          (0.0028)OR LESS CL=.63    WAGNER    71 IPWA     PI-P TO K LAMB   1/71

R4    N*1/2(1670) INTO (N*3/2(1232) PI)/TOTAL           (P4)
R4 E 12600    0.63       0.1          BRODY     71  HBC     PI-P--2PI N,PWA  6/70
R4 E       ASSUMES ELASTIC BRANCHING RATIO 0.42+-0.04

R5    N*1/2(1670) FROM PI N TO K LAMBDA                 SQRT(P1*P3)          4/75*
R5          -.034      .006           DEVENISH  74          0 FIXED T DISP REL 4/75*

R6    N*1/2(1670) FROM PI N TO ETA N                    SQRT(P1*P2)         11/75*
R6  2       (0.0)OR  (+.009)          FELTESSE  75 DPWA    0 1488 TO 1745 MEV 11/75*
R6  2    USES M AND W OF AYED 74.                                          11/75*

R7    N*1/2(1670) FROM PI N TO K SIGMA                  SQRT(P1*P10)        11/75*
R7  2       LESS THAN .003            DEANS     75 DPWA     PI N TO K SIGMA 11/75*
R7  2    RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                          11/75*
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Data Card Listings

For notation, see key at front of Listings.

Baryons

N(1670), N(1688)

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R8      N*1/2(1670) FROM PI N TO N*3/2(1232) PI,D-WAVE    SQRT(P1*P11)          11/75*
R8   L        (-.45)OR  -.50             LONGACRE  75 IPWA    PI N TO 2PI N     11/75*
   SEE NOTE PRECEDING THE N*1/2(1688) INELASTIC DECAY MODE MEASUREMENTS.
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                 64  N*1/2(1670) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
      REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*1/2(1670) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1             .027      .030            DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A1           (.023)                      HEMMI1    73       + FWD PIO PHTOPROD   2/74
A1            +.011      .012            MOORHOUS  73 DPWA    PI N PHOTO-PROD    2/73
A1             .019      .021            DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A1             .013      .014            KNIES     74 DPWA    PI N PHOTO PROD    2/74
A1            +.010      .013            METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A1             .019      .007            MOORHOUS  74 DPWA    PI N PHOTO-PROD    2/74
A1            +.027      .009            CRAWFORD  75 DPWA    PI N PHOTO-PROD    1/76*
A1           (+.008)                     BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A1               . . . . . . . . .
A1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A2      N*1/2(1670) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2             .036      .030            DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A2            +.021      .020            MOORHOUS  73 DPWA    PI N PHOTO-PROD    2/73
A2             .014      .004            DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A2             .014      .008            KNIES     74 DPWA    PI N PHOTO PROD    2/74
A2            +.042      .024            METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A2             .016      .002            MOORHOUS  74 DPWA    PI N PHOTO-PROD    2/74
A2            +.015      .006            CRAWFORD  75 DPWA    PI N PHOTO-PROD    1/76*
A2           (+.021)                     BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A2               . . . . . . . . .
A2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A3      N*1/2(1670) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3            -.060      .062            DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A3            +.010      .040            MOORHOUS  73 DPWA    PI N PHOTO-PROD    2/73
A3            -.029      .023            DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A3            -.043      .006            KNIES     74 DPWA    PI N PHOTO PROD    2/74
A3             .004      .015            METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A3            -.017      .004            MOORHOUS  74 DPWA    PI N PHOTO-PROD    2/74
A3            -.052      .003            CRAWFORD  75 DPWA    PI N PHOTO-PROD    1/76*
A3           (-.058)                     BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A3               . . . . . . . . .
A3   AVERAGE MEANINGLESS (SCALE FACTOR = 4.4)

A4      N*1/2(1670) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4            -.072      .022            DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A4            -.035      .014            MOORHOUS  73 DPWA    PI N PHOTO-PROD    2/73
A4            -.068      .020            DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A4            -.071      .030            KNIES     74 DPWA    PI N PHOTO PROD    2/74
A4            -.009      .029            METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A4            -.049      .004            MOORHOUS  74 DPWA    PI N PHOTO-PROD    2/74
A4            -.083      .007            CRAWFORD  75 DPWA    PI N PHOTO-PROD    1/76*
A4           (-.080)                     BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A4               . . . . . . . . .
A4   AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)

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                              REFERENCES FOR N*1/2(1670)

BRANDSEN 65 PL 19 420          +ODONNELL, MCORHOUSE          (DURHAM, RHEL)IJP

TRIPP    67 NP B3 10           + LEITH, +        (LRL,SLAC,CERN,HEID,SACLAY)

BAREYRE  68 PR 165 1731        P BAREYRE, C BRICMAN, G VILLET      (SACLAY)IJP
DONNACH1 68 PL 26B 161         A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
  ALSO   68 VIENNA 139         DONNACHIE  RAPPORTEUR.S TALK            (GLAS)
  ALSO   68 THESIS             R G KIRSOPP                             (EDIN)
DUKE     68 PR 166 1448        +JONES,KEMP,MURPHY,THRESHER, +   (RHEL,OXF)IJP
    INSIGHTFUL QUALITATIVE ARGUMENTS CONCERNING EXISTENCE AND IJP.
RUSH     68 PR 173 1776        J E RUSH                       (UNIV ALABAMA)

BOTKE    69 PR 180 1417        J C BOTKE                              (UCSB)
DEANS    69 PR 185 1797        S DEANS, J WOOTEN            (UNIV S FLORIDA)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET          (SACL)IJP
CARRERAS 70 NP 16B 35          B CARRERAS, A DONNACHIE          (DARE,MCHS)
DAVIES   70 NP B21 359         A DAVIES                               (GLAS)

BRODY    71 PL 34B 665         +CASHMORE+..+HERNDON+..            (SLAC+LRL)
WAGNER   71 NP B25 411         F WAGNER, C LOVELACE                   (CERN)

ALMEHED  72 NP B40 157         +LOVELACE                       (LUND,RUTG)IJP

DEVENISH 73 PL 47B 53          DEVENISH,RANKIN,LYTH        (LOUC+BONN+LANC)IJP
HEMMI1   73 PL 43B 79          HEMMI,INAGAKI+         (KYOTO+SAGA+KEK+TCKY)IJP
MOORHOUS 73 PL 43B 44          MOORHOUSE, OBERLACK            (GLAS+LBL)IJP

AYED     74 PRIVATE COMMCTN.   AYED,BAREYRE                        (SACL)IJP
  ALSO   73 AIX CONFERENCE     AYED,BAREYRE                        (SACL)IJP
DEVENISH 74 NP B81 330         DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227         DEVENISH,LYTH,RANKIN       (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680         KNIES,MOORHOUSE,OBERLACK       (LBL,GLAS)IJP
METCALF  74 NP B76 253         W J METCALF,R L WALKER                 (CIT)IJP
MOORHOUS 74 PRD 9 1            MOORHOUSE,OBERLACK,ROSENFELD   (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125         R L CRAWFORD                        (GLAS)IJP
DEANS    75 NP B96 90          +MITCHELL,MONTGOMERY,+      (SFLA,ALABAMA)IJP
FELTESSE 75 NP B93 242         +AYED,BAREYRE,BORGEAUD,CAVID,ERNWEIN+(SACL)IJP
LONGACRE 75 PL 55B 415         +ROSENFELD,LASINSKI,SMADJA+    (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP       I. M. BARBOUR,R. L. CRAWFORD        (GLAS)IJP

                               PAPERS NOT REFERRED TO IN DATA CARDS.

BAREYRE  65 PL 18 342          + BRICMAN, STIRLING, VILLET       (SACLAY)IJP
DUKE     65 PRL 15 468         +JONES,KEMP,MURPHY,PRENTICE, +   (RHEL,OXF)IJP
JOHNSON  67 UCRL-17683 THESIS  C H JOHNSON                             (LRL)
DEANS    69 PRL 177 2623       S R DEANS                    (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433         A DONNACHIE, R KIRSOPP          (GLAS+EDIN)
AYED     70 PL 31B 598         +BAREYRE+VILLET                      (SACLAY)

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N(1688) F'_{15}

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       65  N*1/2(1688, JP=5/2+) I=1/2
       THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.

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                 65  N*1/2(1688) MASS (MEV)

M           (1680.0)                     BRANDSEN  65 RVUE    PHASE SHIFT ANAL   7/66
M    1      (1690.0)                     BAREYRE   68 RVUE    PHASE-SHIFT ANAL  11/67
M    1          WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3      (1687.0)                     DONNACH1  68 RVUE    PHASE-SHIFT ANAL   6/68
M           (1682.0)                     DUKE      68 CNTR    PI-P EL + POL      6/68
M    6      (1682.0)                     AYED      70 IPWA                       1/71
M    6    FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4      (1685.0)                     DAVIES    70 RVUE    P-S ANAL  SOL A    8/69
M    7      (1688.)                      ALMEHED   72 IPWA                       2/72
M           (1680.)                      AYED      74 IPWA                       2/74
M            1674. TO 1676.              CRAWFORD  75 DPWA    PI N PHOTO-PROD    1/76*
M           (1685.)                      KNASEL    75 DPWA  O PI- P TO KO LAM   11/75*
M    L       1680. OR 1670.              LONGACRE  75 IPWA    PI N TO 2PI N     11/75*
M    L    THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.     11/75*
M           (1680.)                      BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*

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                 65  N*1/2(1688) WIDTH (MEV)

W    1      (110.0)                      BAREYRE   68 RVUE                      11/67
W    3      (177.0)                      DONNACH1  68 RVUE                       6/68
W    6      (109.0)                      AYED      70 IPWA                       1/71
W    4      (104.0)                      DAVIES    70 RVUE    P-S ANAL  SOL A    8/69
W    7      (140.)                       ALMEHED   72 IPWA                       2/72
W           (126.)                       AYED      74 IPWA                       2/74
W            115. TO  124.               CRAWFORD  75 DPWA    PI N PHOTO-PROD    1/76*
W           (155.)                       KNASEL    75 DPWA  O PI- P TO KO LAM   11/75*
W    L       125. OR  130.               LONGACRE  75 IPWA    PI N TO 2PI N     11/75*
W           (120.)                       BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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                 65  N*1/2(1688) REAL PART OF POLE POSITION (MEV)           11/75*

RE          (1688.)                      LONGACRE  75 IPWA    PI N TO 2PI N     11/75*

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                 65  N*1/2(1688) 2*IMAG PART OF POLE POSITION (MEV)         11/75*

IM          (132.)                       LONGACRE  75 IPWA    PI N TO 2PI N     11/75*

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                 65  N*1/2(1688) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      N*1/2(1688) INTO PI N                             139+ 938
P2      N*1/2(1688) INTO N ETA                            939+ 548
P3      N*1/2(1688) INTO LAMBDA K                        1115+ 497
P4      N*1/2(1688) INTO N*3/2(1232) PI                  1232+ 139
P5      N*1/2(1688) INTO N PI PI                          938+ 139+ 139
P6      N*1/2(1688) INTO GAM P, HELICITY=1/2                0+ 938
P7      N*1/2(1688) INTO GAM P, HELICITY=3/2                0+ 938
P8      N*1/2(1688) INTO GAM N, HELICITY=1/2                0+ 939
P9      N*1/2(1688) INTO GAM N, HELICITY=3/2                0+ 939
P10     N*1/2(1688) INTO N EPSILON                        938+1200
P11     N*1/2(1688) INTO N RHO                            938+ 773
P12     N*1/2(1688) INTO N*3/2(1232) PI,P-WAVE           1232+ 139
P13     N*1/2(1688) INTO N*3/2(1232) PI,F-WAVE           1232+ 139
P14     N*1/2(1688) INTO N RHO,S=3/2,P-WAVE               938+ 773
P15     N*1/2(1688) INTO SIGMA K                          493+1189

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                 65  N*1/2(1688) BRANCHING RATIOS

R1      N*1/2(1688) INTO (PI N)/TOTAL                         (P1)
R1   1        (0.64)                     BAREYRE   68 RVUE                      11/67
R1   3        (0.560)                    DONNACH1  68 RVUE                       6/68
R1   6        (0.593)                    AYED      70 IPWA                       1/71
R1   4        (0.54)                     DAVIES    70 RVUE       SOL A AND B     8/69
R1   7        (0.65)                     ALMEHED   72 IPWA                       2/72
R1             (.593)                    AYED      74 IPWA                       2/74
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

    MORE INFORMATION ON THE INELASTIC DECAY MODES OF THE 1690 MEV
    BUMP, AS SEEN IN PRODUCTION EXPERIMENTS, MAY BE FOUND BELOW

R2      N*1/2(1688) INTO (N ETA)/TOTAL                        (P2)
R2            (0.015)OR LESS             TRIPP     67 RVUE                       8/67
R2   B        (0.0004)                   BOTKE     69 MPWA    T POLE + RESON.   10/69
R2   B        (0.003)  (0.002)           DEANS     69 MPWA    T POLE + RESON.    5/70
R2   B        (0.0005)OR .001            CARRERAS  70 MPWA    T POLE + RESON.    5/70
R2   B    PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R3      N*1/2(1688) INTO (N ETA)/(PI N)                       (P2)/(P1)
R3            (0.027)OR LESS             HEUSCH    66 RVUE +  PIO, ETA PHOTO     9/66

R4      N*1/2(1688) INTO (LAMBDA K)/TOTAL                     (P3)
R4            (0.0013)OR LESS            TRIPP     67 RVUE                       8/67
R4   B        (0.001)OR LESS             RUSH      68 MPWA    T POLE + RESON.    5/70
R4   B    PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING
R4            (0.001)OR LESS  CL=.63     WAGNER    71 IPWA    PI-P TO K LAMB     1/71

R5      N*1/2(1688) INTO (N*3/2(1232) PI)/TOTAL               (P4)
R5 E 12600    (0.13)    (0.04)  SOLN.A   BRODY     71  HBC    PI-P--2PI N/PWA    6/70
R5 E 12600    (0.39)    (0.10)  SOLN.B   BRODY     71  HBC    PI-P--2PI N/PWA    6/70
R5 E      ASSUMES ELASTIC BRANCHING RATIO 0.62+-0.06

R6      N*1/2(1688) FROM PI N TO K LAMBDA                   SQRT(P1*P3)          4/75*
R6           -.009       .009             DEVENISH  74        O FIXED T DISP REL  4/75*
R6           (.01)                        KNASEL    75 DPWA  O PI- P TO KO LAM   11/75*

R7      N*1/2(1688) FROM PI N TO N EPSILON                  SQRT(P1*P10)        11/75*
R7   L        (-.28)OR  -.30             LONGACRE  75 IPWA    PI N TO 2PI N     11/75*

R8      N*1/2(1688) FROM PI N TO N*3/2(1232) PI,P-WAVE    SQRT(P1*P12)          11/75*
R8   L        (+.26)OR  +.25             LONGACRE  75 IPWA    PI N TO 2PI N     11/75*

R9      N*1/2(1688) FROM PI N TO N*3/2(1232) PI,F-WAVE    SQRT(P1*P13)          11/75*
R9   L        (0.) OR  (-.08)            LONGACRE  75 IPWA    PI N TO 2PI N     11/75*
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Baryons
N(1688), N(1700)

Data Card Listings
For notation, see key at front of Listings.

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R10    N*1/2(1688) FROM PI N TC N RHO,S=3/2,P-WAVE      SQRT(P1*P14)        11/75*
R10  L        (+.27)OR  +.30          LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

R11    N*1/2(1688) FRCM PI N TO K SIGMA                  SQRT(P1*P15)        11/75*
R11 2       LESS THAN .001             DEANS     75 DPWA   PI N TO K SIGMA  11/75*
R11 2   RANGE GIVEN IS FROM 3 OF 4 BEST SOLUTIONS, NOT PRESENT IN SLTN.1.    11/75*
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                    65  N*1/2(1688) PHOTCN DECAY AMPL(GEV**-1/2)

      FCR DEFINITION OF GAMMA-NUCLECN DECAY AMPLITUDES, SEE MINI-
      REVIEW PRECEDING THE BARYCN LISTINGS.

A1     N*1/2(1688) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1          .015      .023          DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A1        (-.003)                   HEMMI1    73       + FWD PIO PHTOPRCD   2/74
A1         -.008      .004          MOORHOUS  73 DPWA    PI N PHOTO-PROD    2/73
A1          .027      .019          DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A1         -.016      .014          KNIES     74 DPWA    PI N PHOTO PRCD    2/74
A1         -.008      .011          METCALF   74 DPWA    PI N PHOTO-PRCD    2/74
A1         -.014      .003          MOORHOUS  74 DPWA    PI N PHOTO-PROD    2/74
A1         -.013      .002          CRAWFORD  75 DPWA    PI N PHOTO-PRCD    1/76*
A1        (-.004)                   BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A1     . . . . . . . . .
A1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A2     N*1/2(1688) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2          .146      .031          DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A2         +.100      .012          MOORHOUS  73 DPWA    PI N PHOTC-PRCD    2/73
A2          .163      .011          DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A2          .097      .007          KNIES     74 DPWA    PI N PHOTO PROD    2/74
A2          .129      .016          METCALF   74 DPWA    PI N PHOTO-PRCD    2/74
A2          .147      .006          MOORHOUS  74 DPWA    PI N PHOTO-PROD    2/74
A2         +.135      .006          CRAWFORD  75 DPWA    PI N PHOTO-PRCD    1/76*
A2        (+.132)                   BARBOUR   76 DPWA    PI N PHOTO-PRCD    1/76*
A2     . . . . . . . . .
A2   AVERAGE MEANINGLESS (SCALE FACTOR = 3.0)

A3     N*1/2(1688) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3          .035      .049          DEVENISH  73 DPWA    PI N PHOTC PROD    2/74
A3         +.017      .014          MOORHCUS  73 DPWA    PI N PHOTO-PRCD    2/73
A3          .031      .028          DEVENIS2  74 DPWA    PI N PHOTO-PRCD    4/75*
A3          .023      .005          KNIES     74 DPWA    PI N PHOTC PRCD    2/74
A3          .008      .018          METCALF   74 DPWA    PI N PHOTO-PRCD    2/74
A3          .023      .003          MOORHCUS  74 CPWA    PI N PHOTO-PROD    2/74
A3         +.021      .001          CRAWFORD  75 DPWA    PI N PHOTC-PRCD    1/76*
A3        (+.034)                   BARBOUR   76 DPWA    PI N PHOTO-PRCD    1/76*
A3     . . . . . . . . .
A3   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A4     N*1/2(1688) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4         -.018      .039          DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A4         -.005      .018          MOCRHOUS  73 DPWA    PI N PHOTO-PROD    2/73
A4         -.021      .028          DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A4          .001      .018          KNIES     74 DPWA    PI N PHOTO PROD    2/74
A4          .00       .030          METCALF   74 DPWA    PI N PHOTO-PRCD    2/74
A4         -.041      .004          MOORHOUS  74 DPWA    PI N PHOTO-PROD    2/74
A4         -.015      .004          CRAWFORD  75 DPWA    PI N PHOTO-PRCD    1/76*
A4        (-.028)                   BARBOUR   76 DPWA    PI N PHOTO-PRCD    1/76*
A4     . . . . . . . . .
A4   AVERAGE MEANINGLESS (SCALE FACTOR = 2.9)

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REFERENCES FOR N*1/2(1688)

SEE A PREVIOUS EDITICN (RMP 37, 633, 1965) FOR EARLIER REFERENCES.


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BRANDSEN 65 PL 19 420            +ODONNELL, MCORHOUSE           (DURHAM, RHEL)IJP
HEUSCH   66 PRL 17 1019          C A HEUSCH, C Y PRESCOTT, R F DASHEN   (CIT)
TRIPP    67 NP B3 10             + LEITH, +         (LRL,SLAC,CERN,HEID,SACLAY)

BAREYRE  68 PR 165 1731          P BAREYRE, C BRICMAN, G VILLET    (SACLAY)IJP
DCNNACH1 68 PL 26B 161           A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
   ALSO  68 VIENNA 139           DCNNACHIE  RAPPORTEUR.S TALK          (GLAS)
   ALSO  68 THESIS               R G KIRSOPP                           (EDIN)
DUKE     68 PR 166 1448          +JCNES,KEMP,MURPHY,THRESHER, +   (RHEL,OXF)IJP
RUSH     68 PR 173 1776          J E RUSH                     (UNIV ALABAMA)

BOTKE    69 PR 180 1417          J C BOTKE                             (UCSB)
DEANS    69 PR 185 1797          S DEANS, J WOOTEN            (UNIV S FLORIDA)

AYED     70 KIEV CONF            R AYED,P BAREYRE, G VILLET          (SACL)IJP
CARRERAS 70 NP 16B 35            B CARRERAS, A DONNACHIE          (DARE,MCHS)
DAVIES   70 NP B21 359           A DAVIES                              (GLAS)

BRODY    71 PL 34B 253           +CASHMORE+..+HERNDON+..           (SLAC+LRL)
WAGNER   71 NP B25 411           F WAGNER, C LOVELACE                  (CERN)

ALMEHED  72 NP B40 157           +LOVELACE                      (LUND,RUTG)IJP
DEVENISH 73 PL 47B 53            DEVENISH,RANKIN,LYTH        (LOUC+BONN+LANC)IJP
HEMMI1   73 PL 43B 79            HEMMI,INAGAKI+          (KYOTO+SAGA+KEK+TOKY)IJP
MOORHOUS 73 PL 43B 44            MOORHOUSE, OBERLACK            (GLAS+LBL)IJP

AYED     74 PRIVATE COMMCTN.     AYED,BAREYRE                       (SACL)IJP
   ALSO  73 AIX CONFERENCE       AYED,BAREYRE                       (SACL)IJP
DEVENISH 74 NP B81 330           DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227           DEVENISH,LYTH,RANKIN       (DESY,LANC,BCNN)IJP
KNIES    74 PRD 9 2680           KNIES,MOORHCUSE,OBERLACK        (LBL,GLAS)IJP
METCALF  74 NP B76 253           W J METCALF,R L WALKER               (CIT)IJP
MOORHOUS 74 PRD 9 1              MCORHOUSE,OBERLACK,ROSENFELD   (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125           R L CRAWFORD                        (GLAS)IJP
DEANS    75 NP B96 90            +MITCHELL,MONTGOMERY,+      (SFLA,ALABAMA)IJP
KNASEL   75 PRD 11 1             +LINDQUIST,NELSON+      (CHIC,WUSL,OSU,ANL)IJP
LONGACRE 75 PL 55B 415           +ROSENFELD,LASINSKI,SMADJA+     (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP         I. M. BARBOUR,R. L. CRAWFORD       (GLAS)IJP

                                 PAPERS NOT REFERRED TO IN DATA CARDS.

CROUCH   65 DESY CONF II 21      +   (BROWN,CEA,HARVARD,MIT,PADOVA,WEIZMANN)
DERADO   65 ATHENS CONF 244      +KENNEY,LAMSA, +          (NOTRE DAME,KENTUCKY)
DUKE     65 PRL 15 468           +JONES,KEMP,MURPHY,PRENTICE, +   (RHEL,OXF)IJP
MERLO    66 P ROY SOC 289 489    J P MERLO, G VALLADAS                (SACLAY)
ROBERTS  67 PREPRINT             R G ROBERTS                          (DURHAM)
BANNER   68 PR 166 1347          +DETOEUF,FAYOUX,HAMEL, +       (SACLAY,CAEN)
  THE ABOVE PAPERS DISCUSS INELASTIC CHANNELS NEAR THE BUMP.
BAREYRE  65 PL 18 342            + BRICMAN, STIRLING, VILLET       (SACLAY)IJP
DEANS    69 PRL 177 2623         S R DEANS                   (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433           A DONNACHIE, R KIRSOPP           (GLAS+EDIN)
AYED     70 PL 31B 598           +BAREYRE+VILLET                     (SACLAY)

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N(1700) — S''_{11}

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66  N*1/2(1700, JP=1/2-) I=1/2
THE EXISTENCE OF THIS RESCNANCE IS WELL ESTABLISHED.

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                    66  N*1/2(1700) MASS (MEV)

M          (1695.0)                    BRANDSEN  65 RVUE   PHASE-SHIFT ANAL  9/66
M          (1700.0)                    MICHAEL   66 RVUE   FITS BAREYRE S11  7/66
M    1     (1710.0)                    BAREYRE   68 RVUE   PHASE-SHIFT ANAL 11/67
M    1          WHEPE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3     (1710.0)                    DCNNACH1  68 RVUE   PHASE-SHIFT ANAL  8/68
M          (1705.0)    (10.0)          ORITO     69 RVUE   K LAMBDA PS ANAL  8/69
M    6     (1689.0)                    AYED      70 IPWA                     1/71
M    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4     (1766.0)                    DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
M          (1678.0)                    SCHORSCH  70 DPWA   K LAM PHOTOPRC.  10/71
M    A     (1685.0)                    WAGNER    71 IPWA   PI-P TO K LAMB    1/71
M    A   THERE ARE 3 SIMILAR SCLUTICNS
M    7     (1670.)                     ALMEHED   72 IPWA                     2/72
M    2     (1699.)                     HICKS     73 MPWA   GAM P-ETA P       9/73
M    2   ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUDED IN LISTINGS.     9/73
M    2   M AND W ARE FROM SOLUTION C2,BR=SQRT(G)/W WITH G FROM TABLE VII.    9/73
M    1     (1860.)                     LANGBEIN  73 IPWA   PI N-K SIG,SOL 2  9/73
M    1   S11 AMPLITUDE LARGE BUT NCT RESONANT IN SOLUTICN 1 OF LANGBEIN73    9/73
M          (1672.)                     AYED      74 IPWA                     2/74
M          (1675.)                     KNASEL    75 DPWA  O PI- P TO KO LAM 11/75*
M    L      1675. OR 1660.             LCNGACRE  75 IPWA    PI N TC 2PI N   11/75*
M    L   THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.  11/75*
M          (1676.)                     BARBOUR   76 DPWA    PI N PHOTO-PRCD  1/76*
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                    66  N*1/2(1700) WIDTH (MEV)

W          (240.0)                     MICHAEL   66 RVUE                     7/66
W    1     (260.0)                     BAREYRE   68 RVUE                    11/67
W    3     (300.0)                     DCNNACH1  68 RVUE                     8/69
W          (104.0)    (15.0)           ORITO     69 RVUE                     8/69
W    6     (166.0)                     AYED      70 IPWA                     1/71
W    4     (404.0)                     DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
W    4   SOL B GIVES 121 MEV                                                 2/73
W           (99.0)                     SCHORSCH  70 DPWA   K LAM PHOTOPRO.  10/71
W    A     (110.0)OR(140.0)            WAGNER    71 IPWA   PI-P TO K LAMB    1/71
W    7     (120.)                      ALMEHED   72 IPWA                     2/72
W    2     (195.)                      HICKS     73 MPWA   GAM P-ETA P       9/73
W    1     (200.)                      LANGBEIN  73 IPWA   PI N-K SIG,SOL 2  9/73
W          (179.)                      AYED      74 IPWA                     2/74
W          (170.)                      KNASEL    75 DPWA  O PI- P TO KO LAM 11/75*
W    L      150. OR  130.              LONGACRE  75 IPWA   PI N TO 2PI N    11/75*
W          (194.)                      BARBOUR   76 DPWA   PI N PHOTO-PROD   1/76*
     SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
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           66  N*1/2(1700) REAL PART OF PCLE PCSITION (MEV)                 11/75*

RE         (1648.)                     LONGACRE  75 IPWA   PI N TO 2PI N    11/75*
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           66  N*1/2(1700) 2*IMAG PART OF POLE POSITION (MEV)               11/75*

IM         (117.)                      LONGACRE  75 IPWA   PI N TO 2PI N    11/75*
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                    66  N*1/2(1700) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     N*1/2(1700) INTO PI N                                139+ 938
P2     N*1/2(1700) INTC N ETA                               939+ 548
P3     N*1/2(1700) INTO LAMBDA K                           1115+ 497
P4     N*1/2(1700) INTO GAM P, HELICITY=1/2                   0+ 938
P5     N*1/2(1700) INTO GAM N, HELICITY=1/2                   0+ 939
P6     N*1/2(1700) INTC N PI PI                             938+ 139+ 139
P7     N*1/2(1700) INTO N EPSILON                           938+1200
P8     N*1/2(1700) INTC N RHC                               938+ 773
P9     N*1/2(1700) INTO K SIGMA                             493+1189
P10    N*1/2(1700) INTC N RHO,S=1/2,S-WAVE                  938+ 773
P11    N*1/2(1700) INTO N*3/2(1232) PI                     1232+ 139
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                    66  N*1/2(1700) BRANCHING RATIOS

R1     N*1/2(1700) INTO (PI N)/TOTAL                    (P1)
R1          (1.0)        APPROX        MICHAEL   66 RVUE                     7/66
R1   3      (0.79)                     DCNNACH1  68 RVUE                     8/69
R1   6      (0.642)                    AYED      70 IPWA                     1/71
R1   4      (0.56)                     DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
R1   7      (0.5)                      ALMEHED   72 IPWA                     2/72
R1          (.586)                     AYED      74 IPWA                     2/74

R2     N*1/2(1700) FROM PI N TO K LAMBDA                SQRT(P1*P3)          4/75*
R2          (.20)     (.05)            ORITO     69 RVUE                     4/75*
R2   A      (.21)OR .23                WAGNER    71 IPWA    PI- P TO K LAMB  4/75*
R2          -.179      .033            DEVENISH  74        O FIXED T DISP REL 4/75*
R2          (.12)                      KNASEL    75 DPWA  O PI- P TO KO LAM 11/75*

R3     N*1/2(1700) INTO (LAMBCA K)/TOTAL                 (P3)
R3   B      (0.028)      APPROX.       RUSH      68 MPWA    T POLE + RESON.  8/69
R3   B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R4     N*1/2(1700) INTO (N ETA)/TCTAL                    (P2)
R4   B      (0.013)                    BOTKE     69 MPWA    T POLE + RESON. 10/69
R4   B      (0.03)    (0.02)           DEANS     69 MPWA    T PCLE + RESON.  8/69
R4   C      (0.19) OR 0.27             CARRERAS  70 MPWA    T POLE + RESON.  5/70
R4   B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING
R4   C   CARRERAS 70 USES REGGE POLES + RESONANCES. VALUES SUSPICIOUSLY LARG

R5     N*1/2(1700) FROM GAMMA PROTON TO K LAMBDA        SQRT(P3*P4)          9/73
R5          (0.002)OR LESS             ORITO2    69 CNTR   K LAM PHOTOPRO   10/71
R5          (0.0072)                   SCHORSCH  70 DPWA   K LAM PHOTOPRO.  10/71
R5          (.0060)                    DEANS     72 MPWA   GAM P-K LM,SOL D  9/73

R6     N*1/2(1700) FROM GAMMA PRGTON TO ETA PROTON       SQRT(P2*P4)          9/73
R6   2      (.0101)                    HICKS     73 MPWA   GAM P-ETA P       9/73
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Data Card Listings

For notation, see key at front of Listings.

Baryons

N(1700)

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R7     N*1/2(1700) FROM PI N TO K SIGMA                  SQRT(P1*P9)           9/73
R7  1          (.11)             LANGBEIN  73 IPWA     PI N-K SIG,SOL 2   9/73
R7  5          (.066)TO  .137    DEANS     75 DPWA     PI N TO K SIGMA   11/75*
R7  5   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                          11/75*
R7             (.20)             KNASEL    75 DPWA   0 PI- P TO KO LAM   11/75*

R8     N*1/2(1700) FROM PI N TO N*3/2(1232) PI          SQRT(P1*P11)         11/75*
R8  L         (-.16)OR  -.15     LONGACRE  75 IPWA     PI N TO 2PI N     11/75*

R9     N*1/2(1700) FROM PI N TO N RHO,S=1/2,S-WAVE      SQRT(P1*P10)         11/75*
R9  L         (.23)OR  +.16      LONGACRE  75 IPWA     PI N TO 2PI N     11/75*

R10    N*1/2(1700) FROM PI N TO N EPSILON               SQRT(P1*P7)          11/75*
R10 L         (-.23)OR  -.25     LONGACRE  75 IPWA     PI N TO 2PI N     11/75*

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               66  N*1/2(1700) PHOTON DECAY AMPL(GEV**-1/2)

     FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
   REVIEW PRECEDING THE BARYON LISTINGS.

A1     N*1/2(1700) INTO GAM P, HELICITY=1/2 (GEV**-1/2)
A1            .024     .033      DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A1           +.066     .042      MOORHOUS  73 DPWA    PI N PHOTO-PROD    2/73
A1            .029     .018      DEVENIS2  74 DPWA    PI N PHOTC-PROD    4/75*
A1            .058     .018      KNIES     74 DPWA    PI N PHOTO PROD    2/74
A1           +.012     .015      METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A1            .054     .005      MOORHOUS  74 DPWA    PI N PHOTO-PROD    2/74
A1           +.044     .018      CRAWFORD  75 DPWA    PI N PHOTO-PROD    1/76*
A1          (+.044)              BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A1              . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

A2     N*1/2(1700) INTO GAM N, HELICITY=1/2 (GEV**-1/2)
A2            .010     .043      DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A2           -.072     .066      MOORHOUS  73 DPWA    PI N PHOTO-PROD    2/73
A2           -.006     .031      DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A2           -.015     .035      KNIES     74 DPWA    PI N PHOTO PROD    2/74
A2           -.019     .022      METCALF   74 DPWA    PI N PHOTC-PROD    2/74
A2           -.027     .009      MOORHCUS  74 DPWA    PI N PHOTO-PROD    2/74
A2           -.103     .010      CRAWFORD  75 DPWA    PI N PHOTC-PROD    1/76*
A2          (-.022)              BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A2              . . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 2.9)


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                           REFERENCES FOR N*1/2(1700)

BRANDSEN 65 PL 19 420        +ODONNELL, MOORHOUSE          (DURHAM, RHEL)IJP

MICHAEL  66 PL 21 93         C MICHAEL                              (OXF)

BAREYRE  68 PR 165 1731      P BAREYRE, C BRICMAN, G VILLET     (SACLAY)IJP
DONNACH1 68 PL 26B 161       A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
   ALSO  68 VIENNA 139       DONNACHIE  RAPPORTEUR.S TALK          (GLAS)
   ALSO  68 THESIS           R G KIRSOPP                           (EDIN)
RUSH     68 PR 173 1776      J E RUSH                        (UNIV ALABAMA)

BOTKE    69 PR 180 1417      J C BOTKE                             (UCSB)
DEANS    69 PR 185 1797      S DEANS, J WOOTEN              (UNIV S FLORIDA)
ORITO    69 LNC 1 936        S ORITO,S SASAKI                (TOKYO-OSAKA)
ORITO2   69 INS J 113        S ORITO (THESIS)                      (TOKYO)

AYED     70 KIEV CONF        R AYED,P BAREYRE, G VILLET          (SACL)IJP
CARRERAS 70 NP 16B 35        B CARRERAS, A DONNACHIE           (DARE,MCHS)
DAVIES   70 NP B21 359       A DAVIES                              (GLAS)
SCHORSCH 70 NP  B25 179      +TIETGE,WEILNBOECK                    (MPIM)

WAGNER   71 NP B25 411       F WAGNER, C LOVELACE                  (CERN)

ALMEHED  72 NP B40 157       +LOVELACE                       (LUND,RUTG)IJP
DEANS    72 PRD 6 1906       DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
DEVENISH 73 PL 47B 53        DEVENISH,RANKIN,LYTH       (LOUC+BONN+LANC)IJP
HICKS    73 PRD 7 2614       +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP
LANGBEIN 73 NP B53 251       LANGBEIN,WAGNER                     (MUNICH)IJP
MOORHOUS 73 PL 43B 44        MOORHOUSE, OBERLACK               (GLAS+LBL)IJP

AYED     74 PRIVATE COMMCTN. AYED,BAREYRE                          (SACL)IJP
   ALSO  73 AIX CONFERENCE   AYED,BAREYRE                          (SACL)IJP
DEVENISH 74 NP B81 330       DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227       DEVENISH,LYTH,RANKIN          (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680       KNIES,MOORHOUSE,OBERLACK           (LBL,GLAS)IJP
METCALF  74 NP B76 253       W J METCALF,R L WALKER                 (CIT)IJP
MOORHOUS 74 PRD 9 1          MOORHOUSE,OBERLACK,ROSENFELD      (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125       R L CRAWFORD                          (GLAS)IJP
DEANS    75 NP B96 90        +MITCHELL,MONTGOMERY,+        (SFLA,ALABAMA)IJP
KNASEL   75 PRD 11 1         +LINDQUIST,NELSON+      (CHIC,WUSL,OSU,ANL)IJP
LONGACRE 75 PL 55B 415       +ROSENFELD,LASINSKI,SMADJA+        (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP     I. M. BARBOUR,R. L. CRAWFORD          (GLAS)IJP

                             PAPERS NOT REFERRED TO IN DATA CARDS.

BAREYRE  65 PL 18 342        + BRICMAN, STIRLING, VILLET         (SACLAY)IJP
JOHNSON  67 UCRL-17683 THESIS C H JOHNSON                            (LRL)
DEANS    69 PR  177 2623     S R DEANS                      (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433       A DONNACHIE, R KIRSOPP             (GLAS+EDIN)
AYED     70 PL 31B 598       +BAREYRE+VILLET                       (SACLAY)
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N(1700) **D''_{13}**

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18   N*1/2(1700, JP=3/2-) I=1/2

AYED 74 AND LONGACRE 75 BOTH FIND EVIDENCE FOR
THIS STATE.  THERE IS ADDITIONAL EVIDENCE FROM
PHOTOPRODUCTION AND ASSOCIATED PRODUCTION.

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               18   N*1/2(1700) MASS  (MEV)

M   3      (1730.)                    DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
M   3      (1680.)                    KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
M   3   WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1   10/69
M   A      (1780.0)                   WAGNER    71 IPWA    PI-P TO K LAMB    1/71
M   A  D13 RESONATES ONLY IN ONE OUT OF 3 POSSIBLE SOL.
M          (1670.)                    DEANS     72 MPWA    GAM P-K LM,SOL D  9/73
M   1      (1790.)                    LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
M   1   NOT SEEN IN SOLUTION 2 OF LANGBEIN73                                 9/73
M          (1710.)                    AYED      74 IPWA                      2/74
M   L       1710. OR 1710.            LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
M   L   THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.   11/75*

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               18   N*1/2(1700) WIDTH (MEV)

W          (90.)                      DEANS     72 MPWA    GAM P-K LM,SOL D  9/73
W   1      (120.)                     LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
W          (100.)                     AYED      74 IPWA                      2/74
W   L       100. OR  300.             LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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               18   N*1/2(1700) REAL PART OF POLE POSITION (MEV)        11/75*

RE         (1710.)                    LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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               18   N*1/2(1700) 2*IMAG PART OF POLE POSITION (MEV)      11/75*

IM         (607.)                     LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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               18   N*1/2(1700) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     N*1/2(1700) INTO PI N                             139+ 938
P2     N*1/2(1700) INTO LAMBDA K                        1115+ 497
P3     N*1/2(1700) INTO GAM P,HELICITY=3/2                 0+ 938
P4     N*1/2(1700) INTO GAM P,HELICITY=1/2                 0+ 938
P5     N*1/2(1700) INTO GAM N,HELICITY=3/2                 0+ 939
P6     N*1/2(1700) INTO GAM N,HELICITY=1/2                 0+ 939
P7     N*1/2(1700) INTO K SIGMA                          493+1189
P8     N*1/2(1700) INTO N EPSILON                        938+1200
P9     N*1/2(1700) INTO N*3/2(1232) PI,S-WAVE           1232+ 139
P10    N*1/2(1700) INTO N*3/2(1232) PI,D-WAVE           1232+ 139
P11    N*1/2(1700) INTO N RHO,S=3/2,S-WAVE               938+ 773

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               18   N*1/2(1700) BRANCHING RATIOS

R1     N*1/2(1700) FROM GAMMA PROTON TO K LAMBDA        SQRT((P3+P4)*P2)      9/73
R1            (.0077)                DEANS     72 MPWA    GAM P-K LM,SOL D  9/73

R2     N*1/2(1700) FROM PI N TO K SIGMA                 SQRT(P1*P7)           9/73
R2  1          (.10)                 LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
R2  2       LESS THAN .017           DEANS     75 DPWA    PI N TO K SIGMA  11/75*
R2  2   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                           11/75*

R3     N*1/2(1700) INTO PI N/TOTAL                      (P1)
R3            (.089)                 AYED      74 IPWA                      2/74

R4     N*1/2(1700) FROM PI N TO K LAMBDA                SQRT(P1*P2)           4/75*
R4           +.026     .019          DEVENISH  74        0 FIXED T DISP REL  4/75*

R5     N*1/2(1700) FROM PI N TO N EPSILON               SQRT(P1*P8)          11/75*
R5  L        (-.2) OR  -.2           LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

R6     N*1/2(1700) FROM PI N TO N*3/2(1232) PI,S-WAVE   SQRT(P1*P9)          11/75*
R6  L        (+.15)OR  +.16          LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

R7     N*1/2(1700) FROM PI N TO N*3/2(1232) PI,D-WAVE   SQRT(P1*P10)         11/75*
R7  L        (-.10)OR  -.14          LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

R8     N*1/2(1700) FROM PI N TO N RHO,S=3/2,S-WAVE      SQRT(P1*P11)         11/75*
R8  L        (0.) OR  (-.07)         LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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               18   N*1/2(1700) PHOTON DECAY AMPL(GEV**-1/2)

     FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
   REVIEW PRECEDING THE BARYON LISTINGS.

A1     N*1/2(1700) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1           -.103     .130          DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A1           -.048     .050          DEVENIS2  74 DPWA    PI N PHOTC-PROD    4/75*
A1           -.015     .040          KNIES     74 DPWA    PI N PHOTC PROD    2/74
A1            .0       .034          METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A1           (.023)                  MOORHOUS  74 DPWA    PI N PHOTO PROD    2/74
A1           -.012     .010          CRAWFORD  75 DPWA    PI N PHOTO-PROD    1/76*
A1          (-.005)                  BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A1              . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A2     N*1/2(1700) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2            .055     .065          DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A2           -.006     .014          DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A2            .030     .040          KNIES     74 DPWA    PI N PHOTO PROD    2/74
A2            .0       .029          METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A2           (.035)                  MOORHOUS  74 DPWA    PI N PHOTO PROD    2/74
A2           -.012     .010          CRAWFORD  75 DPWA    PI N PHOTO-PROD    1/76*
A2          (-.009)                  BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A2              . . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A3     N*1/2(1700) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3            .013     .222          DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A3           -.021     .058          DEVENIS2  74 DPWA    PI N PHOTC-PROD    4/75*
A3           -.036     .040          KNIES     74 DPWA    PI N PHOTO PROD    2/74
A3            .0       .034          METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A3          (-.015)                  MOORHOUS  74 DPWA    PI N PHOTO PROD    2/74
A3           +.081     .015          CRAWFORD  75 DPWA    PI N PHOTO-PROD    1/76*
A3          (+.017)                  BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A3              . . . . . . . . . .
A3  AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)

A4     N*1/2(1700) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4           -.088     .087          DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A4           -.026     .067          DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A4            .024     .024          KNIES     74 DPWA    PI N PHOTO PROD    2/74
A4            .0       .044          METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A4           (.028)                  MOORHCUS  74 DPWA    PI N PHOTO PROD    2/74
A4           +.107     .025          CRAWFORD  75 DPWA    PI N PHOTC-PROD    1/76*
A4          (+.022)                  BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A4              . . . . . . . . . .
A4  AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)

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Baryons

N(1700)

Data Card Listings

For notation, see key at front of Listings.


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                          REFERENCES FOR N*1/2(1700)

DONNACH2 68 VIENNA 139          DONNACHIE  RAPPORTEUR.S TALK           (GLAS)
KIRSOPP  68 THESIS              R G KIRSOPP                            (EDIN)
WAGNER   71 NP B25 411          F WAGNER, C LOVELACE                   (CERN)
DEANS    72 PRD 6 1906          DEANS,JACOBS, LYONS,MONTGCMERY (SOUTH FLA.)IJP
DEVENISH 73 PL 47B 53           CEVENISH,RANKIN,LYTH         (LOUC+BONN+LANC)IJP
LANGBEIN 73 NP B53 251          LANGBEIN,WAGNER                       (MUNICH)IJP

AYED     74 PRIVATE CCMMCTN.    AYEC,BAREYRE                            (SACL)IJP
   ALSO  73 AIX CONFERENCE      AYED,BAREYRE                            (SACL)IJP
DEVENISH 74 NP B81 330          DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227          CEVENISH,LYTH,RANKIN         (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680          KNIES,MOORHOUSE,OBERLACK           (LBL,GLAS)IJP
METCALF  74 NP B76 253          W J METCALF,R L WALKER                   (CIT)IJP
MCORHOUS 74 PRD 9 1             MCORHOUSE,OBERLACK,ROSENFELD       (GLAS+LBL)IJP

CRAWFCRD 75 NP B97 125          R L CRAWFORD                            (GLAS)IJP
DEANS    75 NP B96 90           +MITCHELL,MONTGCMERY,+         (SFLA,ALABAMA)IJP
LONGACRE 75 PL 55B 415          +ROSENFELD,LASINSKI,SMADJA+        (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP        I. M. BARBOUR,R. L. CRAWFCRD            (GLAS)IJP

                                PAPERS NOT REFERREC TO IN CATA CARDS.

HERNDON  72 LBL 1065            +...ROSENFELD...+CASHMORE+...       (LBL,SLAC)
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1700 MEV REGION – PRODUCTION EXPERIMENTS

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                20  N*1/2(1700, JP=    ) I=1/2   PRODUCTICN EXPERIMENTS

                PARTIAL WAVE ANALYSIS REQUIRES AT LEAST FOUR I=1/2 STAT
                IN THE 1670 TO 1780 REGION (D15, F15, S11, P11) AND AT
                LEAST ONE I=3/2 STATE (D33).  OBVIOUSLY, DIFFERENT EXPE
                IMENTS ARE SEEING DIFFERENT STATES AND OFTEN IT IS NCT
   CLEAR WHAT ISOSPIN STATE IS BEING OBSERVED.  NO EFFORT WAS MADE
   TO SEPARATE TFESE EXPERIMENTS ACCORDING TO JP, SINCE NONE OF THE
   REPORTED JP IS FIRMLY ESTABLISFED.  WE LIST ALL THE INFORMATION HERE,
   BUT WE HAVE NOT USED IT IN THE BARYCN TABLE.
      FOR SPIN-PARITY ANALYSIS OF THIS MASS REGION, SEE JOHNSTAD 72 AND
   LAMSA 72.  SEE LEDNICKY 75 FOR A SPIN-PARITY ANALYSIS OF P+OMEGA
   PRODUCTION NEAR 1800 MEV.

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                20  N*1/2(1700) MASS (MEV) (PROD. EXP.)

M          (1695.0)   (9.0)              A-BORELLI 67 HBC  +  PBAR P 5.7 BEV/C  8/67
M          (1734.0)   (21.0)             ALMEIDA   68 HBC  +  PP 10 BEV/C       9/69
M          (1730.0)   (18.0)             GALLCWAY  68 HBC     PI-P 6 GEV/C      8/69
M    1     (1712.0)   (6.0)              BARNES    69 HBC     K-P TO K-P 2PI    7/70
M    1      IJP CONSISTENT WITF S11(1700) OR P11(1780) IN FORMATION
M    A     (1667.0)   (5.0)              BENVENUTI 69 DBC   0 PI-D 2.26 GEV     5/70
M    A        J CONSISTENT WITH 5/2 OR 7/2
M    B  190(1693.)    (15.)              RHODE     69 HBC     PP 22 GEV/C      10/69
M    B  JP IS PROBABLY 5/2+
M          (1691.)    (4.)               ANDERSON  70 MMS  -  PI- P TO PI- MMS  2/71
M       177(1710.)    (10.)              CIRBA     70 HBC  +  PI+ P TO P+3PI    2/71
M        40(1763.)    (25.)              COOPER    70 HBC  +  LAMB. K PROD.     2/71
M       505(1730.0)   (15.0)             CRENNELL  70 HBC  +  PI-P,PI+P 6 GEV   1/71
M        60(1710.)                       KUZNETSOV 70 HLBC -  LAMB. K PROD.     2/71
M    A     (1719.0)   (6.0)              WILLMANN  70 HBC  +  PI+P 13. GEV      5/70
M    A        J CONSISTENT WITH 5/2 OR 7/2
M          (1694.0)   (8.0)              AMALDI    71 CNTR    P P AT 24 GEV    10/71
M          (1730.)    (20.)              BALLAM    71 HBC  +- PI+-P AT 16GEV    2/72
M          (1700.)                       BEKETOV   71 HBC  +  PI- P 4.45GEV/C   3/72
M          (1711.)    (10.)              BOESEBEC  71 RVUE    PP,PI-P,K-P PRCD  3/72
M          (1672.0)   (4.0)              ELLIS     71 CNTR    MMS PP 3.7 GEV/C 10/71
M        80(1650.0)   (10.0)    80/120   MA        71 HBC  +  P P TO P N PI    10/71
M          (1700.0)   (10.0)             MORSE     71 HBC  +  PI-P   25 GEV/C   3/72
M           1670. TO 1730.               MORSE     71 HBC  +0 PI-P  7   GEV/C   3/72
M          (1720.)    (20.)              RUSHBROOKE71 HBC  +  PP TO P2PI 16GEV  2/72
M          (1690.3)   (4.5)              EDELSTEIN 72 MMS  +  PP 6 TO 30 GEV    1/73
M          (1668.0)   (19.0)    24/45    KARSHON   72 CBC  +  PD--PD2PI 7 GEV  12/72
M    C     (1715.0)   (5.0)              LAMSA     72 HBC  +  PI+-P 8TO18 GEV   1/73
M    C   ANALYSIS GIVES JP = 5/2+
M     2    (1660.)  (15.                 OH        72 DBC   0 PI-N TO PI-PI-P   2/73
M     2  DETERMINE J=5/2,F15 PROBABLE                                           2/73
M          (1720.)    (15.)              RONAT     72  HBC    PI+P TO 3PI P     2/73
M    3     (1820.)                       DAVIDSON  74 HBC   + PI-P TO PI- OM P 10/74*
M    3   OMEGA PROTON ENHANCEMENT,MOMENTS ANALYSIS CONSISTENT WITH 2J=1 OR 3  10/74*
M          (1732.)    (7.)               LICHTMAN  74 HBC  +  PI+P TO 3PI P     4/75*
M          (1694.)    (10.)              LICHTMAN  74 HBC  +  PI-P TO 3PI P     4/75*
M    4     (1700.)                       BLOBEL    75 HBC  +  PP TO P(PI+PI-P)  1/76*
M    4   PWA INDICATES PI+PI-P ENHANCEMENT IS PRIMARILY A                       1/76*
M    4   P-WAVE P EPSILON SYSTEM WITH I,JP=1/2,3/2-.                            1/76*
M           1660. TO 1670.               BRAUN1    75 HBC     PBAR P 5.7 GEV   11/75*
M          (1691.)    (11.)              CAVALLI   75 SPEC +  PP TO 2N*,W=23GV  1/76*
M          (1691.)    (8.)               CAVALLI   75 SPEC +  PP TO 2N*,W=31GV  1/76*
M          (1715.)    (10.)              CAVALLI   75 SPEC +  PP TO 2N*,W=53GV  1/76*
M          (1686.)    (12.)              MUSGRAVE  75 HBC     K+ P TO K PI N   11/75*
M          (1650.)                       STRACHMA  75  BC     NBAR (N PI)       1/76*
M           1678.      4.                WEBB      75 ISR  +  P P TO P N*       1/76*

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                20  N*1/2(1700) WIDTH (MEV) (PROD. EXP.)

W            (70.0)   (20.0)             A-BORELLI 67 HBC                       9/69
W           (140.0)   (57.0)             ALMEIDA   68 HBC  +                    9/69
W            (55.0)   (15.0)             GALLOWAY  68 HBC                       8/69
W    1       (70.0)   (15.0)             BARNES    69 HBC     K-P TO K-P 2PI    7/70
W    A      (105.0)   (16.0)             BENVENUTI 69 DBC   0                   5/70
W    B  190 (235.)    (50.)              RHODE     69 HBC     PP 22 GEV/C      10/69
W           (130.)    (10.)              ANDERSON  70 MMS  -  PI- P TO PI- MMS  2/71
W       177  (66.)    (26.)              CIRBA     70 HBC  +  PI+ P AT 5 GEV/C  2/71
W           (102.)    (40.)              COOPER    70 HBC  +  PI+P, 5.5 GEV/C   2/71
W       505 (130.0)   (30.0)             CRENNELL  70 HBC  +                    1/71
W        60 (220.)                       KUZNETSOV 70 HLBC -  PI-P, 4 GEV/C     2/71
W    A       (63.0)   (12.0)             WILLMANN  70 HBC  +                    5/70
W           (152.0)   (15.0)             AMALDI    71 CNTR    P P AT 24 GEV    10/71
W           (120.)    (50.)              BALLAM    71 HBC  +- PI+-P AT 16GEV    2/72
W            (57.)    (15.)              BOESEBEC  71 RVUE    PP,PI-P,K-P PROD  3/72
W           (102.0)    (9.0)             ELLIS     71 CNTR    MMS PP 3.7 GEV/C 10/71
W        80  (94.0)   (20.0)    80/120   MA        71 HBC  +  P P TO P N PI    10/71
W            (70.)    (20.)              MORSE     71 HBC  +  PI-P   25 GEV/C   3/72
W             70. TO  120.               MORSE     71 HBC  +0 PI-P  7   GEV/C   3/72
W           (120.)    (40.)              RUSHBROOKE71 HBC  +  PP TO P2PI 16GEV  2/72
W           (133.0)   (26.0)             EDELSTEIN 72 MMS  +  PP 6 TO 30 GEV    1/73
W           (168.0)   (64.0)             KARSHON   72 CBC  +  PD--PD2PI 7 GEV  12/72
W            (80.0)  APPROX.             LAMSA     72 HBC     PI P  18.5 GEV/C 12/72
W     2    (128.)   (40.                 OH        72 CBC   0 PI-N TO PI-PI-P   2/73
W            (60.)    (40.)              RONAT     72  HBC    PI+P TO 3PI P     2/73
W           (157.)    (12.)              ABE       74      +  P+P->P+X,JCBN PK  4/75*
W    3      (120.)                       DAVIDSON  74 HBC   + PI-P TO PI- OM P 10/74*
W            (34.)    (14.)              LICHTMAN  74 HBC  +  PI+P TO 3PI P     4/75*
W            (48.)    (20.)              LICHTMAN  74 HBC  +  PI-P TO 3PI P     4/75*
W           (140.)                       BRAUN1    75 HBC     PBAR P 5.7 GEV   11/75*
W           (188.)   (112.)              CAVALLI   75 SPEC +  PP TO 2N*,W=23GV  1/76*
W           (133.)    (38.)              CAVALLI   75 SPEC +  PP TO 2N*,W=31GV  1/76*
W           (100.)    (10.)              CAVALLI   75 SPEC +  PP TO 2N*,W=53GV  1/76*
W           (135.)    (20.)              MUSGRAVE  75 HBC     K+ P TO K PI N   11/75*
W             148.     16.               WEBB      75
      SEE THE NOTES ACCOMPANYING TFE MASSES QUOTED

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                20  N*1/2(1700) PARTIAL DECAY MODES (PROD. EXP.)

                                                            DECAY MASSES
P1      N*1/2(1700) INTO PI N                              139+ 938
P2      N*1/2(1700) INTO N PI PI                           938+ 139+ 139
P3      N*1/2(1700) INTO N*3/2(1232) PI                   1232+ 139
P4      N*1/2(1700)+ INTO NEUTRON PI+                      939+ 139
P5      N*1/2(1700)+ INTO PROTON PI+ PI-                   938+ 139+ 139
P6      N*1/2(1700)+ INTO N*3/2(1232)++ PI-               1232+ 139
P7      N*1/2(1700) INTO N ETA                             939+ 548
P8      N*1/2(1700) INTO LAMBDA K                         1115+ 497
P9      N*1/2(1700) INTO SIGMA K                          1189+ 493
P10     N*1/2(1700) INTO OMEGA PROTON                      783+ 938
P11     N*1/2(1700) INTO RHOO PROTON                       773+ 938

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                20  N*1/2(1700) BRANCHING RATIOS (PROD. EXP.)

R1      N*1/2(1700) INTO (PI N)/(PI N*3/2(1232))           (P1)/(P3)
R1           (0.77) OR LESS            LEE       67 HBC     PI-P 3.6 GEV/C    11/67
R1   A       (9.0)  OR MORE            BENVENUTI 69 CBC   0                    5/70

R2      N*1/2(1700) INTO (N ETA)/(N PI + N PI PI)          (P7)/(P1+P2)
R2           (0.025)OR LESS            KRAEMER   64 DBC  +  PI+D 1.2
R2           (0.042)OR LESS  CL=.95    A-BORELLI 67 HBC  +  PBAR P 5.7 BEV/C   9/69

R3      N*1/2(1700) INTO (LAMBCA K)/(P PI+ PI-)            (P8)/(P5)
R3           (0.034)OR LESS            ALEXANDER 67 HBC  +  PP 5.5 BEV/C      11/67
R3           (0.07) OR LESS  CL=.95    CIRBA     70 HBC     PI+P AT 5 GEV/C    2/71

R4      N*1/2(1700) INTO (LAMBCA K)/(N PI + N PI PI)       (P8)/(P1+P2)
R4           (0.013)OR LESS  CL=.95    A-BORELLI 67 HBC  +                     8/67
R4             SEEN                    CHINOWSKY 68 HBC     PP TO K+ Y N       6/68
R4   1      LIMITS 0.025 TO 0.11       BARNES    69 HBC     K-P TO K-P 2PI     7/70
R4     25     0.025      0.005         CRENNELL  70 HBC  +                     1/71
R4   A      LESS THAN    0.025         WILLMANN  70 HBC     PI+P TO 3PI P      6/70
R4     25  SEEN. CONS. WITH J=1/2      MORSE     71 HBC   0 PI-P  7   GEV/C    3/72

R5      N*1/2(1700) INTO (N PI)/(N PI PI)                  (P1)/(P2)
R5           (1.26) OR LESS  CL=.95    A-BORELLI 67 HBC  +                     8/67
R5            0.025      0.13          CRENNELL  70 HBC  +                     1/71

R6      N*1/2(1700) INTO (N*3/2(1232) PI)/(N PI PI)        (P3)/(P2)
R6             NO EVIDENCE             A-BORELLI 67 HBC  +                     8/67
           SEE MERLC 66 FOR A REVIEW.

R7      N*1/2(1700) INTO (NEUTRON PI+)/(P PI+ PI-)         (P4)/(P5)
R7            0.67       0.40          ALEXANDER 67 HBC  +  PP 5.5 BEV/C      11/67
R7            0.47       0.25          A-BORELLI 67 HBC     PBAR P 5.5 GEV/C   7/70
R7            . . . . . . . . .
R7   AVG      0.53       0.21     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R7   STUDENT  0.53       0.23     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R8      N*1/2(1700) INTO (N*3/2(1232)++ PI-)/(P PI+ PI-) (P6)/(P5)
R8            0.74       0.14          ALEXANDER 67 HBC  +  PP 5.5 BEV/C      11/67
R8            1.0        0.3           ALMEIDA   68 HBC  +  PP 10 BEV/C        9/66
R8           (0.83)                    KAYAS     68 HBC     PP 8.1 BEV/C      11/68
R8   1      LESS THAN    0.15          BARNES    69 HBC     K-P TO K-P 2PI     7/70
R8           (0.50) OR LESS  CL=.95    CIRBA     70 HBC     PI+P AT 5 GEV/C    2/71
R8            NO EVIDENCE              CRENNELL  70 HBC  +                     1/71
R8   A       (2.3)      (1.6)          WILLMANN  70 HBC     PI+P TO 3PI P      6/70
R8           (1.0)   OR MORE  CL=.95   BEKETOV   71 HBC  +  DEL(1232)++ PI-    3/72
R8            0.75       0.75          BOESEBEC  71 RVUE    PP,PI-P,K-P PROD   3/72
R8            0.35       0.20          RUSHBROOKE71 HBC  +  PP TO P2PI 16GEV   2/72
R8 C          0.65       0.15          LAMSA     72 HBC     PI P  18.5 GEV/C  12/72
R8            . . . . . . . . .
R8   AVG      0.66       0.10     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R8   STUDENT  0.665      0.099    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R9      N*1/2(1700) INTO (SIG K)/(LAMB K)                  (P9)/(P8)
R9          LESS THAN     .20          COOPER    70 HBC  +  PI+P, 5.5 GEV/C    2/71

R10     N*1/2(1700) INTO (PI N)+/(CMEGA PROTCN)            (P1)/(P10)
R10      LESS THAN .36 (90 PCT CL)     DAVIDSON  74 HBC   + PI-P TO PI- OM P 10/74*

R11     N*1/2(1700) INTO (RHOO PROTON)/(OMEGA PROTCN)      (P11)/(P10)
R11      LESS THAN .12 (90 PCT CL)     DAVIDSON  74 HBC   + PI-P TO PI- OM P 10/74*

        SEE THE NOTES ACCOMPANYING THE MASSES QUOTEC

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                          REFERENCES FOR N*1/2(1700) (PROD. EXP.)

KRAEMER  64 PR 136 B496         +MADANSKY,+  (J HOPKINS,NWESTERN,WOODSTOCK) I

ALEXANDE 67 PR 154 1284         ALEXANDER,BENARY,CZAPEK,+  (WEIZMANN(CERN))
A-BORELL 67 NC 47 232           ALLES-BORELLI,FRENCH,FRISK,MICHEJDA  (CERN)
LEE      67 PR 159 1156         +MOEBS,ROE,SINCLAIR,VANDER VELDE      (MICH)

ALMEICA  68 PR 174 1638         +RUSHBROOKE, +               (CAVE,DESY(CERN))
CHINOWSK 68 PR 165 1466         CHINOWSKY,KINSEY,KLEIN, +          (LRL,SLAC)
GALLOWAY 68 PL 27B 250          GALLOWAY,ALYEA,CRITTENDEN,PRICKETT,+  (IND)
KAYAS    68 NP B5 169           +GUYADER,SENE,YIOU,ALITTI,+  (ORSAY,SACLAY)

BARNES   69 PRL 23 1516         +BASSANO+CHUNG+EISNER+FLAMINTO+KINSON (BNL)IJ
BENVENUT 69 PR 187 1852         BENVENUTI, MARQUIT, OPPENHEIMER (MINN,COLO)
RHODE    69 PR 187 1844         RHCDE, LEACCCK, KERNAN, JESPERSEN,+   (ISU)

ANDERSON 70 PRL 25,699          +BLESER,BLIEDEN,COLLINS++         (BNL,CARN)
CIRBA    70 NP B23,533          +VANDERHAGEN+   (EPOL,DURH,NIJM, TORI,BONN)
CCOPER   70 NP B23,605          +MANNER,MUSGRAVE,POLLARD,VOYVODIC      (ANL)
CRENNELL 70 PRL 25 187          +LAI, LOUIE, SCARR, SIMS               (BNL)
KUZNETSOV70 SJNP 10,332         +MELNIKOV,RYLTSEVA,CHADRAA,BALINTP    (JINR)
WILLMANN 70 PRL 24 1260         +LAMSA,GAIDOS,EZELL                  (PURD)IJ
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Data Card Listings

For notation, see key at front of Listings.

Baryons

N(1700), N(1780)


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AMALDI   71 PL  34B 435        +BIANCASTELLI,BCSIO,+  (I SANITA RCMA+CERN)
BALLAM   71 PR D4 1946         +CHADWICK,GUIRAGOSSIAN,JOHNSON,++     (SLAC) I
BEKETOV  71 SJNP 13 605        ,ZCMBKOVSKII,KONOVALCV,KRUCHININ,++  (ITEP)IJ
BOESEBEC 71 NP B33 445         BOESEBECK,GRAESSLER,KRAUS,+++      (ABBCHLV) I
ELLIS    71 PRL 27 442         +MAGLICH,NOREM,SANNES,SILVERMAN        (RUTG)
MA       71 PRL  26  333       +CCLTON                            (MSU+LBL)I
MORSE    71 PR D4 133          +OH,WALKER,CARRCLL,LYNCH +       (WISC+TNTO)I
RUSHBROO 71 PR D4 3273         RUSHBROOKE,WILLIAMS+BAREFORD++   (CAVE,LOIC) IJ

EDELSTEI 72 PR D5 1073         EDELSTEIN,CARRIGAN,HIEN,MCMAHCN,+(CARN+BNL)
JOHNSTAD 72 NP B42 588         +MOLLERUD+...+JACOBSEN(BOHR,HELS,OSLO,STOH) IJP
KARSHON  72 NP B37 371         +YEKUTIELI,YAFFE,SHAPIRA,RCNAT,+      (REHO) I
LAMSA    72 NP B37 364         +WILLMANN+..+GO,BISWAS+...      (PURO,NCAM) IJP
OH       72 PL 42B 497         +FUNG,KERNAN,POE,SCHALK,SHEN           (UCR)IJP
RONAT    72 NP B38 20          +EISENBERG,LYCNS,SHAPIRA,TCAFF+       (REHO)

ABE      74 PL 53B 114         +ALSPECTOR,BOMBEROWITZ+       (RUTG,UPNJ,FSU)
DAVIDSON 74 PRL 32 855         CAVIDSON,DZIERBA,FIRESTONE,+  (CIT+BNL+LBL)I
LICHTMAN 74 NP B81 31          LICHTMAN,BISWAS,CASON,KENNEY,MCGAHAN+(NDAM)I

BLOBEL   75 NP B97 201         +ESKREYS,FESEFELDT,FRANZ+  (BCNN+HAMB+MPIM)IJP
BRAUN1   75 NP B95 481         +GERBER,MAURER,MICHALCN,SCHIBY+ (STRB,LPNP)I
CAVALLI  75 LNC 14 353         CAVALLI-SFORZA,CONTA+             (PAVIA+PRIN)
   ALSO  75 LNC 14 345+359     CAVALLI-SFORZA,CONTA+             (PAVIA+PRIN)
MUSGRAVE 75 NP B87 365         +PEETERS,SCREINER,WHITMORE,YUTA          (ANL)
STRACHMA 75 NP B98 120         STRACHMAN,BRAUN,GERBER,MAURER+  (LPNP+STRB)I
WEBB     75 PL 55B 331         +TRILLING,TELEGDI+      (AACH+UCLA+UCR+CERN)
   ALSO  75 PL 55B 336         +TRILLING,TELEGDI+      (AACH+UCLA+UCR+CERN)

                               PAPERS NOT REFERRED TO IN CATA CAROS.

MERLO    66 P ROY SOC 289 489 J P MERLO, G VALLACAS                (SACLAY)
ANTIPOV  75 NP B99 189         +ASCOLI,BAUD+          (CERN-IHEP BOSON SPEC)
LEDNICKY 75 PL 58B 89          R. LEDNICKY                            (JINR)
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N(1780) 14 N*1/2(1780, JP=1/2+) I=1/2 **P''_{11}**

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THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.

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                 14  N*1/2(1780) MASS (MEV)

M   3     (1751.0)                   DONNACH1  68 RVUE    PHASE-SHIFT ANAL  8/69
M         (1640.0)   (70.0)          ORITO     69 RVUE    K LAMBDA PS ANAL  8/69
M         (1700.0)                   ORITO2    69 CNTR    K LAM PHOTOPRC   10/71
M   6     (1645.0)                   AYED      70 IPWA                      1/71
M   6  FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4     (1770.0)                   DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M         (1809.0)                   SCHORSCH  70 DPWA    K LAM PHOTOPRO.  10/71
M   A     (1685.0)OR(1740.0)         WAGNER    71 IPWA    PI-P TC K LAMB    1/71
M   A  THERE ARE 3 SIMILAR SOLUTIONS
M   7     (1720.)                    ALMEHED   72 IPWA                      2/72
M    2    (1728.)                    HICKS     73 MPWA    GAM P-ETA P       9/73
M    2  ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUCED IN LISTINGS.     9/73
M    2  M AND W ARE FROM SOLUTICN C2,BR=SQRT(G)/W WITH G FROM TABLE VII.    9/73
M         (1780.)                    LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
M         (1780.)                    LANGBEIN  73 IPWA    PI N-K SIG,SOL 2  9/73
M         (1729.)                    AYED      74 IPWA                      2/74
M         (1670.)                    KNASEL    75 DPWA  O PI- P TO KO LAM  11/75*
M    L     1730. OR 1710.            LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
M    L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.  11/75*

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                 14  N*1/2(1780) WIDTH (MEV)

W   3     (327.0)                    DONNACH1  68 RVUE                      8/69
W         (310.0)    (50.0)          ORITO     69 RVUE                      8/69
W         (210.0)                    ORITO2    69 CNTR    K LAM PHOTOPRO   10/71
W   6      (50.0)                    AYED      70 IPWA                      1/71
W   4     (445.0)                    DAVIES    70 RVUE    SOL A             8/69
W         (280.0)                    SCHORSCH  70 DPWA    K LAM PHOTOPRO.  10/71
W   A     (160.0)OR(220.0)           WAGNER    71 IPWA    PI-P TO K LAMB    1/71
W   7     (160.)                     ALMEHED   72 IPWA                      2/72
W    2    (203.)                     HICKS     73 MPWA    GAM P-ETA P       9/73
W         (130.)                     LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
W         (130.)                     LANGBEIN  73 IPWA    PI N-K SIG,SOL 2  9/73
W         (217.)                     AYED      74 IPWA                      2/74
W         (174.)                     KNASEL    75 DPWA  O PI- P TO KO LAM  11/75*
W    L    (165.) OR (75.)            LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
    SEE THE NOTES ACCCMPANYING THE MASSES QUOTED.

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                 14  N*1/2(1780) REAL PART OF POLE PCSITION (MEV)          11/75*

RE        (1708.)                    LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                 14  N*1/2(1780) 2*IMAG PART OF POLE PCSITION (MEV)        11/75*

IM        (17.)                      LCNGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                 14  N*1/2(1780) PARTIAL DECAY MODES

                                                   DECAY MASSES
P1     N*1/2(1780) INTO PI N                      139+ 938
P2     N*1/2(1780) INTO LAMBDA K                 1115+ 497
P3     N*1/2(1780) INTO N ETA                     939+ 548
P4     N*1/2(1780) INTO GAM P, HELICITY=1/2         0+ 938
P5     N*1/2(1780) INTO GAM N, HELICITY=1/2         0+ 939
P6     N*1/2(1780) INTO N PI PI                   938+ 139+ 139
P7     N*1/2(1780) INTO N EPSILCN                 938+1200
P8     N*1/2(1780) INTC N RHO                     938+ 773
P9     N*1/2(1780) INTO K SIGMA                   493+1189
P10    N*1/2(1780) INTO N*3/2(1232) PI           1232+ 139
P11    N*1/2(1780) INTO N RHO,S=1/2,P-WAVE        938+ 773

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                 14  N*1/2(1780) BRANCHING RATIOS

R1     N*1/2(1780) INTO (PI N)/TOTAL                     (P1)
R1  3      (0.32)                    DCNNACH1  68 RVUE                      8/69
R1  6      (0.149)                   AYED      70 IPWA                      1/71
R1  4      (0.43)                    DAVIES    70 RVUE    SOL A             8/69
R1  7      (0.2)                     ALMEHED   72 IPWA                      2/72
R1          (.188)                   AYED      74 IPWA                      2/74

R2     N*1/2(1780) FROM PI N TO K LAMBDA                 SQRT(P1*P2)        4/75*
R2          (.06)     (.03)          ORITO     69 RVUE                      4/75*
R2  A       (.16)OR .21              WAGNER    71            PI- P TO K LAMB 4/75*
R2          -.150      .038          DEVENISH  74         O FIXED T DISP REL 4/75*
R2          (.10)                    KNASEL    75 DPWA  O PI- P TO KO LAM  11/75*

R3     N*1/2(1780) INTO (LAMBDA K)/TOTAL                 (P2)
R3  B      (0.003)TO 0.065           RUSH      68 MPWA    T POLE + RESON.   8/69
R3  B   PARAMETRIZATION USEC COULD BE IN DANGER CF DOUBLE COUNTING

R4     N*1/2(1780) INTO (N ETA)/TOTAL                    (P3)
R4  B      (0.19)                    BOTKE     69 MPWA    T POLE + RESON.  10/69
R4  B      (0.09)    (0.05)          DEANS     69 MPWA    T POLE + RESON.   5/70
R4  B      (0.015)OR 0.035           CARRERAS  70 MPWA    T POLE + RESON.   5/70
R4  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R5     N*1/2(1780) FROM GAMMA PRCTCN TO K LAMBDA         SQRT(P2*P4)        9/73
R5         (0.0027)                  ORITO2    69 CNTR    K LAM PHOTOPRC   10/71
R5         (0.0088)                  SCHORSCH  70 DPWA    K LAM PHOTOPRC.  10/71
R5         (.0104)                   DEANS     72 MPWA    GAM P-K LM,SOL D  9/73

R6     N*1/2(1780) FPOM GAMMA PROTON TO ETA PROTCN       SQRT(P3*P4)        9/73
R6   2     (.0075)                   HICKS     73 MPWA    GAM P-ETA P       9/73

R7     N*1/2(1780) FROM PI N TO K SIGMA                  SQRT(P1*P9)        9/73
R7         (.11)                     LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
R7         (.14)                     LANGBEIN  73 IPWA    PI N-K SIG,SOL 2  9/73
R7  1      (.075)TO  .203            DEANS     75 DPWA    PI N TO K SIGMA  11/75*
R7  1   RANGE GIVEN IS FRCM FOUR BEST SCLUTICNS.                           11/75*

R8     N*1/2(1780) FROM PI N TO N*3/2(1232) PI           SQRT(P1*P10)      11/75*
R8   L     (.13)OR  -.20             LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

R9     N*1/2(1780) FROM PI N TO N RHO,S=1/2,P-WAVE       SQRT(P1*P11)      11/75*
R9   L    (+.32)OR  +.20             LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

R10    N*1/2(1780) FROM PI N TO N EPSILON                SQRT(P1*P7)       11/75*
R10  L    (+.18)OR  +.28             LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

R11    N*1/2(1780) FROM PI N TO ETA N                    SQRT(P1*P3)       11/75*
R11 5     (+.382)TO +.383            FELTESSE  75 DPWA  O 1488 TO 1745 MEV 11/75*
R11 5   USES M AND W OF AYED 74.  NOTE THAT THIS GIVES A BRANCHING         11/75*
R11 5   RATIO TO ETA N OF AEOUT 80 PCT, IN STRONG DISAGREEMENT WITH        11/75*
R11 5   EARLIER EXPERIMENTS.                                               11/75*

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                 14  N*1/2(1780) PHOTON DECAY AMPL(GEV**-1/2)

        FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
      REVIEW PRECEDING THE BARYCN LISTINGS.

A1     N*1/2(1780) INTO GAM P, HELICITY=1/2 (GEV**-1/2)
A1          .022       .057          DEVENISH  73 DPWA    PI N PHOTO PRCD   2/74
A1         +.026       .028          MCORHOUS  73 DPWA    PI N PHOTO-PRCD   2/73
A1         -.014       .021          DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*
A1          .022       .015          KNIES     74 CPWA    PI N PHOTO PROD   2/74
A1         -.068       .024          METCALF   74 DPWA    PI N PHOTO-PRCD   2/74
A1          .016       .025          MOORHOUS  74 DPWA    PI N PHOTO-PRCD   2/74
A1         +.062       .007          CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
A1         (+.005)                   BARBOUR   76 DPWA    PI N PHOTC-PRCD   1/76*
A1          . . . . . . . . .
A1   AVERAGE MEANINGLESS (SCALE FACTOR = 2.8)

A2     N*1/2(1780) INTO GAM N, HELICITY=1/2 (GEV**-1/2)
A2         -.028       .067          DEVENISH  73 DPWA    PI N PHOTO PRCD   2/74
A2         +.027       .022          MOORHOUS  73 DPWA    PI N PHOTC-PRCD   2/73
A2         -.060       .061          DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*
A2          .027       .015          KNIES     74 DPWA    PI N PHCTC PROD   2/74
A2          .048       .045          METCALF   74 DPWA    PI N PHOTO-PROD   2/74
A2          .057       .022          MCORHOUS  74 DPWA    PI N PHOTO-PROD   2/74
A2         -.020       .016          CRAWFORD  75 DPWA    PI N PHOTO-PRCD   1/76*
A2         (-.010)                   BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*
A2          . . . . . . . . .
A2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

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                              REFERENCES FOR N*1/2(1780)
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DONNACH1 68 PL 26B 161         A DCNNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
   ALSO  68 VIENNA 139         DONNACHIE  RAPPORTEUR.S TALK            (GLAS)
   ALSO  68 THESIS             R G KIRSOPP                             (EDIN)
RUSH     68 PR 173 1776        J E RUSH                        (UNIV ALABAMA)

BOTKE    69 PR 180 1417        J C BOTKE                               (UCSB)
DEANS    69 PR 185 1797        S DEANS, J WOOTEN              (UNIV S FLORIDA)
ORITO    69 LNC 1 936          S CRITO,S SASAKI                 (TOKYO-OSAKA)
ORITO2   69 INS J 113          S CRITO (THESIS)                       (TCKYO)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET           (SACL)IJP
CARRERAS 70 NP 16B 35          B CARRERAS, A DONNACHIE          (DARE,MCHS)
DAVIES   70 NP B21 359         A DAVIES                                (GLAS)
SCHCRSCH 70 NP  B25 179        +TIETGE,WEILNBOECK                      (MPIM)

WAGNER   71 NP B25 411         F WAGNER, C LOVELACE                    (CERN)

ALMEHED  72 NP B40 157         +LCVELACE                        (LUND,RUTG)IJP
DEANS    72 PRD 6 1906         DEANS,JACOBS, LYONS,MONTGCMERY (SOUTH FLA.)IJP

DEVENISH 73 PL 47B 53          DEVENISH,RANKIN,LYTH         (LOUC+BONN+LANC)IJP
HICKS    73 PRD 7 2614         +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP
LANGBEIN 73 NP B53 251         LANGBEIN,WAGNER                      (MUNICH)IJP
MOORHOUS 73 PL 43B 44          MOORHOUSE, OBERLACK               (GLAS+LBL)IJP

AYED     74 PRIVATE COMMCTN.   AYED,BAREYRE                          (SACL)IJP
   ALSO  73 AIX CONFERENCE     AYED,BAREYRE                          (SACL)IJP
DEVENISH 74 NP B81 330         DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227         DEVENISH,LYTH,RANKIN      (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680         KNIES,MOORHOUSE,OBERLACK           (LBL,GLAS)IJP
METCALF  74 NP B76 253         W J METCALF,R L WALKER                 (CIT)IJP
MOORHCUS 74 PRD 9 1            MCORHOUSE,OBERLACK,ROSENFELD      (GLAS+LBL)IJP

CRAWFCRD 75 NP B97 125         R L CRAWFCRD                          (GLAS)IJP
DEANS    75 NP B96 90          +MITCHELL,MONTGCMERY,+          (SFLA,ALABAMA)IJP
FELTESSE 75 NP B93 242         +AYED,BAREYRE,BORGEAUD,DAVID,ERNWEIN+(SACL)IJP
KNASEL   75 PRD 11 1           +LINDQUIST,NELSON+     (CHIC,WUSL,OSU,ANL)IJP
LCNGACRE 75 PL 55B 415         +ROSENFELD,LASINSKI,SMADJA+        (LBL,SLAC)IJP

BARBCUR  76 SBMTD. TO NP       I. M. BARBCUR,R. L. CRAWFCRD          (GLAS)IJP
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Baryons

N(1780), N(1810), N(1990)

Data Card Listings

For notation, see key at front of Listings.

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                        PAPERS NOT REFERRED TO IN CATA CARDS.

DEANS     69 PR  177 2623     S R DEANS                   (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433        A DONNACHIE, R KIRSOPP         (GLAS+EDIN)
AYED      70 PL 31B 598       +BAREYRE+VILLET                   (SACLAY)

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N(1810) — P13

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15  N*1/2(1810, JP=3/2+) I=1/2

THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.

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               15  N*1/2(1810) MASS (MEV)

M   3     (1860.0)                    DONNACHI  68 RVUE    PHASE-SHIFT ANAL  6/68
M   X     (1860.0)         APPROX     LEA       69 CNTR    PI-P ELASTIC      8/69
M   X   SEE ALSO APLIN 71
M   6     (1766.0)                    AYED      70 IPWA                      1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4     (1844.0)                    DAVIES    70 RVUE    P-S ANAL  SCL A   8/69
M   A     (1800.0)                    WAGNER    71 IPWA    PI-P TO K LAMB    1/71
M   A   P13 RESONATES ONLY IN ONE CUT OF 3 POSSIBLE SOLUTIONS
M   7     (1850.)                     ALMEHED   72 IPWA                      2/72
M    1    (1833.)                     HICKS     73 MPWA    GAM P-ETA P       9/73
M    1  ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUDED IN LISTINGS.      9/73
M    1  M AND W ARE FROM SOLUTICN C2,BR=SQRT(G)/W WITH G FROM TABLE VII.     9/73
M         (1696.)                     AYED      74 IPWA                      2/74
M         (1850.)                     KNASEL    75 DPWA  0 PI- P TO KO LAM  11/75*
M    L     1695. OR 1720.             LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
M    L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.   11/75*

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               15  N*1/2(1810) WIDTH (MEV)

W   3     (296.00)                    DONNACHI  68 RVUE                      8/69
W   6     (182.0)                     AYED      70 IPWA                      1/71
W   4     (449.0)                     DAVIES    70 RVUE    SOL A             8/69
W   4   SOL B GIVES 307 MEV                                                  2/73
W   A     (220.0)                     WAGNER    71 IPWA    PI-P TO K LAMB    1/71
W   7     (300.)                      ALMEHED   72 IPWA                      2/72
W    1    (250.)                      HICKS     73 MPWA    GAM P-ETA P       9/73
W         (117.)                      AYED      74 IPWA                      2/74
W         (327.)                      KNASEL    75 DPWA  0 PI- P TO KO LAM  11/75*
W    L    (115.)OR (150.)             LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
             SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

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               15  N*1/2(1810) REAL PART OF POLE POSITION (MEV)             11/75*

RE        (1716.)                     LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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               15  N*1/2(1810) 2*IMAG PART OF POLE POSITION (MEV)           11/75*

IM        (124.)                      LONGACRE  75 IPWA    PI N TC 2PI N    11/75*

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               15  N*1/2(1810) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      N*1/2(1810) INTO PI N                              139+ 938
P2      N*1/2(1810) INTO LAMBDA K                          1115+ 497
P3      N*1/2(1810) INTO N ETA                             939+ 548
P4      N*1/2(1810) INTO N PI PI                           938+ 139+ 139
P5      N*1/2(1810) INTO GAM P,HELICITY=3/2                  0+ 938
P6      N*1/2(1810) INTO GAM P,HELICITY=1/2                  0+ 938
P7      N*1/2(1810) INTO GAM N,HELICITY=3/2                  0+ 939
P8      N*1/2(1810) INTO GAM N,HELICITY=1/2                  0+ 939
P9      N*1/2(1810) INTO SIGMA K                           493+1189
P10     N*1/2(1810) INTO N RHO,S=1/2,P-WAVE                938+ 773

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               15  N*1/2(1810) BRANCHING RATIOS

R1      N*1/2(1810) INTO (PI N)/TOTAL                         (P1)
R1  3     (0.21)                      DONNACHI  68 RVUE                      8/69
R1  6     (0.149)                     AYED      70 IPWA                      1/71
R1  4     (0.40)                      DAVIES    70 RVUE    SCL A             8/69
R1  7     (0.25)                      ALMEHED   72 IPWA                      2/72
R1        (.145)                      AYED      74 IPWA                     10/74*

R2      N*1/2(1810) INTO (LAMBDA K)/TOTAL                     (P2)
R2  B     (0.014)TO 0.16              RUSH      68 MPWA    T POLE + RESON.   8/69
R2  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R3      N*1/2(1810) INTO (N ETA)/TCTAL                        (P3)
R3  B     (0.0364)                    BOTKE     69 MPWA    T POLE + RESON.  10/69
R3  B     (0.003)  (0.003)            DEANS     69 MPWA    T POLE + RESON.   5/70
R3  B     (0.030)OR 0.094             CARRERAS  70 MPWA    T PCLE + RESON.   5/70
R3  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R4      N*1/2(1810) FROM PI N TO K LAMBDA                     SQRT(P1*P2)       4/75*
R4  A     (.12)                       WAGNER    71 IPWA    PI- P TO K LAMB   4/75*
R4        -.067      .033             DEVENISH  74       0 FIXED T DISP REL  4/75*
R4        (.13)                       KNASEL    75 DPWA  0 PI- P TO KO LAM  11/75*

R5      N*1/2(1810) FROM GAMMA PROTON TO K LAMBDA             SQRT((P5+P6)*P2)  9/73
R5        (.0082)                     DEANS     72 MPWA    GAM P-K LM,SOL D  9/73

R6      N*1/2(1810) FROM GAMMA PROTON TO ETA PROTON           SQRT((P5+P6)*P3)  9/73
R6   1    (.0052)                     HICKS     73 MPWA    GAM P-ETA P       9/73

R7      N*1/2(1810) FROM PI N TO K SIGMA                      SQRT(P1*P9)      11/75*
R7  2     (.051)TO  .087              DEANS     75 DPWA    PI N TO K SIGMA  11/75*
R7  2   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                            11/75*

R8      N*1/2(1810) FROM PI N TO N RHO,S=1/2,P-WAVE           SQRT(P1*P10)     11/75*
R8   L    (-.35)OR  -.40              LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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               15  N*1/2(1810) PHOTON DECAY AMPL(GEV**-1/2)

   FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
   REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*1/2(1810) INTO GAM P, HELICITY=1/2   (GEV**-1/2)
A1         -.022       .094          DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A1          .025       .034          DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A1         -.004       .032          KNIES     74 DPWA    PI N PHOTO PROD    2/74
A1          .0         .025          METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A1         +.022       .012          CRAWFORD  75 DPWA    PI N PHOTO-PROD    1/76*
A1        (+.086)                    BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A1        . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A2      N*1/2(1810) INTO GAM P, HELICITY=3/2   (GEV**-1/2)
A2         -.001       .106          DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A2         -.087       .057          DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A2         -.006       .030          KNIES     74 DPWA    PI N PHOTO PROD    2/74
A2          .0         .022          METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A2         -.016       .016          CRAWFORD  75 DPWA    PI N PHOTO-PROD    1/76*
A2        (-.060)                    BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A2        . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A3      N*1/2(1810) INTO GAM N, HELICITY=1/2   (GEV**-1/2)
A3          .132       .173          DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A3          .013       .045          DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A3          .014       .014          KNIES     74 DPWA    PI N PHOTO PROD    2/74
A3          .0         .050          METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A3         -.037       .022          CRAWFORD  75 DPWA    PI N PHOTO-PROD    1/76*
A3        (-.020)                    BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A3        . . . . . . . . .
A3  AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

A4      N*1/2(1810) INTO GAM N, HELICITY=3/2   (GEV**-1/2)
A4          .080       .133          DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A4         -.083       .090          DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A4         -.008       .025          KNIES     74 DPWA    PI N PHOTO PROD    2/74
A4          .0         .044          METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A4         -.038       .015          CRAWFORD  75 DPWA    PI N PHOTO-PROD    1/76*
A4        (+.046)                    BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A4        . . . . . . . . .
A4  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                         REFERENCES FOR N*1/2(1810)

DONNACHI 68 PL 26B 161        A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
   ALSO 68 VIENNA 139         DONNACHIE  RAPPORTEUR.S TALK              (GLAS)
   ALSO 68 THESIS             R G KIRSOPP                               (EDIN)
RUSH     68 PR 173 1776       J E RUSH                         (UNIV ALABAMA)

BOTKE    69 PR 180 1417       J C BOTKE                                 (UCSB)
DEANS    69 PR 185 1797       S DEANS, J WOOTEN             (UNIV S FLORIDA)
LEA      69 PL 29B 584        LEA,OADES,WARD,COWAN,+  (RHEL,BRISTOL,DARE)

AYED     70 KIEV CONF         R AYED,P BAREYRE, G VILLET          (SACL)IJP
CARRERAS 70 NP 16B 35         B CARRERAS, A DONNACHIE            (DARE,MCHS)
DAVIES   70 NP B21 359        A DAVIES                                  (GLAS)

WAGNER   71 NP B25 411        F WAGNER, C LOVELACE                      (CERN)

ALMEHED  72 NP B40 157        +LOVELACE                        (LUND,RUTG)IJP
DEANS    72 PRD 6 1906        DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
DEVENISH 73 PL 47B 53         DEVENISH,RANKIN,LYTH          (LOUC+BONN+LANC)IJP
HICKS    73 PRD 7 2614        +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP

AYED     74 PRIVATE COMMCTN.  AYED,BAREYRE                        (SACL)IJP
   ALSO 73 AIX CONFERENCE     AYED,BAREYRE                        (SACL)IJP
DEVENISH 74 NP B81 330        DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227        DEVENISH,LYTH,RANKIN         (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680        KNIES,MOORHOUSE,OBERLACK           (LBL,GLAS)IJP
METCALF  74 NP B76 253        W J METCALF,R L WALKER                   (CIT)IJP

CRAWFORD 75 NP B97 125        R L CRAWFORD                            (GLAS)IJP
DEANS    75 NP B96 90         +MITCHELL,MONTGOMERY,+      (SFLA,ALABAMA)IJP
KNASEL   75 PRD 11 1          +LINDQUIST,NELSON+      (CHIC,WUSL,OSU,ANL)IJP
LONGACRE 75 PL 55B 415        +ROSENFELD,LASINSKI,SMADJA+        (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP      I. M. BARBOUR,R. L. CRAWFORD            (GLAS)IJP

                              PAPERS NOT REFERRED TO IN CATA CARDS.

DEANS    69 PR  177 2623      S R DEANS                    (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433        A DONNACHIE, R KIRSOPP           (GLAS+EDIN)

AYED     70 PL 31B 598        +BAREYRE,VILLET                        (SACLAY)
APLIN    71 NP  B32 253       +COWAN,GIBSON,GILMORE++         (RHEL,BRISTOL)
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N(1990) — F17

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17  N*1/2(1990, JP=7/2+) I=1/2

-->  THE MOST RECENT PI N PARTIAL WAVE ANALYSIS, AYED 74,
     FINDS EVIDENCE FOR THIS STATE.  THERE IS ALSO SOME
     INDICATION IN ASSOCIATED PRODUCTION.

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               17  N*1/2(1990) MASS (MEV)

M   3     (1983.0)                    DONNACHI  68 RVUE    PHASE-SHIFT ANAL
M   3     (1995.)                     KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
M   3   WHERE MAX. ABSORPTION IS -DONNACHI, 2 ,KIRSOPP EYEBALL FIT CERN 1   10/69
M   X     (2000.0)         APPROX     LEA       69 CNTR    PI-P ELASTIC      8/69
M   X   SEE ALSO APLIN 71
M   7     (2000.)                     ALMEHED   72 IPWA                      2/72
M    1    (1970.)                     HICKS     73 MPWA    GAM P-ETA P       9/73
M    1  ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUDED IN LISTINGS.      9/73
M    1  M AND W ARE FROM SOLUTICN C2,BR=SQRT(G)/W WITH G FROM TABLE VII.     9/73
M    1    (1960.)                     LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
M    1  NOT SEEN IN SOLUTION 2 CF LANGBEIN73                                 9/73
M         (2049.)                     AYED      74 IPWA                      2/74

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Data Card Listings

For notation, see key at front of Listings.

Baryons

N(1990), N(2000), N(2040)

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                17  N*1/2(1990) WIDTH (MEV)

W  3      (225.0)              DONNACH1  68 RVUE                         8/69
W  3      (250.)               KIRSOPP   68 RVUE    PHASE SHIFT ANAL    10/69
W  7      (200.)               ALMEHED   72 IPWA                         2/72
W  1      (300.)               HICKS     73 MPWA    GAM P-ETA P          9/73
W  1      (170.)               LANGBEIN  73 IPWA    PI N-K SIG,SOL 1     9/73
W         (119.)               AYED      74 IPWA                         2/74
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                17  N*1/2(1990) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1     N*1/2(1990) INTO PI N                               139+ 938
P2     N*1/2(1990) INTO N PI PI                            938+ 139+ 139
P3     N*1/2(1990) INTO N ETA                              939+ 548
P4     N*1/2(1990) INTO LAMBDA K                           1115+ 497
P5     N*1/2(1990) INTO GAM P,HELICITY=3/2                 0+ 938
P6     N*1/2(1990) INTO GAM P,HELICITY=1/2                 0+ 938
P7     N*1/2(1990) INTO GAM N,HELICITY=3/2                 0+ 939
P8     N*1/2(1990) INTO GAM N,HELICITY=1/2                 0+ 939
P9     N*1/2(1990) INTO K SIGMA                            493+1189
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                17  N*1/2(1990) BRANCHING RATIOS

R1     N*1/2(1990) INTO (PI N)/TOTAL                    (P1)
R1  3        (.09)             KIRSOPP   68 RVUE    PHASE SHIFT ANAL    10/69
R1  7       (0.15)             ALMEHED   72 IPWA                         2/72
R1          (.064)             AYED      74 IPWA                         2/74

R2     N*1/2(1990) INTO (N ETA)/TOTAL                   (P3)
R2  B      (0.02)   (0.02)     DEANS     69 MPWA    T POLE + RESON.      5/70
R2  B  PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R3     N*1/2(1990) FROM GAMMA PROTON TO K LAMBDA        SQRT((P5+P6)*P4)     9/73
R3          .0034              DEANS     72 MPWA    GAM P-K LM,SOL D     9/73

R4     N*1/2(1990) FROM GAMMA PROTON TO ETA PROTON      SQRT((P5+P6)*P3)     9/73
R4  1      (.0045)             HICKS     73 MPWA    GAM P-ETA P          9/73

R5     N*1/2(1990) FROM PI N TO K SIGMA                 SQRT(P1*P9)          9/73
R5  1        (.06)             LANGBEIN  73 IPWA    PI N-K SIG,SOL 1     9/73
R5  2      (.010)TO  .023      DEANS     75 DPWA    PI N TO K SIGMA    11/75*
R5  2  RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                        11/75*

R6     N*1/2(1990) FROM PI N TO K LAMBDA                SQRT(P1*P4)         4/75*
R6         -.021     .033      DEVENISH  74         0 FIXED T DISP REL  4/75*
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                17  N*1/2(1990) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
    REVIEW PRECEDING THE BARYON LISTINGS.

A1     N*1/2(1990) INTO GAM P, HELICITY=1/2  (GEV**-1/2)                   1/76*
A1          (+.011)            BARBOUR   76 DPWA    PI N PHOTO-PROD     1/76*

A2     N*1/2(1990) INTO GAM P, HELICITY=3/2  (GEV**-1/2)                   1/76*
A2          (-.008)            BARBOUR   76 DPWA    PI N PHOTO-PROD     1/76*

A3     N*1/2(1990) INTO GAM N, HELICITY=1/2  (GEV**-1/2)                   1/76*
A3          (-.099)            BARBOUR   76 DPWA    PI N PHOTO-PROD     1/76*

A4     N*1/2(1990) INTO GAM N, HELICITY=3/2  (GEV**-1/2)                   1/76*
A4          (-.070)            BARBOUR   76 DPWA    PI N PHOTO-PROD     1/76*
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                          REFERENCES FOR N*1/2(1990)

DONNACH1 68 PL 268 161       A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
KIRSOPP  68 THESIS           R G KIRSOPP                           (EDIN)

DEANS    69 PR 185 1797      S DEANS, J WOOTEN            (UNIV S FLORIDA)
LEA      69 PL 29B 584       LEA,OADES,WARD,COWAN,+  (RHEL,BRISTOL,CARE)

ALMEHED  72 NP B40 157       ,LOVELACE                             (RUTG)IJP
DEANS    72 PRD 6 1906       DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
HICKS    73 PRD 7 2614       +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP
LANGBEIN 73 NP B53 251       LANGBEIN,WAGNER                     (MUNICH)IJP

AYED     74 PRIVATE COMMCTN. AYED,BAREYRE                          (SACL)IJP
   ALSO  73 AIX CONFERENCE   AYED,BAREYRE                          (SACL)IJP
DEVENISH 74 NP B81 330       DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEANS    75 NP B96 90        +MITCHELL,MONTGOMERY,+        (SFLA,ALABAMA)IJP

BARBOUR  76 SBMTD. TO NP     I. M. BARBOUR,R. L. CRAWFORD          (GLAS)IJP

                             PAPERS NOT REFERRED TO IN DATA CARDS.

DEANS    69 PR  177 2623     S R DEANS                    (UNIV S FLORIDA)
AYED     70 PL 31B 598       +BAREYRE,VILLET                       (SACLAY)
APLIN    71 NP  B32 253      +COWAN,GIBSON,GILMORE++         (RHEL,BRISTOL)
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N(2000)

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06  N*1/2(2000, JP=5/2+) I=1/2   F''15

THE MOST RECENT PI N PARTIAL WAVE ANALYSIS, AYED 74,
FINDS EVIDENCE FOR THIS STATE.  THERE IS ALSO SOME
INDICATION IN ASSOCIATED PRODUCTION.
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                06  N*1/2(2000) MASS (MEV)

M  7      (2175.)              ALMEHED   72 IPWA                         2/72
M         (1930.)              DEANS     72 MPWA    GAM P-K LM,SOL D     9/73
M  1      (1970.)              LANGBEIN  73 IPWA    PI N-K SIG,SOL 2     9/73
M  1   NOT SEEN IN SOLUTION 1 OF LANGBEIN73                              9/73
M         (1989.)              AYED      74 IPWA                         2/74
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                06  N*1/2(2000) WIDTH (MEV)

W  7      (150.)               ALMEHED   72 IPWA                         2/72
W         (112.)               DEANS     72 MPWA    GAM P-K LM,SOL D     9/73
W  1      (170.)               LANGBEIN  73 IPWA    PI N-K SIG,SOL 2     9/73
W         (179.)               AYED      74 IPWA                         2/74
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                06  N*1/2(2000) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1     N*1/2(2000) INTO PI N                               139+ 938
P2     N*1/2(2000) INTO LAMBDA K                           1115+ 497
P3     N*1/2(2000) INTO GAM P,HELICITY=3/2                 0+ 938
P4     N*1/2(2000) INTO GAM P,HELICITY=1/2                 0+ 938
P5     N*1/2(2000) INTO GAM N,HELICITY=3/2                 0+ 939
P6     N*1/2(2000) INTO GAM N,HELICITY=1/2                 0+ 939
P7     N*1/2(2000) INTO K SIGMA                            493+1189
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                06  N*1/2(2000) BRANCHING RATIOS

R1     N*1/2(2000) INTO (PI N)/TOTAL                    (P1)
R1  7       (0.25)             ALMEHED   72 IPWA                         2/72
R1          (.08)              AYED      74 IPWA                         2/74

R2     N*1/2(2000) FROM GAMMA PROTON TO K LAMBDA        SQRT((P3+P4)*P2)     9/73
R2         (.0022)             DEANS     72 MPWA    GAM P-K LM,SOL D     9/73

R3     N*1/2(2000) FROM PI N TO K SIGMA                 SQRT(P1*P7)          9/73
R3  1        (.05)             LANGBEIN  73 IPWA    PI N-K SIG,SOL 2     9/73
R3  2       (.022)             DEANS     75 DPWA    PI N TO K SIGMA    11/75*
R3  2  VALUE GIVEN IS FROM SOLUTION 1, NOT PRESENT IN SOLUTIONS 2,3,4.  11/75*
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                          REFERENCES FOR N*1/2(2000)

ALMEHED  72 NP B40 157       ,LOVELACE                             (RUTG)IJP
DEANS    72 PRD 6 1906       DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
LANGBEIN 73 NP B53 251       LANGBEIN,WAGNER                     (MUNICH)IJP
AYED     74 PRIVATE COMMCTN. AYED,BAREYRE                          (SACL)IJP
   ALSO  73 AIX CONFERENCE   AYED,BAREYRE                          (SACL)IJP
DEANS    75 NP B96 90        +MITCHELL,MONTGOMERY,+        (SFLA,ALABAMA)IJP
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N(2040)

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16  N*1/2(2040, JP=3/2-) I=1/2   D'''13

THIS STATE IS NOW SEEN BY THE SACLAY GROUP, AYED 74.
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                16  N*1/2(2040) MASS (MEV)

M  3      (2057.0)             DONNACH1  68 RVUE    PHASE-SHIFT ANAL     6/68
M  3      (2030.)              DONNACH2  68 RVUE    PHAS.SHIFT-CERN1    10/69
M  3      (2040.)              KIRSOPP   68 RVUE    PHASE SHIFT ANAL    10/69
M  3   WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1 10/69
M  X      (2030.0)      APPROX LEA       69 CNTR    PI-P ELASTIC         8/69
M  X   SEE ALSO APLIN 71
M  7      (2075.)              ALMEHED   72 IPWA                         2/72
M  1      (2090.)              HICKS     73 MPWA    GAM P-ETA P          9/73
M  1   ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUDED IN LISTINGS.   9/73
M  1   M AND W ARE FROM SOLUTION C2,ER=SQRT(G)/W WITH G FROM TABLE VII.  9/73
M         (2029.)              AYED      74 IPWA                         2/74
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                16  N*1/2(2040) WIDTH (MEV)

W         (293.0)              DONNACH1  68 RVUE                         8/69
W  3      (290.)               DONNACH2  68 RVUE    PHAS.SHIFT-CERN1    10/69
W  3      (240.)               KIRSOPP   68 RVUE    PHASE SHIFT ANAL    10/69
W  7      (150.)               ALMEHED   72 IPWA                         2/72
W  1      (224.)               HICKS     73 MPWA    GAM P-ETA P          9/73
W         (116.)               AYED      74 IPWA                         2/74
    SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
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                16  N*1/2(2040) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1     N*1/2(2040) INTO PI N                               139+ 938
P2     N*1/2(2040) INTO N PI PI                            938+ 139+ 139
P3     N*1/2(2040) INTO N ETA                              939+ 548
P4     N*1/2(2040) INTO LAMBDA K                           1115+ 497
P5     N*1/2(2040) INTO GAM P,HELICITY=3/2                 0+ 938
P6     N*1/2(2040) INTO GAM P,HELICITY=1/2                 0+ 938
P7     N*1/2(2040) INTO GAM N,HELICITY=3/2                 0+ 939
P8     N*1/2(2040) INTO GAM N,HELICITY=1/2                 0+ 939
P9     N*1/2(2040) INTO SIGMA K                            493+1189
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                16  N*1/2(2040) BRANCHING RATIOS

R1     N*1/2(2040) INTO (PI N)/TOTAL                    (P1)
R1  3        (.26)             DONNACH2  68 RVUE    PHAS.SHIFT-CERN1    10/69
R1  3        (.15)             KIRSOPP   68 RVUE    PHASE SHIFT ANAL    10/69
R1  7       (0.3)              ALMEHED   72 IPWA                         2/72
R1          (.100)             AYED      74 IPWA                         2/74

R2     N*1/2(2040) INTO (N ETA)/TOTAL                   (P3)
R2  B        (0.)   OR 0.009   CARRERAS  70 MPWA    T POLE + RESON.      5/70
R2  B  PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R3     N*1/2(2040) FROM GAMMA PROTON TO K LAMBDA        SQRT((P5+P6)*P4)     9/73
R3         (.0070)             DEANS     72 MPWA    GAM P-K LM,SOL D     9/73

R4     N*1/2(2040) FROM GAMMA PROTON TO ETA PROTON      SQRT((P5+P6)*P3)     9/73
R4  1      (.0037)             HICKS     73 MPWA    GAM P-ETA P          9/73

R5     N*1/2(2040) FROM PI N TO K SIGMA                 SQRT(P1*P9)        11/75*
R5  2      (.014)TO  .037      DEANS     75 DPWA    PI N TO K SIGMA    11/75*
R5  2  RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                        11/75*
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Baryons
N(2040), N(2100), N(2190)

Data Card Listings
For notation, see key at front of Listings.

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              16  N*1/2(2040) PHOTCN DECAY AMPL(GEV**-1/2)

     FCR DEFINITICN OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
    REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*1/2(2040) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1               .026     .052          DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*

A2      N*1/2(2040) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2               .128     .057          DEVENIS2  74 DPWA    PI N PHOTO-PRCD   4/75*

A3      N*1/2(2040) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3               .053     .083          DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*

A4      N*1/2(2040) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4               .100     .141          DEVENIS2  74 DPWA    PI N PHCTC-PRCD   4/75*

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                              REFERENCES FOR N*1/2(2040)

DONNACH1 68 PL 26B 161           A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
DONNACH2 68 VIENNA 139           DONNACHIE  RAPPORTEUR.S TALK          (GLAS)
KIRSOPP  68 THESIS               R G KIRSOPP                           (EDIN)

LEA      69 PL 29B 584           LEA,OADES,WARD,COWAN,+  (RHEL,BRISTOL,DARE)

CARRERAS 70 NP 16B 35            B CARRERAS, A DONNACHIE          (DARE,MCHS)

ALMEHED  72 NP B40 157           +LOVELACE                     (LUND,RUTG)IJP
DEANS    72 PRD 6 1906           DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
HICKS    73 PRD 7 2614           +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP

AYED      74 PRIVATE COMMCTN.    AYED,BAREYRE                          (SACL)IJP
   ALSO 73 AIX CCNFERENCE        AYED,BAREYRE                          (SACL)IJP
DEVENIS2 74 PL 52B 227           DEVENISH,LYTH,RANKIN          (DESY,LANC,BCNN)IJP
DEANS    75 NP B96 90            +MITCHELL,MONTGCMERY,+          (SFLA,ALABAMA)IJP

                                 PAPERS NOT REFERRED TO IN DATA CARDS.

DCNNACHI 69 NP 10B 433           A DCNNACHIE, R KIRSOPP           (GLAS+EDIN)
AYED     70 PL 31B 598           +BAREYRE,VILLET                      (SACLAY)
APLIN    71 NP B32 253           +COWAN,GIBSON,GILMCRE++        (RHEL,BRISTOL)

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N(2100) S_{11}''' →

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              04  N*1/2(2100, JP=1/2-) I=1/2
              NOW ALSC SEEN BY SACLAY, AYED 74.

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              04  N*1/2(2100) MASS (MEV)

M          (2070.)                    ROYCHOUD  71 DPWA                    3/72
M    7     (2100.)                    ALMEHED   72 IPWA                    2/72
M          (2283.)                    AYED      74 IPWA                    2/74

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              04  N*1/2(2100) WIDTH (MEV)

W    7     (200.)                     ALMEHED   72 IPWA                    2/72
W          (310.)                     AYED      74 IPWA                    2/74

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              04  N*1/2(2100) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      N*1/2(2100) INTO PI N                             139+ 938

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              04  N*1/2(2100) BRANCHING RATIOS

R1      N*1/2(2100) INTO (PI N)/TOTAL                  (P1)
R1   7        (0.5)                   ALMEHED   72 IPWA                    2/72
R1            (.14)                   AYED      74 IPWA                    2/74

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                              REFERENCES FOR N*1/2(2100)

ROYCHOUD 71 NP B27 125           R K ROYCHOUDHURY,B H BRANSDEN        (DURH)IJP
ALMEHED  72 NP B40 157           +LOVELACE                      (LUND,RUTG)IJP
AYED      74 PRIVATE COMMCTN.    AYED,BAREYRE                          (SACL)IJP
   ALSO 73 AIX CONFERENCE        AYED,BAREYRE                          (SACL)IJP

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N(2100) D_{15}'' →

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              05  N*1/2(2100, JP=5/2-) I=1/2
              NOW ALSC SEEN BY SACLAY, AYED 74.

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              05  N*1/2(2100) MASS (MEV)

M    7     (2100.)                    ALMEHED   72 IPWA                    2/72
M          (2100.)                    AYED      74 IPWA                    2/74

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              05  N*1/2(2100) WIDTH (MEV)

W    7      (150.)                    ALMEHED   72 IPWA                    2/72
W           (220.)                    AYED      74 IPWA                    2/74

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              05  N*1/2(2100) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      N*1/2(2100) INTO PI N                             139+ 938

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              05  N*1/2(2100) BRANCHING RATIOS

R1      N*1/2(2100) INTO (PI N)/TOTAL                  (P1)
R1   7        (0.2)                   ALMEHED   72 IPWA                    2/72
R1            (.08)                   AYED      74 IPWA                    2/74

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                              REFERENCES FOR N*1/2(2100)

ALMEHED  72 NP B40 157           +LOVELACE                      (LUND,RUTG)IJP
AYED      74 PRIVATE COMMCTN.    AYED,BAREYRE                          (SACL)IJP
   ALSO 73 AIX CCNFERENCE        AYED,BAREYRE                          (SACL)IJP

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N(2190) G_{17}

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              71  N*1/2(2190, JP=7/2-) I=1/2
              ROYCHOUDHURY 71 FIND SOME INDICATION OF P11 AND F17 IN
              THIS REGION.BRANSDEN 71 ALSO FIND P11,F15,AND G19 RESO-
              NANT NEAR THIS MASS.  AYED 74 FIND A G19.

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              71  N*1/2(2190) MASS (MEV)

M          (2190.0)                   DIDDENS   63 CNTR    PI+- P TOTAL
M          (2210.0)                   HOHLER    64 RVUE    DATA + DISP REL
M          (2190.0)     APPROX        YOKOSAWA  66 CNTR    PI- P DSIG + POL  7/66
M    3     (2265.0)                   DONNACH1  68 RVUE    PHASE-SHIFT ANAL  6/68
M          (2000.0)     APPROX        LEA       69 CNTR    PI-P ELASTIC      8/69
M           2180.     25.             ANDERSON  70 MMS  -  PI- P TO PI- MMS  2/71
M    6     (2158.0)                   AYED      70 IPWA                      1/71
M    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M          (2260.0)                   HULL      70 MPWA    SMALL ANGLE PI-P  1/71
M          (2160.0)   (50.0)          AMALDI    71 CNTR    P P AT 24 GEV    10/71
M          (2160.)                    BRANSDEN  71 DPWA                      3/72
M          (2200.)                    ROYCHOUD  71 DPWA                      3/72
M    7     (2225.)                    ALMEHED   72 IPWA                      2/72
M          (2190.)                    OTT       72 MPWA  O PI-P BKWD ELSTC   2/73
M     1    (2208.)                    HICKS     73 MPWA    GAM P-ETA P       9/73
M     1  ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUCED IN LISTINGS.    9/73
M     1  M AND W ARE FROM SOLUTION C2,BR=SQRT(G)/W WITH G FROM TABLE VII.   9/73
M          (2208.)    (20.)           ABE       74       + P+P->P+X,JCBN PK  4/75*
M          (2141.)                    AYED      74 IPWA                      2/74
M    2     (2133.)                    AYED      74 IPWA                      2/74
M    2   THIS IS A G19 RESONANCE LISTED HERE UNTIL CONFIRMED.                2/74

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              71  N*1/2(2190) WIDTH (MEV)

W           (200.0)                   DIDDENS   63 CNTR
W           (200.0)                   HOHLER    64 RVUE                      7/66
W           (220.0)     APPROX        YOKOSAWA  66 CNTR                      7/66
W    3      (298.0)                   DONNACH1  68 RVUE                      6/68
W            275.       70.           ANDERSON  70 MMS  -  PI- P TO PI- MMS  2/71
W    6      (325.0)                   AYED      70 IPWA                      1/71
W           (239.0)                   HULL      70 MPWA    SMALL ANGLE PI-P  1/71
W    7      (150.)                    ALMEHED   72 IPWA                      2/72
W     1     (193.)                    HICKS     73 MPWA    GAM P-ETA P       9/73
W           (243.)                    AYED      74 IPWA                      2/74
W    2      (193.)                    AYED      74 IPWA                      2/74
      SEE THE NOTES ACCOMPANYING THE MASSES QUOTEC.

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              71  N*1/2(2190) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      N*1/2(2190) INTO PI N                             139+ 938
P2      N*1/2(2190) INTC LAMBCA K                        1115+1765
P3      N*1/2(2190) INTO N PI PI                          938+ 139+ 139
P4      N*1/2(2190) INTO GAM P,HELICITY=3/2                 0+ 938
P5      N*1/2(2190) INTO GAM P,HELICITY=1/2                 0+ 938
P6      N*1/2(2190) INTO GAM N,HELICITY=3/2                 0+ 939
P7      N*1/2(2190) INTC GAM N,HELICITY=1/2                 0+ 939
P8      N*1/2(2190) INTO ETA N                            548+ 938
P9      N*1/2(2190) INTO SIGMA K                          493+1189

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              71  N*1/2(2190) BRANCHING RATIOS

R1      N*1/2(2190) INTO (PI N)/TOTAL                  (P1)
R1            (0.3)     APPROX        DIDDENS   63 CNTR                      7/66
R1            (0.3)     APPROX        YOKOSAWA  66 CNTR                      7/66
R1   3        (0.349)                 DCNNACH1  68 RVUE                      6/68
R1   6        (0.150)                 AYED      70 IPWA                      1/71
R1            (0.09)                  HULL      70 MPWA    SMALL ANGLE PI-P  1/71
R1   7        (0.35)                  ALMEHED   72 IPWA                      2/72
R1             (.25)                  OTT       72 MPWA  O PI-P BKWD ELSTC   2/73
R1             (.161)                 AYED      74 IPWA                      2/74
R1   2         (.095)                 AYED      74 IPWA                      2/74

R2      N*1/2(2190) FROM GAMMA PROTON TO K LAMBDA      SQRT((P4+P5)*P2)      9/73
R2             (.0161)                DEANS     72 MPWA   GAM P-K LM,SOL D   9/73

R3      N*1/2(2190) FROM GAMMA PROTCN TO ETA PROTCN    SQRT((P4+P5)*P8)      9/73
R3             (.0094)                HICKS     73 MPWA   GAM P-ETA P        9/73

R4      N*1/2(2190) FROM PI N TO K SIGMA               SQRT(P1*P9)          11/75*
R4   4         (.014)TO  .019         DEANS     75 DPWA    PI N TO K SIGMA  11/75*
R4   4   RANGE GIVEN IS FRCM FOUR BEST SOLUTICNS.                           11/75*

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                              REFERENCES FOR N*1/2(2190)

DIDDENS  63 PRL 10 262           +JENKINS, KYCIA, RILEY                 (BNL) I
HOHLER   64 PL 12 149            G HOHLER, J GIESECKE            (KARLSRUHE) I
YOKOSAWA 66 PRL 16 714           +SUWA,HILL,ESTERLING, BOOTH      (ANL,CHIC) JP

DONNACH1 68 PL 26B 161           A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
   ALSO 68 VIENNA 139            DCNNACHIE  RAPPORTEUR.S TALK          (GLAS)
   ALSO 68 THESIS                R G KIRSOPP                           (EDIN)

LEA      69 PL 29B 584           LEA,OADES,WARD,COWAN,+  (RHEL,BRISTOL,DARE)

ANDERSON 70 PRL 25,699           +BLESER,BLIEDEN,COLLINS++         (BNL,CARN)
AYED     70 KIEV CONF            R AYED,P BAREYRE, G VILLET          (SACL)IJP
HULL     70 PR D2 1783           J HULL, R LEACOCK                      (ISU)
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Data Card Listings

For notation, see key at front of Listings.

Baryons

N(2190), N(2220), N(2650), N(3030), N?(3245)

AMALDI 71 PL 34B 435 +BIANCASTELLI,BOSIO,+ (I SANITA ROMA+CERN)
BRANSDEN 71 NP B26 511 ,OGDEN (DURH)IJP
ALSO 70 NP B16 461 ROYCHOUDHURY,PERRIN,BRANSDEN (DURH)IJP
ROYCHOUD 71 NP B27 125 R K ROYCHOUDHURY,B H BRANSDEN (DURH)IJP

ALMEHED 72 NP B40 157 +LOVELACE (LUND,RUTG)IJP
DEANS 72 PRD 6 1906 DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
OTT 72 PL 42B 133 +TRISCHUK,VAVRA,RICHARDS,+ (MCGI,STLO,IOWA)IJP
ALSO 72 MCGILL THESIS J.VAVRA (MCGI) JP
HICKS 73 PRD 7 2614 +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP

ABE 74 PL 53B 114 +ALSPECTOR,BOMBEROWITZ+ (RUTG,UPNJ,FSU)
AYED 74 PRIVATE COMMCTN. AYED,BAREYRE (SACL)IJP
ALSO 73 AIX CONFERENCE AYED,BAREYRE (SACL)IJP
DEANS 75 NP B96 90 +MITCHELL,MONTGOMERY,+ (SFLA,ALABAMA)IJP

PAPERS NOT REFERRED TO IN DATA CARDS.

AYED 70 PL 31B 598 +BAREYRE,VILLET (SACLAY)

QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN DATA CARDS.

BARGER 66 PRL 16 913 V BARGER, D CLINE (WISC) P
CARROLL 66 PRL 16 288 +CORBETT,DAMERELL,MIDDLEMAS, + (RHEL,OXF)J-L
CARROLL 66 PRL 17 1274 +CORBETT,DAMERELL,MIDDLEMAS, + (RHEL,OXF)J-L
ERRATUM CHANGING THE RATHER WEAK DETERMINATION OF J-L TO +1 (2.)
KORMANYO 66 PRL 16 709 KORMANYOS,KRISCH,OFALLON, + (MICH,ANL) P
BUSZA 67 NC 52A 331 +DAVIS,DUFF,HEYMANN, + (LOUC,WESTFIELD)

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N(2220) — 90 N*1/2(2220, JP=9/2+) I=1/2 — H_{19}

THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.

90 N*1/2(2220) MASS (MEV)

M		(2200.) APPROX.	BUSZA	67 OSPK	LEG.POLYN.ANAL.	2/71
M	6	(2221.0)	AYED	70 IPWA		1/71
M	6	FROM ENER. DEP. FIT OF ARGAND DIAGRAM				
M		(2245.0)	HULL	70 MPWA	SMALL ANGLE PI-P	1/71
M		(2249.)	AYED	74 IPWA		2/74

90 N*1/2(2220) WIDTH (MEV)

W	6	(258.0)	AYED	70 IPWA		1/71
W		(329.0)	HULL	70 MPWA	SMALL ANGLE PI-P	1/71
W		(347.)	AYED	74 IPWA		2/74

90 N*1/2(2220) PARTIAL DECAY MODES

		DECAY MASSES
P1	N*1/2(2220) INTO PI N	139+ 938
P2	N*1/2(2220) INTO N ETA	939+ 548

90 N*1/2(2220) BRANCHING RATIOS

R1 N*1/2(2220) INTO (PI N)/TOTAL (P1)

R1	6	(0.140)	AYED	70 IPWA		1/71
R1		(0.15)	HULL	70 MPWA	SMALL ANGLE PI-P	1/71
R1		(.204)	AYED	74 IPWA		2/74

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REFERENCES FOR N*1/2(2220)

BUSZA 67 NC 52A 331 +DAVIS,DUFF,HEYMANN,NIMMON + (LOUC+LOWC)
AYED 70 KIEV CONF R AYED,P BAREYRE, G VILLET (SACL)IJP
HULL 70 PR D2 1783 J HULL, R LEACOCK (ISU)
AYED 74 PRIVATE COMMCTN. AYED,BAREYRE (SACL)IJP
ALSO 73 AIX CONFERENCE AYED,BAREYRE (SACL)IJP

PAPERS NOT REFERED TO IN DATA CARDS

AYED 70 PL 31B 598 +BAREYRE,VILLET (SACLAY)

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N(2650) BUMPS — 72 N*1/2(2650, JP=) I=1/2 PRODUCTION EXPERIMENTS

ROYCHOUDHURY 71 CLAIM F15(2400) AND G19(2400) TO BE POSSIBLE RESONANCES. BRANSDEN 71 FIND THE POSSIBLE RESONANT CANDIDATES S11(2520) AND H19(2590).

72 N*1/2(2650) MASS (MEV) (PROD. EXP.)

M	(2700.0)		ALVAREZ	64 CNTR	PI PHOTOPROD	
M	(2660.0)		HOHLER	64 RVUE	DATA + DISP REL	
M	(2600.0)	APPROX	WAHLIG	64 OSPK	0 PI-P CH EX	
M	(2633.0)		BARGER	66 FIT	TOTAL + CH EX	11/67
M	2649.0	10.0	CITRON	66 CNTR	PI+- P TOTAL	7/66

72 N*1/2(2650) WIDTH (MEV) (PROD. EXP.)

W	(100.0)		ALVAREZ	64 CNTR		
W	(200.0)		HOHLER	64 RVUE		7/66
W	(425.0)		BARGER	66 FIT	TOTAL + CH EX	11/67
W	360.0	20.0	CITRON	66 CNTR		7/66

72 N*1/2(2650) PARTIAL DECAY MODES (PROD. EXP.)

		DECAY MASSES
P1	N*1/2(2650) INTO PI N	139+ 938
P2	N*1/2(2650) INTO LAMBDA K	1115+ 497
P3	N*1/2(2650) INTO N PI PI	938+ 139+ 139

72 N*1/2(2650) BRANCHING RATIOS (PROD. EXP.)

R1 N*1/2(2650) INTO (PI N)/TOTAL (P1)
R1 ONLY (J+1/2)*(PI N/TOTAL) MEASURED FOR THIS STATE

R1	B	(0.456)	(0.018)	BARGER	66 RVUE	TOTAL + CH EXC.	11/67
R1		0.436	0.028	CITRON	66 CNTR	TOTAL CROSS-SEC.	11/67
R1	B	(0.30)		BARGER	67 RVUE	USES KORMANYOS67	11/67

R1 B USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
R1 B FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.

R1	D	(0.24)		DIKMEN	67 RVUE	USES KORMANYOS66	11/67

R1 D USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES

R1		(0.06)		KORMANYOS	67 CNTR	PI-P AT 180 DEG.	11/67

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REFERENCES FOR N*1/2(2650) (PROD. EXP.)

ALVAREZ 64 PRL 12 710 +BAR-YAM,KERN,LUCKEY,OSBORNE, + (MIT,CEA)
HOHLER 64 PL 12 149 G HOHLER, J GIESECKE (KARLSRUHE) I
WAHLIG 64 PRL 13 103 +MANNELLI,SODICKSON,FACKLER,WARD, + (MIT)
BARGER 66 PR 151 1123 V BARGER, M OLSSON (WISC)
CITRON 66 PR 144 1101 +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, + (BNL) I
BARGER 67 PR 155 1792 V BARGER, D CLINE (WISC) P
DIKMEN 67 PRL 18 798 F N DIKMEN (MICH)
KORMANYO 67 PR 164 1661 KORMANYOS, KRISCH, OFALLON, + (MICH,ANL) P

PAPERS NOT REFERRED TO IN DATA CARDS.

BAACKE 67 NC 51A 761 J BAACKE, M YVERT (KARLSRUHE,ORSAY)J-L
DOLEN 68 PR 166 1768 R DOLEN, D HORN, C SCHMID (CIT)
WAHLIG 68 PR 168 1515 M A WAHLIG, I MANNELLI (MIT,PISA)
FINAL VERSION OF DATA USED IN WAHLIG 64. IN CONJUNCTION WITH CITRON 66 TOTAL CROSS SECTIONS, THIS CHARGE EXCHANGE DATA GIVES COMPLEX ELASTIC SCATTERING AMPLITUDE AT 0 DEGREES.

BRANSDEN 71 NP B26 511 ,OGDEN (DURH)IJP
ALSO 70 NP B16 461 ROYCHOUDHURY,PERRIN,BRANSDEN (DURH)IJP
ROYCHOUD 71 NP B27 125 R K ROYCHOUDHURY,B H BRANSDEN (DURH)IJP

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N(3030) BUMPS — 73 N*1/2(3030, JP=) I=1/2 PRODUCTION EXPERIMENTS

73 N*1/2(3030) MASS (MEV) (PROD. EXP.)

M	(3080.0)	HOHLER	64 RVUE	DATA + DISP REL	7/66
M	(3030.0)	CITRON	66 CNTR	PI+- P TOTAL	7/66

73 N*1/2(3030) WIDTH (MEV) (PROD. EXP.)

W	(400.0)	CITRON	66 CNTR	7/66

73 N*1/2(3030) PARTIAL DECAY MODES (PROD. EXP.)

		DECAY MASSES
P1	N*1/2(3030) INTO PI N	139+ 938
P2	N*1/2(3030) INTO N PI PI	938+ 139+ 139

73 N*1/2(3030) BRANCHING RATIOS (PROD. EXP.)

R1 N*1/2(3030) INTO (PI N)/TOTAL (P1)
R1 ONLY (J+1/2)*(PI N/TOTAL) MEASURED FOR THIS STATE

R1	B	(0.088)	(0.016)	BARGER	66 RVUE	TOTAL + CH EXC.	11/67
R1		(0.048)		CITRON	66 CNTR	TOTAL CROS.SEC.	11/67
R1	B	(0.12)		BARGER	67 CNTR	USES KORMANYOS66	11/67

R1 B USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
R1 B FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.

R1	D	(0.016)		DIKMEN	67 RVUE	USES KORMANYOS67	11/67

R1 D USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES

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REFERENCES FOR N*1/2(3030) (PROD. EXP.)

HOHLER 64 PL 12 149 G HOHLER, J GIESECKE (KARLSRUHE) I
BARGER 66 PR 151 1123 V BARGER, M OLSSON (WISC)
CITRON 66 PR 144 1101 +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, + (BNL) I
BARGER 67 PR 155 1792 V BARGER, D CLINE (WISC) P
DIKMEN 67 PRL 18 798 F N DIKMEN (MICH)

PAPERS NOT REFERRED TO IN DATA CARDS

KORMANYO 67 PR 164 1661 KORMANYOS, KRISCH, OFALLON, + (MICH,ANL) P
DOLEN 68 PR 166 1768 R DOLEN, D HORN, C SCHMID (CIT)

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N?(3245) BUMPS — 74 N* /2(3245, JP=) PRODUCTION EXPERIMENTS

EXISTENCE NOT CONCLUSIVELY ESTABLISHED. I-SPIN NOT DETERMINED, BUT THE NARROW WIDTH PRECLUDES IDENTIFICATION WITH THE N*3/2(3230). OMITTED FROM TABLE.

74 N* /2(3245) MASS (MEV) (PROD. EXP.)

M	3245.0	10.0	KORMANYOS	67 CNTR	PI-P 180 DEG EL	6/68

74 N* /2(3245) WIDTH (MEV) (PROD. EXP.)

W	(35.0) OR LESS	KORMANYOS	67 CNTR	6/68

Baryons

N?(3245), N(3690), N?(3755), Δ(1232)

Data Card Listings

For notation, see key at front of Listings.

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                      74  N* /2(3245) PARTIAL DECAY MODES (PROD. EXP.)

                                                                  DECAY MASSES
P1      N* /2(3245) INTO PI N                                   139+ 938

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                      74  N* /2(3245) BRANCHING RATIOS (PROD. EXP.)

R1      N* /2(3245) INTO (PI N)/TOTAL                     (P1)
R1     J IS NOT KNOWN.  FOLLOWING IS (J+1/2)*(PI N)/TOTAL
R1          (0.37)                     KORMANYOS 67 CNTR                       6/68

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                                  REFERENCES FOR N* /2(3245) (PROD. EXP.)

KORMANYO 67 PR 164 1661          KORMANYOS, KRISCH, OFALLON, +     (MICH,ANL) P

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N(3690) BUMPS

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                      75  N*1/2(3690, JP=      ) I=1/2  PRODUCTION EXPERIMENTS

                       A BUMP SEEN IN THE INVARIANT MASS OF A VERY COMPLI-
                       CATED STATE (N + SEVEN PIS), SO AS EVIDENCE FOR
                       A NEW RESONANCE IT IS NOT CONCLUSIVE.  NOT INCLUDED
                       IN TABLE.

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                      75  N*1/2(3690) MASS (MEV) (PROD. EXP.)

M           3690.0     10.0             BARTKE    67 HBC  +  PI+P 8 PRONGS     8/67

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                      75  N*1/2(3690) WIDTH (MEV) (PROD. EXP.)

W             50.0     30.0             BARTKE    67 HBC  +                    8/67

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                      75  N*1/2(3690) PARTIAL DECAY MODES (PROD. EXP.)

                                                                  DECAY MASSES
P1      N*1/2(3690) INTO N + 7 PIS

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                                  REFERENCES FOR N*1/2(3690) (PROD. EXP.)

BARTKE   67 PL 248 118           +CZYZEWSKI,DANYSZ,+            (CRACOW,ORSAY) I

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N?(3755) BUMPS

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                      76  N* /2(3755, JP=      )          PRODUCTION EXPERIMENTS

                       A SMALL PEAK IN THE (P P PBAR) INVARIANT MASS FROM
                       8.4 BEV/C PI+ P TO PI+ P P PBAR EVENTS.  AS EVIDENCE
                       FOR A NEW RESONANCE IT IS NOT CONCLUSIVE.  OMITTED
                       FROM TABLE.

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                      76  N* /2(3755) MASS (MEV) (PROD. EXP.)

M           3755.0      8.0             EHRLICH   68 HBC  +  PI+ P P PBAR      6/68

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                      76  N* /2(3755) WIDTH (MEV) (PROD. EXP.)

W             40.0     20.0             EHRLICH   68 HBC  +                    6/68

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                      76  N* /2(3755) PARTIAL DECAY MODES (PROD. EXP.)

                                                                  DECAY MASSES
P1      N* /2(3755) INTO PI+ P P PBAR                       139+ 938+ 938+ 938

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                                  REFERENCES FOR N* /2(3755) (PROD. EXP.)

EHRLICH  68 PRL 20 686           R EHRLICH,R J PLANC,J B WHITTAKER (RUTGERS)

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S=0 I=3/2 NUCLEON STATES (Δ)

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Δ(1232) **P'33**

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                      33  N*3/2(1232, JP=3/2+) I=3/2

                      THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.
                      SEE CARTER 71 AND CARTER 73 FOR PI N CROSS-SECTION
                      DATA IN THIS REGION.

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                      33  N*3/2(1232)  MASS (MEV)

M          (1234.)                      ROPER     65 DPWA ++0 PHASE SHIFT AN.
M          (1235.)                      ALMEHED   72 IPWA                      2/72
M    3     (1243.3)   (1241.7)          CHENG     73          FIT CARTER 71    2/74
M    3   THE TWO ENTRIES ARE FROM TWO DIFFERENT PARAMETRIZATIONS OF THE        2/74
M    3   RESONANCE CONTRIBUTUION TO THE P33 PHASE SHIFT.                       2/74
M          (1230.4)                     TSCHANG   73          FIT CARTER71 P33 1/74
M          (1234.)                      AYED      74 IPWA                      2/74

M++         1236.0     0.55             OLSSON    65 RVUE ++ TOTAL-SIGMA DATA
M++  2      1231.0     1.5              CARTER    71 MPWA ++ PI+P SIG. TOTAL   1/74
M++  1      1231.1      .2              CARTER    73 IPWA ++ PI N 88-310 MEV   9/73
M++  1   EXPERIMENTAL QUANTITY-SEE CARTER73 FOR COULOMB BARRIER CORRECTIONS    9/73
M++  2   EXPERIMENTAL QUANTITY-SEE CARTER71 FOR COULOMB BARRIER CORRECTIONS    1/74
M++         . . . . . . . . . .
M++ AVERAGE MEANINGLESS (SCALE FACTOR = 8.4)
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M+         (1231.8)                     BERENDS   75 IPWA +  GAM P TO PI NUC   4/75*
M+          1230.6     1.8              CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
M+         (1231.7)                     BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*

MO          1236.45    0.65             OLSSON    65 RVUE  0
MO          1232.9     0.6              CARTER    71 MPWA  0 PI-P SIG. TOTAL   1/71
MO          . . . . . . . . . .
MO  AVERAGE MEANINGLESS (SCALE FACTOR = 4.0)

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                      33  N*3/2(1232) WIDTH (MEV)

W          (120.)                       ROPER     65 DPWA ++0 PHASE SHIFT AN.
W          (129.)                       ALMEHED   72 IPWA                      2/72
W    3     (152.2)    (145.8)           CHENG     73          FIT CARTER 71    2/74
W          (120.)                       TSCHANG   73          FIT CARTER71 P33 1/74
W          (120.)                       AYED      74 IPWA                      2/74

W++         120.0      2.0              OLSSON    65 RVUE ++
W++  2      111.1      1.8              CARTER    71 MPWA ++ PI+P SIG. TOTAL   1/74
W++  1      111.5       .4              CARTER    73 IPWA ++ PI N 88-310 MEV   9/73
W++         . . . . . . . . . .
W++ AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

W+          120.2      3.9              CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
W+         (117.4)                      BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*

WO          119.6      2.4              OLSSON    65 RVUE  0
WO          114.7      3.0              CARTER    71 MPWA  0 PI-P SIG TOT.     1/71
WO          . . . . . . . . . .
WO  AVERAGE MEANINGLESS (SCALE FACTOR = 1.3)

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                      33  (N*O) - (N*++) MASS DIFFERENCE (MEV)

D    R       (0.45)   (0.85)            OLSSON    65 RVUE
D     2       1.3      1.9              CARTER    71 MPWA ++ PI+-P SIG. TOTAL  1/74
D     1       1.4       .4              CARTER    73 IPWA    PI N 88-310 MEV   9/73
D    R     REDUNDANT WITH DATA IN MASS LISTING.
D           . . . . . . . . . .
D   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                      33  (N*O)-(N*++) WIDTH DIFFERENCE (MEV)                  9/73

WD   2        6.5      2.2              CARTER    71 MPWA ++ PI+-P SIG. TOTAL  1/74
WD   1       10.3      1.3              CARTER    73 IPWA    PI N 88-310 MEV   9/73
WD          . . . . . . . . . .
WD  AVERAGE MEANINGLESS (SCALE FACTOR = 1.5)

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                      33  N*3/2(1232) REAL PART OF POLE POSITION(MEV)

REE  M     (1214.)                      MICHAEL   67                           2/74
REE        (1211.)                      BALL      72                           2/73
REE  P      1211.6     0.7              PDG       72          FIT DELTA 33     2/73
REE 3      (1210.7)   (1210.7)          CHENG     73          FIT CARTER 71    2/74
REE         1214.5    10.               NOGOVA    73          FIT ALMEHED72    2/74
REE        (1213.)                      SPEARMAN  74          FIT ZERO TRJCTRY 4/75*
REE  M   FIT INCLUDES OLSSON 65 PARAMETERS PLUS SCATTERING LENGTH PLUS 6
REE  M   PHASE SHIFT VALUES FOR TPI=120 TO 492 MEV.
REE  P   ERROR EST. FROM FITS WITH SOMEWHAT VARYING ASSUMPTIONS
REE         . . . . . . . . . .
REE AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R++  U      1211.5      .6              BALL      75       ++ FIT CARTER 73   11/75*
R++  U      1210.9      .8              LICHTENB  75       ++ FIT CARTER 73   11/75*
R++  C      1209.6      .5              VASAN     75       ++ FIT CARTER 73    1/76*
R++  C   FROM FITS TO COULOMB CORRECTED CARTER 73 PHASE SHIFT.                  1/76*
R++  U     (1210.5)TO(1210.8)           VASAN     75       ++ FIT CARTER 73    1/76*
R++  U   FROM FITS TO UNCORRECTED CARTER 73 PHASE SHIFT.                        1/76*
R++         . . . . . . . . . .
R++ AVERAGE MEANINGLESS (SCALE FACTOR = 1.8)

REO  U     (1211.6)                     BALL      75        0 FIT CARTER 73   11/75*
REO  U      1210.9     1.4              LICHTENB  75        0 FIT CARTER 73   11/75*
REO  C      1210.75     .6              VASAN     75       ++ FIT CARTER 73    1/76*
REO  U     (1210.2)                     VASAN     75       ++ FIT CARTER 73    1/76*
REO         . . . . . . . . . .
REO AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                      33  N*3/2(1232) IMAG PART OF POLE POSITION(MEV)

IME  M      (52.)                       MICHAEL   67                           2/74
IME         (50.)                       BALL      72                           2/73
IME  P       49.5      1.8              PDG       72          FIT DELTA 33     2/73
IME 3       (50.7)    (50.6)            CHENG     73          FIT CARTER 71    2/74
IME          48.6      5.               NOGOVA    73          FIT ALMEHED72    2/74
IME         (49.)                       SPEARMAN  74          FIT ZERO TRJCTRY 4/75*
IME         . . . . . . . . . .
IME AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

I++  U       50.1       .6              BALL      75       ++ FIT CARTER 73   11/75*
I++  U       49.6       .75             LICHTENB  75       ++ FIT CARTER 73   11/75*
I++  C       50.4       .5              VASAN     75       ++ FIT CARTER 73    1/76*
I++  U      (49.9)TO (50.0)             VASAN     75       ++ FIT CARTER 73    1/76*
I++         . . . . . . . . . .
I++ AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

IMO  U      (53.0)                      BALL      75        0 FIT CARTER 73   11/75*
IMO  U       53.25     1.75             LICHTENB  75        0 FIT CARTER 73   11/75*
IMO  C       52.8       .6              VASAN     75       ++ FIT CARTER 73    1/76*
IMO  U      (52.9)TO (53.1)             VASAN     75       ++ FIT CARTER 73    1/76*
IMO         . . . . . . . . . .
IMO AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                      33  N*3/2(1232) ABSOLUTE VALUE OF POLE RESIDUE (MEV)

ABS         (53.)                       BALL      73          FIT DELTA 33     9/73

A++  C      (52.4)TO (53.2)             VASAN     75       ++ FIT CARTER 73    1/76*
A++  U      (52.1)TO (52.4)             VASAN     75       ++ FIT CARTER 73    1/76*

ABO  C      (54.8)TO (55.0)             VASAN     75       ++ FIT CARTER 73    1/76*
ABO  U      (55.2)TO (55.3)             VASAN     75       ++ FIT CARTER 73    1/76*

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Data Card Listings

For notation, see key at front of Listings.

Baryons

Δ(1232)

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                 33  N*3/2(1232) PHASE OF POLE RESIDUE (RADIANS)

PH           (-.81)                       BALL       73         FIT DELTA 33      9/73

P++  C       (-.822)TO -.833              VASAN      75      ++ FIT CARTER 73     1/76*
P++  U       (-.823)TO -.830              VASAN      75      ++ FIT CARTER 73     1/76*

PHO  C       (-.840)TO -.847              VASAN      75      ++ FIT CARTER 73     1/76*
PHO  U       (-.848)TO -.856              VASAN      75      ++ FIT CARTER 73     1/76*
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                 33  N*3/2(1232) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1       N*3/2(1232) INTO N PI                           938+ 139
P2       N*3/2(1232) INTO N GAMMA                        938+   0
P3       N*3/2(1232) INTO N PI PI                        938+ 139+ 139
P4       N*3/2(1232) INTO GAM NUCLEON, HELICITY=1/2        0+ 938
P5       N*3/2(1232) INTO GAM NUCLEON, HELICITY=3/2        0+ 938
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                 33  N*3/2(1232) BRANCHING RATIOS

R1       N*3/2(1232) INTO (N GAMMA)/(N PI) (PERCENT)         (P2)/(P1)
R1           0.55        0.02           DALITZ     66 RVUE                        7/68
R1           0.53        0.025          BERENDS    71 IPWA     PHOTOPROD. ANAL. 10/71
R1           . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R2       N*3/2(1232)0 INTO (N PI)/TOTAL                      (P1)
R2   2       (.99)                      CARTER     71 MPWA ++ PI+-P SIG. TOTAL  1/74
R2           (1.)                       AYED       74 IPWA                      2/74
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                 33  N*3/2(1232) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
      REVIEW PRECEDING THE BARYON LISTINGS.

A1       N*3/2(1232) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1            -.144       .014          DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A1            -.142       .006          MOORHOUS  73 DPWA    PI N PHOTO-PROD    2/73
A1            -.138       .004          KNIES     74 DPWA    PI N PHOTO PROD    2/74
A1            -.140       .006          METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A1            -.142       .001          MOORHOUS  74 DPWA    PI N PHOTO-PROD    2/74
A1            -.130       .002          CRAWFORD  75 DPWA    PI N PHOTC-PROD    1/76*
A1           (-.129)                    BARBOUR   76 DPWA    PI N PHOTC-PROD    1/76*
A1           . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 2.7)

A2       N*3/2(1232) INTO GAM NUCLEON, HELICITY=3/2 (GEV**-1/2)
A2            -.262       .015          DEVENISH  73 DPWA    PI N PHOTC PROD    2/74
A2            -.259       .016          MOORHOUS  73 DPWA    PI N PHOTO-PROD    2/73
A2            -.253       .002          KNIES     74 DPWA    PI N PHOTO PROD    2/74
A2            -.254       .007          METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A2            -.261       .001          MOORHOUS  74 DPWA    PI N PHOTO-PROD    2/74
A2            -.248       .002          CRAWFORD  75 DPWA    PI N PHOTO-PROD    1/76*
A2           (-.251)                    BARBOUR   76 DPWA    PI N PHOTO-PROD    1/76*
A2           . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 4.5)

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                         REFERENCES FOR N*3/2(1232)

OLSSON    65 PRL 14 118        M G OLSSON                           (WISC)
ROPER     65 PR 138 B190       L D ROPER, R M WRIGHT, B T FELD   (LRL+MIT)IJP

DALITZ    66 PR 146 1180       DALITZ,SUTHERLAND                  (OXFORD)
   CONTAINS REFERENCES TO EARLIER WORK ON DELTA PHOTOPRODUCTION.

MICHAEL   67 PR 156 1677       MICHAEL                              (RHEL)IJP
BERENDS   71 NP B30 575        +WEAVER                        (CEA,MIT,TUFT)
CARTER    71 NP B26 445        +WILLIAMS, BUGG, BUSSEY, DANCE  (CAVE,RHEL)

ALMEHED   72 NP B40 157        +LOVELACE                       (LUND,RUTG)IJP
BALL      72 PRL 28 1143       +CAMPBELL,LEE,SHAW          (UTAH,BOISE,UCI)
PDG       72 PL 39B 103        SODING,BARTELS,+  (DESY+LBL+BRAN+CERN+HELS)IJP
BALL      73 PRD 7 2789        BALL,LEE,SHAW                    (UTAH+UCI)IJP
CARTER    73 NP B58 378        CARTER,BUGG,CARTER   (CAVENDISH+QUEEN MARY)IJP
CHENG     73 PRD 7 2249        CHENG,LICHTENBERG                     (IND)IJP
DEVENISH  73 PL 47B 53         DEVENISH,RANKIN,LYTH       (LOUC+BONN+LANC)IJP
MOORHOUS  73 PL 43B 44         MOORHOUSE, OBERLACK             (GLAS+LBL)IJP
NOGOVA    73 NP B61 445        NOGOVA,PISUT(IP SLOVAK ACAD SCI,COMENIUS U)IJP
    ALSO  73 NP B61 438        NOGOVA,PISUT+(IP SLOVK ACAD SCI,COMENIUS U)IJP
    ALSO  73 NP B65 544        NOGOVA,PISUT+(IP SLOVK ACAD SCI,COMENIUS U)IJP
TSCHANG   73 NP B59 445        TSCHANG,PARKINSON       (FLOR+GAINESVILLE)IJP

AYED      74 PRIVATE COMMCTN.  AYED,BAREYRE                         (SACL)IJP
    ALSO  73 AIX CONFERENCE    AYED,BAREYRE                         (SACL)IJP
KNIES     74 PRD 9 2680        KNIES,MOORHOUSE,OBERLACK        (LBL,GLAS)IJP
METCALF   74 NP B76 253        W J METCALF,R L WALKER                (CIT)IJP
MOORHOUS  74 PRD 9 1           MOORHOUSE,OBERLACK,ROSENFELD    (GLAS+LBL)IJP
SPEARMAN  74 PRD 10 1660       T D SPEARMAN          (TRINITY COLLEGE,DUBLIN)

BALL      75 PRD 11 1171       J S BALL,R L GOBLE                   (UTAH)IJP
BERENDS   75 NP B84 342        BERENDS,DONNACHIE                (LEID,MCHS)
CRAWFORD  75 NP B97 125        R L CRAWFORD                         (GLAS)IJP
LICHTENB  75 LNC 12 616        D B LICHTENBERG                       (IND)IJP
VASAN     75 COO-3066-58 (PPT) S. S. VASAN                          (CARN)IJP

BARBOUR   76 SBMTD. TO NP      I. M. BARBOUR,R. L. CRAWFORD         (GLAS)IJP

                         PAPERS NOT REFERRED TO IN DATA CARDS.

DONNACHI  68 PL 26B 161        DONNACHIE,LOVELACE,KIRSOPP           (CERN)
FONDA     73 PRD 8 353         FONDA,GHIRARDI,SHAW     (ICTP,TRIESTE+TRST)IJP
HENYEY    74 PR D9 302         HENYEY,KANE                          (MICH)IJP
OLSSON    74 LNC 10 333        OLSSON                               (CERN)IJP
PFEIL     74 NP B73 166        PFEIL,ROLLNIK,STANKOWSKI             (BONN)
SUZUKI    74 NP B68 413        SUZUKI,KUROKAWA,KONDO                (TOKYO)
NIGRO     75 NP B84 201        NIGRO,SPILLANTINI,VALENTE         (PADO,FRAS)

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1232 MEV REGION - PRODUCTION EXPERIMENTS

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                 81  N*3/2(1232, JP=3/2+)  I=3/2  PRODUCTION EXPERIMENTS

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                 81  N*3/2(1232) MASS (MEV) (PROD. EXP.)

M            1217.       8.             ANDERSON  70 MMS  -  PI- P TO PI- MMS  2/71
M            1227.0      7.0            ELLIS     71 CNTR    MMS PP 3.7 GEV/C 10/71
M            . . . . . . . . . .
M    AVG     1222.7      5.3      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    STUDENT 1222.7      5.9      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M++         (1232.0)    (6.0)           FERRO-LUZ 65 HBC  ++ K+P TO K0 P PI+
M++         (1236.0)                    DEANS     66 RVUE ++ PI+P TOTAL        7/66
M++         (1233.4)    (4.4)           GIDAL     66 DBC  ++ D D TO NN(NN) PI  7/66
M++         (1224.0)    (2.0)           HABER     70 DBC     K-D TO 4 BOD(P)   7/70
M++          1236.0      2.0            COLTON    72 HBC  ++ PP TO PI+PN 7GEV  1/73
M++          1226.0      2.0            COLTON    72 HBC  ++  TO PI+PI-PP      1/73
M++          1222.0      3.0            COLTON    72 HBC  ++ TO PI+PI-PI0PP    1/73
M++          1226.0      2.0            COLTON    72 HBC  ++ TO PI+PI-PI-PN    1/73
M++         (1231.)     (3.)            LEWIS     73 HBC  ++ K+ P TO K P 2PI   1/76*
M++          1219.       5.             LICHTMAN  74 HBC  ++ PI+P TO 3PI P     4/75*
M++          1213.       3.             LICHTMAN  74 HBC  ++ PI-P TO 3PI P     4/75*
M++         (1224.)      5. TO 10.      BRAUN2    75  BC     PBAR P AND D,5.7 11/75*
M++          . . . . . . . . . .
M++  AVG     1226.3      3.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.1)
M++  STUDENT 1225.3      1.4      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M+           1224. TO 1230.             BRAUN1    75 HBC     PBAR P 5.7 GEV   11/75*

M0           1231.       11.            COOPER    74 HBC   0 D P CEX           4/75*
M0          (1230.)                     BRAUN1    75 HBC     PBAR P 5.7 GEV   11/75*
M0          (1220.)      5. TO 10.      BRAUN2    75  BC     PBAR P AND D,5.7 11/75*

M-          (1241.3)    (5.1)           GIDAL     66 DBC  -                    7/66
M-           1239.0      5.0            COLTON    72 HBC  -  TO PI+PI-PI-PN    1/73
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                 81  (N*-) - (N*++) MASS DIFFERENCE (MEV) (PROD. EXP.)

D               7.9      6.8            GIDAL     66 DBC
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                 81  N*3/2(1232) WIDTH (MEV) (PROD. EXP.)

W             115.       5.             ANDERSON  70 MMS  -  PI- P TO PI- MMS  2/71
W             105.0      7.0            ELLIS     71 CNTR    MMS PP 3.7 GEV/C 10/71
W             141.       11.            MUSGRAVE  75 HBC     K+ P TO K PI N   11/75*
W            . . . . . . . . . .
W    AVG      115.2      7.5      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)
W    STUDENT  114.5      4.6      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W++          (125.0)    (30.0)          FERRO-LUZ 65 HBC  ++
W++          (121.0)                    DEANS     66 RVUE ++                   7/66
W++          (124.0)    (14.0)          GIDAL     66 DBC  ++                   7/66
W++          (120.0)     (8.0)          HABER     70 DBC     K-D TO 4 BOD(P)   7/70
W++           115.0      6.0            COLTON    72 HBC  ++ PP TO PI+PN 7GEV  1/73
W++           127.0      5.0            COLTON    72 HBC  ++  TO PI+PI-PP      1/73
W++           122.0      9.0            COLTON    72 HBC  ++ TO PI+PI-PI0PP    1/73
W++           106.0      7.0            COLTON    72 HBC  ++ TO PI+PI-PI-PN    1/73
W++          (146.)     (10.)           LEWIS     73 HBC  ++ K+ P TO K P 2PI   1/76*
W++           166.       14.            LICHTMAN  74 HBC  ++ PI+P TO 3PI P     4/75*
W++           134.       7.             LICHTMAN  74 HBC  ++ PI-P TO 3PI P     4/75*
W++          (110.)      10. TO 20.     BRAUN2    75  BC     PBAR P AND D,5.7 11/75*
W++          . . . . . . . . . .
W++  AVG      123.2      5.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)
W++  STUDENT  123.3      3.7      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W+            110. TO 130.              BRAUN1    75 HBC     PBAR P 5.7 GEV   11/75*

W0            109.       32.      25.   COOPER    74 HBC   0 D P CEX           4/75*
W0           (120.)                     BRAUN1    75 HBC     PBAR P 5.7 GEV   11/75*
W0           (120.)      10. TO 20.     BRAUN2    75  BC     PBAR P AND D,5.7 11/75*

W-           (149.0)    (18.0)          GIDAL     66 DBC  -                    7/66
W-            237.0      22.0           COLTON    72 HBC  -  TO PI+PI-PI-PN    1/73

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                         REFERENCES FOR N*3/2(1232) (PROD. EXP.)

FERRO-LU  65 NC 36 1101        FERRO-LUZZI,GEORGE, +                (CERN)
DEANS     66 PREPRINT          S R DEANS, W G HOLLADAY       (VANDERBILT)
GIDAL     66 PR 141 1261       G GIDAL, A KERNAN, S KIM              (LRL)

ANDERSON  70 PRL 25 699        +BLESER,BLIEDEN,COLLINS++        (BNL,CARN)
HABER     70 NP 178 289        +SHAPIRA,MERRILL,MCNARI++      (SABRE COLL)
ELLIS     71 PRL 27 442        +MAGLICH,NOREM,SANNES,SILVERMAN      (RUTG)
COLTON    72 PR D6 95          E COLTON, A KIRSCHBAUM                (LBL)
LEWIS     73 NP B60 283        +ALLEN,JACOBS,DANYSZ,ISLAM+(LOWC+LOIC+CDEF)

COOPER    74 NP B79 259        COOPER,SEIDL,VANDERVELDE             (MICH)
LICHTMAN  74 NP B81 31         LICHTMAN,BISWAS,CASON,KENNEY,MCGAHAN+(NDAM)I

BRAUN1    75 NP B95 481        +GERBER,MAURER,MICHALON,SCHIBY+ (STRB,LPNP)I
BRAUN2    75 NP B95 503        +GERBER,MAURER,MICHALON,SCHIBY+ (STRB,LPNP)I
MUSGRAVE  75 NP B87 365        +PEETERS,SCREINER,WHITMORE,YUTA       (ANL)

                         PAPERS NOT REFERRED TO IN DATA CARDS

ALEXANDE  73 NP B52 221        ALEXANDER,BENARY+(TEL-AVIV+HEIDELBERG+DESY)
BEAUPRE   73 NP B66 93                (AACH+BERL+BONN+CERN+NDAM+PENN+TOHO)I
BERLAND   74 NP B75 93         BERLAND,HABER,HODOUS,HULSIZER,+        (MIT)I
    ALSO  74 PL 51B 187        BERLAND,HABER,HODOUS,HULSIZER,+        (MIT)I
STRACHMA  75 NP B98 120        STRACHMAN,BRAUN,GERBER,MAURER+   (LPNP+STRB)I

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Baryons
Δ(1650), Δ(1670)

Data Card Listings
For notation, see key at front of Listings.

Δ(1650) S_{31}

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82   N*3/2(1650, JP=1/2-) I=3/2
THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.

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          82   N*3/2(1650) MASS (MEV)

M       (1648.0)   (12.0)        DEVLIN    65 CNTR    PI+- P TOTAL
M   1   (1695.0)                 BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
M   1         WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M   3   (1635.0)                 DONNACHI  68 RVUE    PHASE-SHIFT ANAL  6/68
M   6   (1614.0)                 AYED      70 IPWA                      1/71
M   6   ENER. DEP. FIT OF ARGAND DIAGRAM
M   4   (1617.0)                 DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M   7   (1623.)                  ALMEHED   72 IPWA                      2/72
M       (1623.)                  AYED      74 IPWA                      2/74
M        1622. TO 1688.          CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
M    L   1625. OR 1630.          LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
M    L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75. 11/75*
M       (1680.)                  BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*

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          82   N*3/2(1650) WIDTH (MEV)

W   1    (250.0)                 BAREYRE   68 RVUE                     11/67
W   3    (177.0)                 DONNACHI  68 RVUE                      6/68
W   6    (142.0)                 AYED      70 IPWA                      1/71
W   4    (141.0)                 DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
W   7    (140.)                  ALMEHED   72 IPWA                      2/72
W        (161.)                  AYED      74 IPWA                      2/74
W         125. TO  214.          CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
W    L    160. OR  150.          LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
W        (246.)                  BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*
W      SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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          82   N*3/2(1650) REAL PART OF POLE POSITION (MEV)            11/75*

RE       (1583.)                 LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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          82   N*3/2(1650) 2*IMAG PART OF POLE POSITION (MEV)          11/75*

IM       (143.)                  LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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          82   N*3/2(1650) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      N*3/2(1650) INTO PI N                            139+ 938
P2      N*3/2(1650) INTO N PI PI                         938+ 139+ 139
P3      N*3/2(1650) INTO GAM NUCLEON, HELICITY=1/2         0+ 938
P4      N*3/2(1650) INTO N*3/2(1232) PI                 1232+ 139
P5      N*3/2(1650) INTO N RHO                           938+ 773
P6      N*3/2(1650) INTO N RHO,S=1/2,S-WAVE              938+ 773

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          82   N*3/2(1650) BRANCHING RATIOS

R1      N*3/2(1650) INTO (PI N)/TOTAL                        (P1)
R1  3     (0.284)                DONNACHI  68 RVUE                      6/68
R1  6     (0.317)                AYED      70 IPWA                      1/71
R1  4     (0.28)                 DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
R1  7     (0.35)                 ALMEHED   72 IPWA                      2/72
R1        (.315)                 AYED      74 IPWA                      2/74

R2      N*3/2(1650) FROM PI N TO N*3/2(1232) PI        SQRT(P1*P4)     11/75*
R2   L      (+.40)OR  +.40       LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

R3      N*3/2(1650) FROM PI N TO N RHO,S=1/2,S-WAVE    SQRT(P1*P6)     11/75*
R3   L      (.18)OR  -.28        LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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          82   N*3/2(1650) PHOTON DECAY AMPL(GEV**-1/2)

     FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
     REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*3/2(1650) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1          .004     .033        DEVENISH  73 DPWA    PI N PHOTO PROD   2/74
A1         (.113)                HEMMI1    73       + FWD PI0 PHTOPROD  2/74
A1         +.090     .076        MOORHOUS  73 DPWA    PI N PHOTO-PROD   2/73
A1         -.10      .017        DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*
A1          .033     .015        KNIES     74 DPWA    PI N PHOTO PROD   2/74
A1          .105     .038        METCALF   74 DPWA    PI N PHOTO-PROD   2/74
A1          .078     .066        MOORHOUS  74 DPWA    PI N PHOTO-PROD   2/74
A1         +.044     .027        CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
A1         (+.055)               BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*
A1       . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 3.2)

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REFERENCES FOR N*3/2(1650)


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DEVLIN    65 PRL 14 1031         T J DEVLIN,J SOLOMON,G BERTSCH  (PRINCETON) I

BAREYRE   68 PR 165 1731         P BAREYRE, C BRICMAN, G VILLET     (SACLAY)IJP
DONNACHI  68 PL 26B 161          A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
   ALSO   68 VIENNA 139          DONNACHIE  RAPPORTEUR'S TALK          (GLAS)
   ALSO   68 THESIS              R G KIRSOPP                           (EDIN)

AYED      70 KIEV CONF           R AYED,P BAREYRE, G VILLET          (SACL)IJP
DAVIES    70 NP B21 359          A DAVIES                              (GLAS)

ALMEHED   72 NP B40 157          +LOVELACE                      (LUND,RUTG)IJP
DEVENISH  73 PL 47B 53           DEVENISH,RANKIN,LYTH     (LOUC+BONN+LANC)IJP
HEMMI1    73 PL 43B 79           HEMMI,INAGAKI+        (KYOTO+SAGA+KEK+TOKY)IJP
MOORHOUS  73 PL 43B 44           MOORHOUSE, OBERLACK             (GLAS+LBL)IJP

AYED      74 PRIVATE COMMCTN.    AYED,BAREYRE                        (SACL)IJP
   ALSO   73 AIX CONFERENCE      AYED,BAREYRE                        (SACL)IJP
DEVENIS2  74 PL 52B 227          DEVENISH,LYTH,RANKIN      (DESY,LANC,BONN)IJP
KNIES     74 PRD 9 2680          KNIES,MOORHOUSE,OBERLACK        (LBL,GLAS)IJP
METCALF   74 NP B76 253          W J METCALF,R L WALKER               (CIT)IJP
MOORHOUS  74 PRD 9 1             MOORHOUSE,OBERLACK,ROSENFELD    (GLAS+LBL)IJP
CRAWFORD  75 NP B97 125          R L CRAWFORD                        (GLAS)IJP
LONGACRE  75 PL 55B 415          +ROSENFELD,LASINSKI,SMADJA+     (LBL,SLAC)IJP

BARBOUR   76 SBMTD. TO NP        I. M. BARBOUR,R. L. CRAWFORD        (GLAS)IJP

                                 PAPERS NOT REFERRED TO IN DATA CARDS.

CARRUTHE  60 PRL 4 303           P CARRUTHERS                      (CORNELL) I
DEVLIN    62 PR 125 690          T J DEVLIN, B J MOYER, V PEREZ-MENDEZ (LRL) I
HELLAND   64 PR 134 B1062        +DEVLIN,HAGGE,LONGO,MOYER,WOOD        (LRL) I
BAREYRE   65 PL 18 342           + BRICMAN, STIRLING, VILLET        (SACLAY)IJP
JOHNSON   67 UCRL-17683 THESIS C H JOHNSON                             (LRL)
DONNACHI  69 NP B10 433          A DONNACHIE, R KIRSOPP            (GLAS+EDIN)
AYED      70 PL 31B 598          +BAREYRE,VILLET                      (SACLAY)
BOWLER    70 NP 17B 331          +CASHMORE                        (U. OXFORD)
DEANS     75 NP B96 90           +MITCHELL,MONTGOMERY,+      (SFLA,ALABAMA)IJP
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Δ(1670) D_{33}

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10   N*3/2(1670, JP=3/2-) I=3/2
THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.

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          10   N*3/2(1670) MASS (MEV)

M   3    (1691.0)                DONNACHI  68 RVUE    PHASE-SHIFT ANAL  8/69
M   6    (1722.0)                AYED      70 IPWA                      1/71
M   6   ENER. DEP. FIT OF ARGAND DIAGRAM
M   4    (1649.0)                DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M   7    (1700.)                 ALMEHED   72 IPWA                      2/72
M        (1723.)                 AYED      74 IPWA                      2/74
M         1612. TO 1624.         CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
M        (1660.)     (10.)       GAIDOS    75 HBC  ++ PI+P TO N* 2PI    1/76*
M    L    1725. OR 1680.         LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
M    L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75. 11/75*
M        (1629.)                 BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*

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          10   N*3/2(1670) WIDTH (MEV)

W   3    (269.0)                 DONNACHI  68 RVUE                      8/69
W   6    (258.0)                 AYED      70 IPWA                      1/71
W   4    (188.0)                 DAVIES    70 RVUE    SOL A             8/69
W   7    (260.)                  ALMEHED   72 IPWA                      2/72
W        (192.)                  AYED      74 IPWA                      2/74
W         210. TO  268.          CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
W        (180.)     (35.)  (20.) GAIDOS    75 HBC  ++ PI+P TO N* 2PI    1/76*
W    L    190. OR  240.          LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
W        (222.)                  BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*
W      SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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          10   N*3/2(1670) REAL PART OF POLE POSITION (MEV)            11/75*

RE       (1681.)                 LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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          10   N*3/2(1670) 2*IMAG PART OF POLE POSITION (MEV)          11/75*

IM       (245.)                  LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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          10   N*3/2(1670) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      N*3/2(1670) INTO PI N                            139+ 938
P2      N*3/2(1670) INTO N PI PI                         938+ 139+ 139
P3      N*3/2(1670) INTO K SIGMA                         493+1189
P4      N*3/2(1670) INTO GAM NUCLEON, HELICITY=1/2         0+ 938
P5      N*3/2(1670) INTO GAM NUCLEON, HELICITY=3/2         0+ 938
P6      N*3/2(1670) INTO N*3/2(1232) PI                 1232+ 139
P7      N*3/2(1670) INTO N*3/2(1232) PI,S-WAVE          1232+ 139
P8      N*3/2(1670) INTO N*3/2(1232) PI,D-WAVE          1232+ 139
P9      N*3/2(1670) INTO N RHO,S=3/2,S-WAVE              938+ 773

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          10   N*3/2(1670) BRANCHING RATIOS

R1      N*3/2(1670) INTO (PI N)/TOTAL                        (P1)
R1  3      (0.14)                DONNACHI  68 RVUE                      8/69
R1  6      (0.217)               AYED      70 IPWA                      1/71
R1  4      (0.12)                DAVIES    70 RVUE    SOL A             8/69
R1  7      (0.16)                ALMEHED   72 IPWA                      2/72
R1         (.166)                AYED      74 IPWA                      2/74

R2      N*3/2(1670) INTO (K SIGMA)/TOTAL                     (P3)
R2  1      (.00002)OR LESS          FEUERBACH 70 RVUE    PI P TO K+ SIG+   7/70
R2  1     ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1     MODEL USED MAY DOUBLE COUNT.

R3      N*3/2(1670) FROM PI N TO N*3/2(1232) PI,S-WAVE  SQRT(P1*P7)    11/75*
R3   L      (-.25)OR  -.24       LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

R4      N*3/2(1670) FROM PI N TO N*3/2(1232) PI,D-WAVE  SQRT(P1*P8)    11/75*
R4   L      (0.) OR  (-.10)      LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

R5      N*3/2(1670) FROM PI N TO N RHO,S=3/2,S-WAVE     SQRT(P1*P9)    11/75*
R5   L      (.20)OR  +.30        LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

R6      N*3/2(1670) FROM PI N TO K SIGMA                SQRT(P1*P3)    11/75*
R6  2      (.001)TO  .011        DEANS     75 DPWA    PI N TO K SIGMA  11/75*
R6  2   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                       11/75*

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          10   N*3/2(1670) PHOTON DECAY AMPL(GEV**-1/2)

     FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
     REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*3/2(1670) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1          .036     .052        DEVENISH  73 DPWA    PI N PHOTO PROD   2/74
A1         +.068     .042        MOORHOUS  73 DPWA    PI N PHOTO-PROD   2/73
A1          .054     .029        DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*
A1          .078     .009        KNIES     74 DPWA    PI N PHOTO PROD   2/74
A1          .0       .048        METCALF   74 DPWA    PI N PHOTO-PROD   2/74
A1          .041     .028        MOORHOUS  74 DPWA    PI N PHOTO-PROD   2/74
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Data Card Listings

For notation, see key at front of Listings.

Baryons

Δ(1670), Δ(1690), Δ(1890)

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A1          +.101     .011            CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
A1         (+.120)                    BARBOUR   76 DPWA    PI N PHOTO-PRCD   1/76*
A1          . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

A2      N*3/2(1670) INTO GAM NUCLECN, HELICITY=3/2 (GEV**-1/2)
A2           .110     .039            DEVENISH  73 DPWA    PI N PHOTO PROD   2/74
A2          +.022     .052            MOORHOUS  73 DPWA    PI N PHOTO-PROD   2/73
A2           .072     .014            DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*
A2           .070     .009            KNIES     74 DPWA    PI N PHOTC PROD   2/74
A2           .0       .041            METCALF   74 DPWA    PI N PHOTO-PROD   2/74
A2           .021     .020            MOORHOUS  74 DPWA    PI N PHOTO-PROD   2/74
A2          +.116     .024            CRAWFORD  75 DPWA    PI N PHOTO-PRCD   1/76*
A2         (+.117)                    BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*
A2          . . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 1.6)

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                        REFERENCES FOR N*3/2(1670)

DCNNACH1 68 PL 26B 161          A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139          CONNACHIE  RAPPORTEUR'S TALK          (GLAS)
    ALSO 68 THESIS              R G KIRSOPP                           (EDIN)

AYED     70 KIEV CCNF           R AYED,P BAREYRE, G VILLET            (SACL)IJP
DAVIES   70 NP B21 359          A DAVIES                              (GLAS)
FEUERBAC 70 NP 16B 85           FEUERBACHER+HOLLADAY            (VANDERBILT)

ALMEHEC  72 NP B40 157          +LOVELACE                        (LUND,RUTG)IJP
DEVENISH 73 PL 47B 53           DEVENISH,RANKIN,LYTH        (LOUC+BONN+LANC)IJP
MOORHOUS 73 PL 43B 44           MOORHOUSE, OBERLACK                (GLAS+LBL)IJP

AYED     74 PRIVATE COMMCTN.    AYEC,BAREYRE                          (SACL)IJP
    ALSO 73 AIX CONFERENCE      AYED,BAREYRE                          (SACL)IJP
DEVENIS2 74 PL 52B 227          DEVENISH,LYTH,RANKIN        (DESY,LANC,BCNN)IJP
KNIES    74 PRD 9 2680          KNIES,MOORHOUSE,OBERLACK           (LBL,GLAS)IJP
METCALF  74 NP B76 253          W J METCALF,R L WALKER                 (CIT)IJP
MOORHOUS 74 PRD 9 1             MOORHOUSE,OBERLACK,ROSENFELD       (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125          R L CRAWFORD                          (GLAS)IJP
DEANS    75 NP B96 90           +MITCHELL,MCNTGOMERY,+         (SFLA,ALABAMA)IJP
GAIDOS   75 PRD 12 2565         GAIDOS,MILLER                         (PURD)IJP
LONGACRE 75 PL 55B 415          +ROSENFELD,LASINSKI,SMADJA+        (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP        I. M. BARBOUR,R. L. CRAWFORD          (GLAS)IJP

                                PAPERS NOT REFERRED TO IN CATA CARDS.

DCNNACHI 69 NP 10B 433          A DONNACHIE, R KIRSOPP           (GLAS+EDIN)
AYED     70 PL 31B 598          +BAREYRE,VILLET                      (SACLAY)
BOWLER   70 NP 17B 331          +CASHMORE                        (U. OXFORD)

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Δ(1690) → P''_{33}

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19   N*3/2(1690, JP=3/2+) I=3/2

RECENT ANALYSES INDICATE A POSSIBLE P''33 RESCNANCE
SOMEWHERE IN THE 1600-2000 MEV REGION.  SEE ALSO THE
N*3/2(2160) LISTINGS.

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                   19   N*3/2(1690) MASS (MEV)

M   3     (1690.)                  DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
M   3     (1690.)                  KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
M   3   WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1  10/69
M   6     (1801.0)                 AYED      70 IPWA                      1/71
M   6   ENER. DEP. FIT OF ARGAND DIAGRAM
M   7     (1680.)                  ALMEHED   72 IPWA                      2/72
M         (1904.)                  AYED      74 IPWA                      2/74
M     L     1900. OR 1640.         LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
M     L   THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.  11/75*

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                   19   N*3/2(1690) WIDTH (MEV)

W   3     (281.)                   DCNNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
W   3     (240.)                   KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
W   6     (598.0)                  AYED      70 IPWA                      1/71
W   7     (220.)                   ALMEHED   72 IPWA                      2/72
W         (204.)                   AYED      74 IPWA                      2/74
W     L     205. OR  300.          LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
      SEE THE NOTES ACCCMPANYING MASSES QUOTEC

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                   19   N*3/2(1690) REAL PART OF POLE POSITICN (MEV)      11/75*

RE        (1609.)                  LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                   19   N*3/2(1690) 2*IMAG PART CF POLE PCSITION (MEV)    11/75*

IM        (323.)                   LCNGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                   19   N*3/2(1690) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      N*3/2(1690) INTO PI N                               139+ 938
P2      N*3/2(1690) INTO K SIGMA                            493+1189
P3      N*3/2(1690) INTO N*3/2(1232) PI,P-WAVE             1232+ 139

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                   19   N*3/2(169C) BRANCHING RATIOS

R1      N*3/2(1690) INTO (PI N)/TCTAL                        (P1)
R1  3         (.10)                DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
R1  3         (.08)                KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
R1  6         (0.135)              AYED      70 IPWA                      1/71
R1  7         (0.1)                ALMEHED   72 IPWA                      2/72
R1            (.194)               AYED      74 IPWA                      2/74

R2      N*3/2(1690) INTO (K SIGMA)/TOTAL                     (P2)
R2  1       (.00002)OR LESS        FEUERBACH 70 RVUE    PI P TO K+ SIG+   7/70
R2  1      ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1      MODEL USED MAY DOUBLE COUNT.

R3      N*3/2(1690) FROM PI N TO K SIGMA                  SQRT(P1*P2)          11/75*
R3  2          (.006)TO  .042         DEANS     75 DPWA    PI N TO K SIGMA  11/75*
R3  2   RANGE GIVEN IS FROM FOUR BEST SOLUTICNS.                             11/75*

R4      N*3/2(1690) FROM PI N TC N*3/2(1232) PI,P-WAVE   SQRT(P1*P3)          11/75*
R4    L       (-.36)OR  -.30          LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                   19   N*3/2(1690) PHOTON DECAY AMPL(GEV**-1/2)

     FOR DEFINITION OF GAMMA-NUCLECN DECAY AMPLITUDES, SEE MINI-
   REVIEW PRECEDING THE BARYCN LISTINGS.

A1      N*3/2(1690) INTO GAM NUCLECN, HELICITY=1/2 (GEV**-1/2)
A1           .016     .055            DEVENISH  73 DPWA    PI N PHOTO PROD   2/74
A1          -.033     .037            DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*
A1           .003     .015            KNIES     74 DPWA    PI N PHOTC PRCD   2/74
A1           .0       .038            METCALF   74 DPWA    PI N PHOTO-PROD   2/74
A1          . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A2      N*3/2(1690) INTO GAM NUCLECN, HELICITY=3/2 (GEV**-1/2)
A2           .074     .064            DEVENISH  73 DPWA    PI N PHOTO PRCD   2/74
A2           .008     .046            DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*
A2          -.034     .022            KNIES     74 DPWA    PI N PHOTO PROD   2/74
A2           .0       .033            METCALF   74 DPWA    PI N PHOTC-PROD   2/74
A2          . . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                        REFERENCES FOR N*3/2(1690)

DONNACH2 68 VIENNA 139          DONNACHIE  RAPPORTEUR'S TALK          (GLAS)
KIRSOPP  68 THESIS              R G KIRSOPP                           (EDIN)

AYED     70 KIEV CONF           R AYED,P BAREYRE, G VILLET            (SACL)IJP
FEUERBAC 70 NP 16B 85           FEUERBACHER+HOLLADAY            (VANDERBILT)
ALMEHED  72 NP B40 157          +LOVELACE                        (LUND,RUTG)IJP
DEVENISH 73 PL 47B 53           DEVENISH,RANKIN,LYTH        (LOUC+BONN+LANC)IJP

AYED     74 PRIVATE COMMCTN.    AYED,BAREYRE                          (SACL)IJP
    ALSO 73 AIX CONFERENCE      AYED,BAREYRE                          (SACL)IJP
DEVENIS2 74 PL 52B 227          DEVENISH,LYTH,RANKIN        (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680          KNIES,MOORHCUSE,OBERLACK           (LBL,GLAS)IJP
METCALF  74 NP B76 253          W J METCALF,R L WALKER                 (CIT)IJP

DEANS    75 NP B96 90           +MITCHELL,MONTGCMERY,+         (SFLA,ALABAMA)IJP
LONGACRE 75 PL 55B 415          +ROSENFELD,LASINSKI,SMADJA+        (LBL,SLAC)IJP

                                PAPERS NOT REFERRED TO IN DATA CARDS.

AYED     70 PL 31B 598          +BAREYRE,VILLET                      (SACLAY)
BOWLER   70 NP 17B 331          +CASHMORE                        (U. OXFORD)

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Δ(1890) F_{35}

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11   N*3/2(1890, JP=5/2+) I=3/2
THE EXISTENCE OF THIS RESCNANCE IS WELL ESTABLISHED.

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                   11   N*3/2(1890) MASS (MEV)

M   3     (1913.0)                 DONNACH1  68 RVUE    PHASE-SHIFT ANAL  8/69
M   6     (1837.0)                 AYED      70 IPWA                      1/71
M   6   FROM ENER. DEP. FIT OF ARGANC DIAGRAM
M   4     (1841.0)                 DAVIES    70 RVUE    P-S ANAL  SCL A   8/69
M   7     (1875.)                  ALMEHED   72 IPWA                      2/72
M    1      1890. TO 1986.         MEHTANI   72 DPWA    PI+P TO PI+PIOP   9/73
M         (1890.)                  LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
M         (1890.)                  LANGBEIN  73 IPWA    PI N-K SIG,SOL 2  9/73
M         (1869.)                  AYED      74 IPWA                      2/74
M     L     1870. OR 1830.         LONGACRE  75 IPWA    PI N TC 2PI N    11/75*
M     L   THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.  11/75*

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                   11   N*3/2(1890) WIDTH (MEV)

W   3     (350.0)                  DCNNACH1  68 RVUE                      8/69
W   6     (198.0)                  AYED      70 IPWA                      1/71
W   4     (136.0)                  DAVIES    70 RVUE    SOL A             8/69
W   7     (250.)                   ALMEHED   72 IPWA                      2/72
W    1      273. TO 322.           MEHTANI   72 DPWA    PI+P TO PI+PIOP   9/73
W         (180.)                   LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
W         (140.)                   LANGBEIN  73 IPWA    PI N-K SIG,SOL 2  9/73
W         (255.)                   AYED      74 IPWA                      2/74
W     L     255. OR  220.          LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
          SEE NOTES ACCCMPANYING MASSES QUOTED AS FOR N*1/2(1910)

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                   11   N*3/2(1890) REAL PART OF POLE PCSITICN (MEV)      11/75*

RE        (1813.)                  LCNGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                   11   N*3/2(1890) 2*IMAG PART OF POLE POSITICN (MEV)    11/75*

IM        (193.)                   LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                   11   N*3/2(1890) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      N*3/2(1890) INTO PI N                               139+ 938
P2      N*3/2(1890) INTC N PI PI                            938+ 139+ 139
P3      N*3/2(1890) INTO K SIGMA                            493+1189
P4      N*3/2(1890) INTO N*3/2(1232) PI                    1232+ 139
P5      N*3/2(1890) INTO GAM NUCLECN, HELICITY=1/2            0+ 938
P6      N*3/2(1890) INTO GAM NUCLEON, HELICITY=3/2            0+ 938
P7      N*3/2(1890) INTO N RHO                              938+ 773
P8      N*3/2(1890) INTO N*3/2(1232) PI,P-WAVE             1232+ 139
P9      N*3/2(1890) INTO N*3/2(1232) PI,F-WAVE             1232+ 139
P10     N*3/2(1890) INTC N RHO,S=3/2,P-WAVE                 938+ 773

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Baryons

Δ(1890), Δ(1900), Δ(1910)

Data Card Listings

For notation, see key at front of Listings.

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                 11  N*3/2(1890) BRANCHING RATIOS

R1      N*3/2(1890) INTO (PI N)/TOTAL                    (P1)
R1  3         (0.16)              DONNACH1  68 RVUE                        8/69
R1  6         (0.147)             AYED      70 IPWA                        1/71
R1  4         (0.20)              DAVIES    70 RVUE     SOL A              8/69
R1  7         (0.18)              ALMEHED   72 IPWA                        2/72
R1            (.144)              AYED      74 IPWA                        2/74

R2      N*3/2(1890) INTO (K SIGMA)/TOTAL                 (P3)
R2  1         (0.008)OR LESS      FEUERBACH 70 RVUE     PI P TO K+ SIG+    7/70
R2  1     ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1     MODEL USED MAY DOUBLE COUNT.

R3      N*3/2(1890) INTO (SIGMA K)*(PI N)/TOTAL**2       (P3*P1)
R3            (.0016)OR LESS      KALMUS    70 DPWA     PI+P TO K+ SIG+    1/71

R4      N*3/2(1890)  FROM PI N TO N*3/2(1232) PI         SQRT(P1*P4)
R4   1      .19 TO .23            MEHTANI   72 DPWA     PI+P TO PI+PIOP    9/73
R4   1  MOSTLY F WAVE DECAY                                                9/73

R5      N*3/2(1890) FROM PI N TO K SIGMA                 SQRT(P1*P3)        9/73
R5            (.06)               LANGBEIN  73 IPWA     PI N-K SIG,SOL 1   9/73
R5            (.06)               LANGBEIN  73 IPWA     PI N-K SIG,SOL 2   9/73
R5  2         (.021)TO  .054      DEANS     75 DPWA     PI N TO K SIGMA   11/75*
R5  2   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                          11/75*

R6      N*3/2(1890) FROM PI N TO N*3/2(1232) PI,F-WAVE   SQRT(P1*P9)       11/75*
R6   L        (-.12)OR  -.20      LONGACRE  75 IPWA     PI N TO 2PI N     11/75*

R7      N*3/2(1890) FROM PI N TO N RHO,S=3/2,P-WAVE      SQRT(P1*P10)      11/75*
R7   L        (-.28)OR  -.33      LONGACRE  75 IPWA     PI N TO 2PI N     11/75*
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                 11  N*3/2(1890) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
     REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*3/2(1890) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1            .019      .027      DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A1            .042      .016      KNIES     74 DPWA     PI N PHOTO PROD    2/74
A1           +.047      .067      METCALF   74 DPWA     PI N PHOTO-PROD    2/74
A1           -.003      .009      CRAWFORD  75 DPWA     PI N PHOTO-PROD    1/76*
A1          (+.035)               BARBOUR   76 DPWA     PI N PHOTO-PROD    1/76*
A1            . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.8)

A2      N*3/2(1890) INTO GAM NUCLEON, HELICITY=3/2 (GEV**-1/2)
A2            .078      .020      DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A2           -.022      .020      KNIES     74 DPWA     PI N PHOTO PROD    2/74
A2           -.028      .066      METCALF   74 DPWA     PI N PHOTO-PROD    2/74
A2           -.021      .036      CRAWFORD  75 DPWA     PI N PHOTO-PROD    1/76*
A2          (-.013)               BARBOUR   76 DPWA     PI N PHOTO-PROD    1/76*
A2            . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 2.2)

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                      REFERENCES FOR N*3/2(1890)

DONNACH1 68 PL 26B 161         A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139         DONNACHIE  RAPPORTEUR'S TALK         (GLAS)
    ALSO 68 THESIS             R G KIRSOPP                          (EDIN)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET         (SACL)IJP
DAVIES   70 NP B21 359         A DAVIES                             (GLAS)
FEUERBAC 70 NP 16B 85          FEUERBACHER+HOLLADAY          (VANDERBILT)
KALMUS   70 PR D2 1824         G KALMUS, G BORREANI, J LOUIE         (LRL)

ALMEHED  72 NP B40 157         +LOVELACE                     (LUND,RUTG)IJP
MEHTANI  72 PRL 29 1634        +FUNG, KERNAN, SCHALK, +       (UCR +LBL)
LANGBEIN 73 NP B53 251         LANGBEIN,WAGNER                  (MUNICH)IJP
AYED     74 PRIVATE COMMCTN.   AYED,BAREYRE                       (SACL)IJP
    ALSO 73 AIX CONFERENCE     AYED,BAREYRE                       (SACL)IJP
DEVENIS2 74 PL 52B 227         DEVENISH,LYTH,RANKIN     (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680         KNIES,MOORHOUSE,OBERLACK       (LBL,GLAS)IJP
METCALF  74 NP B76 253         W J METCALF,R L WALKER               (CIT)IJP

CRAWFORD 75 NP B97 125         R L CRAWFORD                        (GLAS)IJP
DEANS    75 NP B96 90          +MITCHELL,MONTGOMERY,+     (SFLA,ALABAMA)IJP
LONGACRE 75 PL 55B 415         +ROSENFELD,LASINSKI,SMADJA+    (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP       I. M. BARBOUR,R. L. CRAWFORD        (GLAS)IJP

                               PAPERS NOT REFERRED TO IN DATA CARDS.

AYED     70 PL 31B 598         +BAREYRE+VILLET                     (SACLAY)
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Δ(1900) — **S_{31}**

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            30  N*3/2(1900, JP=1/2-) I=3/2                                 9/73
            THIS EFFECT IS SEEN IN TWO CHANNELS.
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                 30  N*3/2(1900) MASS (MEV)                                9/73

M           (1920.)                LANGBEIN  73 IPWA     PI N-K SIG,SOL 1  9/73
M           (1870.)                LANGBEIN  73 IPWA     PI N-K SIG,SOL 2  9/73
M           (2001.)                AYED      74 IPWA                       2/74
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                 30  N*3/2(1900) WIDTH (MEV)                               9/73

W           (140.)                 LANGBEIN  73 IPWA     PI N-K SIG,SOL 1  9/73
W           (160.)                 LANGBEIN  73 IPWA     PI N-K SIG,SOL 2  9/73
W           (307.)                 AYED      74 IPWA                       2/74
        SEE THE NOTES ACCOMPANYING MASSES QUOTED
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                 30  N*3/2(1900) PARTIAL DECAY MODES                       9/73

                                                        DECAY MASSES
P1      N*3/2(1900) INTO PI N                          139+ 938
P2      N*3/2(1900) INTO K SIGMA                       493+1189
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                 30  N*3/2(1900) BRANCHING RATIOS                          9/73

R1      N*3/2(1900) FROM PI N TO K SIGMA                 SQRT(P1*P2)        9/73
R1            (.11)               LANGBEIN  73 IPWA     PI N-K SIG,SOL 1   9/73
R1            (.12)               LANGBEIN  73 IPWA     PI N-K SIG,SOL 2   9/73
R1  1         (.076)              DEANS     75 DPWA     PI N TO K SIGMA   11/75*
R1  1   VALUE GIVEN IS FROM SOLUTION 1, NOT PRESENT IN SOLUTIONS 2,3,4.   11/75*

R2      N*3/2(1900) INTO PI N/TOTAL                      (P1)
R2            (.076)              AYED      74 IPWA                        2/74

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                      REFERENCES FOR N*3/2(1900)

LANGBEIN 73 NP B53 251         LANGBEIN,WAGNER                  (MUNICH)IJP
AYED     74 PRIVATE COMMCTN.   AYED,BAREYRE                       (SACL)IJP
    ALSO 73 AIX CONFERENCE     AYED,BAREYRE                       (SACL)IJP
DEANS    75 NP B96 90          +MITCHELL,MONTGOMERY,+     (SFLA,ALABAMA)IJP
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Δ(1910) — **P_{31}**

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            12  N*3/2(1910, JP=1/2+) I=3/2
            THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.

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                 12  N*3/2(1910) MASS (MEV)

M   3      (1934.0)               DONNACH1  68 RVUE     PHASE-SHIFT ANAL   8/69
M   6      (1783.0)               AYED      70 IPWA                        1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4      (1914.0)               DAVIES    70 RVUE     P-S ANAL  SOL A    8/69
M   7      (1900.)                ALMEHED   72 IPWA                        2/72
M          (1980.)                LANGBEIN  73 IPWA     PI N-K SIG,SOL 1   9/73
M          (1950.)                LANGBEIN  73 IPWA     PI N-K SIG,SOL 2   9/73
M          (1786.)                AYED      74 IPWA                        2/74
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                 12  N*3/2(1910) WIDTH (MEV)

W   3      (339.0)                DONNACH1  68 RVUE                        8/69
W   6      (308.0)                AYED      70 IPWA                        1/71
W   4      (290.)                 DAVIES    70 RVUE     SOL A              8/69
W   7      (200.)                 ALMEHED   72 IPWA                        2/72
W          (190.)                 LANGBEIN  73 IPWA     PI N-K SIG,SOL 1   9/73
W          (170.)                 LANGBEIN  73 IPWA     PI N-K SIG,SOL 2   9/73
W          (222.)                 AYED      74 IPWA                        2/74
        SEE NOTES ACCOMPANYING MASSES QUOTED
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                 12  N*3/2(1910) PARTIAL DECAY MODES

                                                        DECAY MASSES
P1      N*3/2(1910) INTO PI N                          139+ 938
P2      N*3/2(1910) INTO N PI PI                       938+ 139+ 139
P3      N*3/2(1910) INTO K SIGMA                       493+1189
P4      N*3/2(1910) INTO N*3/2(1232) PI               1232+ 139
P5      N*3/2(1910) INTO GAM NUCLEON, HELICITY=1/2        0+ 938
P6      N*3/2(1910) INTO N RHO                         938+ 773
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                 12  N*3/2(1910) BRANCHING RATIOS

R1      N*3/2(1910) INTO (PI N)/TOTAL                    (P1)
R1  3         (0.30)              DONNACH1  68 RVUE                        8/69
R1  6         (0.128)             AYED      70 IPWA                        1/71
R1  4         (0.18)              DAVIES    70 RVUE     SOL A              8/69
R1  7         (0.33)              ALMEHED   72 IPWA                        2/72
R1            (.158)              AYED      74 IPWA                        2/74

R2      N*3/2(1910) INTO (K SIGMA)/TOTAL                 (P3)
R2  1         (0.008)OR LESS      FEUERBACH 70 RVUE     PI P TO K+ SIG+    7/70
R2  1     ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1     MODEL USED MAY DOUBLE COUNT.

R3      N*3/2(1910) FROM PI N TO K SIGMA                 SQRT(P1*P3)        9/73
R3            (.11)               LANGBEIN  73 IPWA     PI N-K SIG,SOL 1   9/73
R3            (.15)               LANGBEIN  73 IPWA     PI N-K SIG,SOL 2   9/73
R3  2         (.082)TO  .184      DEANS     75 DPWA     PI N TO K SIGMA   11/75*
R3  2   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                          11/75*
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                 12  N*3/2(1910) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
     REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*3/2(1910) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1            .000      .025      DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A1            .010      .012      KNIES     74 DPWA     PI N PHOTO PROD    2/74
A1           -.032      .065      METCALF   74 DPWA     PI N PHOTO-PROD    2/74
A1           -.009      .013      CRAWFORD  75 DPWA     PI N PHOTO-PROD    1/76*
A1          (-.031)               BARBOUR   76 DPWA     PI N PHOTO-PROD    1/76*
A1            . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                      REFERENCES FOR N*3/2(1910)

DONNACH1 68 PL 26B 161         A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139         DONNACHIE  RAPPORTEUR'S TALK         (GLAS)
    ALSO 68 THESIS             R G KIRSOPP                          (EDIN)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET         (SACL)IJP
DAVIES   70 NP B21 359         A DAVIES                             (GLAS)
FEUERBAC 70 NP 16B 85          FEUERBACHER+HOLLADAY          (VANDERBILT)

ALMEHED  72 NP B40 157         +LOVELACE                     (LUND,RUTG)IJP
LANGBEIN 73 NP B53 251         LANGBEIN,WAGNER                  (MUNICH)IJP

AYED     74 PRIVATE COMMCTN.   AYED,BAREYRE                       (SACL)IJP
    ALSO 73 AIX CONFERENCE     AYED,BAREYRE                       (SACL)IJP
DEVENIS2 74 PL 52B 227         DEVENISH,LYTH,RANKIN     (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680         KNIES,MOORHOUSE,OBERLACK       (LBL,GLAS)IJP
METCALF  74 NP B76 253         W J METCALF,R L WALKER               (CIT)IJP
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Data Card Listings
For notation, see key at front of Listings.

Baryons
Δ(1910), Δ(1950), Δ(1960)


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CRAWFORD 75 NP B97 125         R L CRAWFORD                        (GLAS)IJP
DEANS    75 NP B96 90          +MITCHELL,MCNTGCMERY,+       (SFLA,ALABAMA)IJP

BARBOUR  76 SBMTD. TO NP       I. M. BARBOUR,R. L. CRAWFCRD        (GLAS)IJP

                               PAPERS NOT REFERREC TO IN CATA CARDS.

CARYANN  65 PR 138 B433        CARAYANNOPOULOS,TAUTFEST,WILLMANN    (PURD)
   A PARTIAL WAVE ANALYSIS OF PI+P TO SIGMA+ K+
AYED     70 PL 31B 598         +BAREYRE+VILLET                    (SACLAY)
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Δ(1950) — F_{37}

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        83  N*3/2(1950, JP=7/2+) I=3/2
            THE EXISTENCE OF THIS RESCNANCE IS WELL ESTABLISHED.

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                 83  N*3/2(1950) MASS (MEV)

M          (1920.0)                DUKE      65 CNTR   PI-P EL + PCL       6/68
M          (1950.0)     APPROX     YOKOSAWA  66 CNTR   PI- P DSIG + PCL    7/66
M   1      (1975.0)                BAREYRE   68 RVUE   PHASE-SHIFT ANAL   11/67
M   1            WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M   3      (1946.0)                DONNACH1  68 RVUE   PHASE-SHIFT ANAL    6/68
M   6      (1931.0)                AYED      70 IPWA                       1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4      (1935.0)                DAVIES    70 RVUE   P-S ANAL  SOL A     8/69
M          (1950.0)   (30.0)       KALMUS    70 DPWA   PI+P TO K+ SIG+     1/71
M          (1930.)                 ROYCHOUD  71 DPWA                       3/72
M   7      (1925.)                 ALMEHED   72 IPWA                       2/72
M    2      1920 TO 1951           MEHTANI   72 MPWA   PI+P TO PI+PIOP     9/73
M    .     (1928.)                 AYED      74 IPWA                       2/74
M    L      1930. OR 1925.         LONGACRE  75 IPWA   PI N TO 2PI N      11/75*
M    L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.  11/75*

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                 83  N*3/2(1950) WIDTH (MEV)

W          (170.0)                 DUKE      65 CNTR                       7/66
W          (200.0)      APPROX     YOKOSAWA  66 CNTR                       7/66
W   1      (180.0)                 BAREYRE   68 RVUE                      11/67
W   3      (221.0)                 DCNNACH1  68 RVUE                       6/68
W   6      (197.0)                 AYED      70 IPWA                       1/71
W   4      (221.0)                 DAVIES    70 RVUE   SOL A               8/69
W          (300.0)   (60.0)        KALMUS    70 DPWA   PI+P TO K+ SIG+     1/71
W   7      (200.)                  ALMEHED   72 IPWA                       2/72
W    2     234 TO 269              MEHTANI   72 MPWA   PI+P TO PI+PIOP     9/73
W          (237.)                  AYED      74 IPWA                       2/74
W    L      235. OR  240.          LONGACRE  75 IPWA   PI N TO 2PI N      11/75*
     SEE THE NOTES ACCCMPANYING THE MASSES QUOTED.

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                 83  N*3/2(1950) REAL PART OF POLE PCSITICN (MEV)         11/75*

RE         (1924.)                 LCNGACRE  75 IPWA   PI N TO 2PI N      11/75*

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                 83  N*3/2(1950) 2*IMAG PART CF POLE PCSITICN (MEV)       11/75*

IM         (258.)                  LCNGACRE  75 IPWA   PI N TO 2PI N      11/75*

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                 83  N*3/2(1950) PARTIAL DECAY MODES

                                                       DECAY MASSES
P1     N*3/2(1950) INTO PI N                            139+ 938
P2     N*3/2(1950) INTO SIGMA K                        1189+ 493
P3     N*3/2(1950) INTO N*3/2(1232) PI                 1232+ 139
P4     N*3/2(1950) INTO Y*1(1385) K                    1384+ 493
P5     N*3/2(1950) INTO N*3/2(1232) RHO                1232+ 773
P6     N*3/2(1950) INTO NEUTRON PI+ PI+                 939+ 139+ 139
P7     N*3/2(1950) INTO N*3/2(1232) PI PI (NOT RHO)    1232+ 139+ 139
P8     N*3/2(1950) INTO GAM NUCLEON, HELICITY=1/2         0+ 938
P9     N*3/2(1950) INTO GAM NUCLEON, HELICITY=3/2         0+ 938
P10    N*3/2(1950) INTO N RHO                           938+ 773
P11    N*3/2(1950) INTO N*3/2(1232) PI,F-WAVE          1232+ 139
P12    N*3/2(1950) INTO N*3/2(1232) PI,H-WAVE          1232+ 139
P13    N*3/2(1950) INTC N RHO,S=3/2,F-WAVE              938+ 773

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                 83  N*3/2(1950) BRANCHING RATIOS

R1     N*3/2(1950) INTO (PI N)/TOTAL                   (P1)
R1          (0.41)                 DUKE      65 CNTR    VERY ENERGY DEP    7/66
R1          (0.4)       APPROX     YOKOSAWA  66 CNTR                       7/66
R1  1       (0.57)                 BAREYRE   68 RVUE                      11/67
R1  3       (0.386)                DONNACH1  68 RVUE                       6/68
R1  6       (0.496)                AYED      70 IPWA                       1/71
R1  4       (0.51)                 DAVIES    70 RVUE    SOL A              8/69
R1  7       (0.4)                  ALMEHED   72 IPWA                       2/72
R1           (.405)                AYED      74 IPWA                       2/74
       SEE THE NOTES ACCOMPANYING THE MASSES CUOTEC.

R2     N*3/2(1950) INTO (SIGMA K)*(PI N)/TCTAL**2      (P2*P1)
R2             SEEN                BORREANI  68 HBC     PI+P 1.35-1.68    10/69
R2  1       (0.004)  (0.008)       FEUERBACH 70 RVUE    PI P TO K+ SIG+    7/70
R2  1     ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1     MODEL USED MAY DOUBLE COUNT.
R2           0.0081   0.0013       KALMUS    70 DPWA    PI+P TO K+ SIG+    1/71

R3     N*3/2(1950)  FROM PI N TC N*3/2(1232) PI        SQRT(P1*P3)
R3   2     .37 TO .48              MEHTANI   72 MPWA    PI+P TO PI+PIOP    9/73
R3   2 MOSTLY F WAVE DECAY                                                 9/73

R4     N*3/2(1950) FROM PI N TO SIGMA K                SQRT(P1*P2)         9/73
R4           (.04)                 LANGBEIN  73 IPWA    PI N-K SIG,SOL 1   9/73
R4           (.05)                 LANGBEIN  73 IPWA    PI N-K SIG,SOL 2   9/73
R4  5        (.022)TO  .040        DEANS     75 CPWA    PI N TO K SIGMA   11/75*
R4  5  RANGE GIVEN IS FROM FOUR BEST SOLUTICNS.                           11/75*

R5     N*3/2(1950) FROM PI N TO N*3/2(1232) PI,F-WAVE  SQRT(P1*P11)       11/75*
R5   L      (-.25)OR  -.32         LONGACRE  75 IPWA    PI N TO 2PI N     11/75*

R6     N*3/2(1950) FROM PI N TC N RHO,S=3/2,F-WAVE     SQRT(P1*P13)       11/75*
R6   L      (.18)OR  -.24          LONGACRE  75 IPWA    PI N TC 2PI N     11/75*

   MORE INFORMATICN ON INELASTIC CECAY MODES OF BUMPS, SEEN IN PRODUCTION
   EXPERIMENTS AROUND 1950 MEV, MAY BE FOUND IN THE NEXT ENTRY

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                 83  N*3/2(1950) PHOTON DECAY AMPL(GEV**-1/2)

     FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
   REVIEW PRECEDING THE BARYON LISTINGS.

A1     N*3/2(1950) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1          -.088      .025        DEVENIS2  74 DPWA   PI N PHOTO-PROD   4/75*
A1          -.070      .012        KNIES     74 CPWA   PI N PHOTO PROD   2/74
A1          -.C59      .029        METCALF   74 DPWA   PI N PHOTO-PRCD   2/74
A1         (-.080)                 MOORHOUS  74 DPWA   PI N PHOTO-PRCD   2/74
A1          -.053      .005        CRAWFORD  75 DPWA   PI N PHOTO-PROD   1/76*
A1         (-.076)                 BARBOUR   76 DPWA   PI N PHOTO-PROD   1/76*
A1          . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.3)

A2     N*3/2(1950) INTO GAM NUCLEON, HELICITY=3/2 (GEV**-1/2)
A2          -.080      .021        DEVENIS2  74 DPWA   PI N PHOTO-PROD   4/75*
A2          -.078      .010        KNIES     74 CPWA   PI N PHOTO PRCD   2/74
A2          -.093      .024        METCALF   74 DPWA   PI N PHOTC-PROD   2/74
A2         (-.180)                 MCORHOUS  74 CPWA   PI N PHOTO-PROD   2/74
A2          -.038      .014        CRAWFORD  75 DPWA   PI N PHOTC-PRCD   1/76*
A2         (-.065)                 BARBOUR   76 DPWA   PI N PHOTC-PRCD   1/76*
A2          . . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 1.5)

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REFERENCES FOR N*3/2(1950)


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DUKE     65 PRL 15 468         +JONES,KEMP,MURPHY,PRENTICE, +   (RHEL,OXF)IJP
YOKOSAWA 66 PRL 16 714         +SUWA, HILL, ESTERLING, BOOTH    (ANL,CHIC)IJP

BAREYRE  68 PR 165 1731        P BAREYRE, C BRICMAN, G VILLET     (SACLAY)IJP
BORREANI 68 UCRL 18350          BORREANI,KALMUS                        (LRL)
DONNACH1 68 PL 26B 161         A DCNNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139         DONNACHIE  RAPPORTEUR'S TALK           (GLAS)
    ALSO 68 THESIS             R G KIRSOPP                            (EDIN)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET          (SACL)IJP
DAVIES   70 NP B21 359         A DAVIES                               (GLAS)
FEUERBAC 70 NP 16B 85          FEUERBACHER+HCLLADAY            (VANDERBILT)
KALMUS   70 PR D2 1824         G KALMUS, G BORREANI, J LOUIE           (LRL)

ROYCHOUD 71 NP B27 125         R K ROYCHOUDHURY,B H BRANSCEN       (DURH)IJP

ALMEHED  72 NP B40 157         +LCVELACE                      (LUND,RUTG)IJP
MEHTANI  72 PRL 29 1634        +FUNG, KERNAN, SCHALK, +         (UCR +LBL)
LANGBEIN 73 NP B53 251         LANGBEIN,WAGNER                   (MUNICH)IJP

AYED     74 PRIVATE COMMCTN.   AYEC,BAREYRE                        (SACL)IJP
    ALSO 73 AIX CCNFERENCE     AYED,BAREYRE                        (SACL)IJP
DEVENIS2 74 PL 52B 227         DEVENISH,LYTH,RANKIN       (DESY,LANC,BCNN)IJP
KNIES    74 PRD 9 2680         KNIES,MOORHOUSE,OBERLACK        (LBL,GLAS)IJP
METCALF  74 NP B76 253         W J METCALF,R L WALKER               (CIT)IJP
MOORHOUS 74 PRD 9 1            MCORHOUSE,OBERLACK,ROSENFELD    (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125         R L CRAWFORD                        (GLAS)IJP
DEANS    75 NP B96 90          +MITCHELL,MONTGCMERY,+       (SFLA,ALABAMA)IJP
LONGACRE 75 PL 55B 415         +ROSENFELD,LASINSKI,SMADJA+     (LBL,SLAC)IJP

BARBOUR  76 SBMTC. TO NP       I. M. BARBOUR,R. L. CRAWFCRD        (GLAS)IJP

                               PAPERS NOT REFERREC TO IN CATA CARDS.

HCHLER   63 NP 48 470          G HOHLER, G EBEL                 (KARLSRUHE) I
LAYSON   63 NC 27 724          W M LAYSON                           (CERN) IJ
AUVIL    64 NC 33 473          P AUVIL, C LOVELACE                  (LOIC)IJP
HELLAND  64 PR 134 B1062       +DEVLIN,HAGGE,LCNGO,MOYER,WOOD        (LRL) IJ
HOHLER   64 PL 12 149          G HOHLER, J GIESECKE             (KARLSRUHE) I
HOLLADAY 65 PR 139 B1348       W G HOLLADAY                    (VANDERBILT)
JOHNSCN  67 UCRL-17683 THESIS  C H JOHNSON                            (LRL)
DCNNACHI 69 NP 10B 433         A DCNNACHIE, R KIRSOPP             (GLAS+EDIN)
AYED     70 PL 31B 598         +BAREYRE+VILLET                      (SACLAY)
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Δ(1960) → — D_{35}

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        13  N*3/2(1960, JP=5/2-) I=3/2
            THIS EFFECT IS SEEN IN TWO CHANNELS.

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                 13  N*3/2(1960) MASS (MEV)

M   3      (1954.0)                DCNNACH1  68 RVUE   PHASE-SHIFT ANAL   6/68
M   3      (1970.)                 KIRSOPP   68 RVUE   PHASE SHIFT ANAL  10/69
M   X      (1950.0)     APPROX     LEA       69 CNTR   PI-P ELASTIC       8/69
M   X  SEE ALSC APLIN 70
M   3   WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1  10/69
M   7      (2200.)                 ALMEHED   72 IPWA                      2/72
M    1     (1960.)                 LANGBEIN  73 IPWA   PI N-K SIG,SOL 2   9/73
M    1  NOT SEEN IN SOLUTION 1 OF LANGBEIN73                              9/73
M          (1889.)                 AYED      74 IPWA                      2/74

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                 13  N*3/2(1960) WIDTH (MEV)

W   3      (311.00)                DCNNACH1  68 RVUE                      8/69
W   3      (400.)                  KIRSOPP   68 RVUE   PHASE SHIFT ANAL  10/69
W   7      (600.)                  ALMEHED   72 IPWA                      2/72
W    1     (150.)                  LANGBEIN  73 IPWA   PI N-K SIG,SOL 2   9/73
W          (121.)                  AYED      74 IPWA                      2/74
       SEE THE NOTES ACCOMPANYING MASSES QUOTED

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Baryons
Δ(1960), Δ(2160)

Data Card Listings
For notation, see key at front of Listings.

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                13  N*3/2(1960) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      N*3/2(1960) INTO PI N                                139+ 938
P2      N*3/2(1960) INTO K SIGMA                             493+1189

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                13  N*3/2(1960) BRANCHING RATIOS

R1      N*3/2(1960) INTO (PI N)/ TOTAL                    (P1)
R1  3          (.154)                DONNACHI  68 RVUE    PHASE SHIFT ANA. 10/69
R1  3          (.12)                 KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
R1  7         (0.25)                 ALMEHED   72 IPWA                      2/72
R1             (.081)                AYED      74 IPWA                      2/74

R2      N*3/2(1960) INTO (K SIGMA)/TOTAL                  (P2)
R2  1          (0.013)  (0.01)       FEUERBACH 70 RVUE    PI P TO K+ SIG+   7/70
R2  1      ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1      MODEL USED MAY DOUBLE COUNT.

R3      N*3/2(1960) FROM PI N TO K SIGMA                  SQRT(P1*P2)       9/73
R3   1         (.08)                 LANGBEIN  73 IPWA    PI N-K SIG,SOL 2  9/73
R3  2          (.018)TO  .035        DEANS     75 DPWA    PI N TO K SIGMA  11/75*
R3  2   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                           11/75*

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                13  N*3/2(1960) PHOTON DECAY AMPL(GEV**-1/2)

    FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
  REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*3/2(1960) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)             1/76*
A1            +.003     .016         CRAWFORD  75 DPWA    PI N PHOTO-PRCD  1/76*
A1            (-.085)                BARBOUR   76 DPWA    PI N PHOTO-PROD  1/76*

A2      N*3/2(1960) INTO GAM NUCLEON, HELICIYT=3/2 (GEV**-1/2)             1/76*
A2            -.010     .032         CRAWFCRD  75 DPWA    PI N PHOTO-PRCD  1/76*
A2            (+.066)                BARBOUR   76 DPWA    PI N PHOTO-PRCD  1/76*

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REFERENCES FOR N*3/2(1960)


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DONNACHI 68 PL 26B 161          A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
KIRSOPP  68 THESIS              R G KIRSOPP                          (EDIN)

LEA      69 PL 29B 584          LEA,OADES,WARD,COWAN,+  (RHEL,BRISTOL,DARE)
FEUERBAC 70 NP 16B 85           FEUERBACHER+HOLLADAY            (VANDERBILT)
ALMEHED  72 NP B40 157          +LOVELACE                       (LUND,RUTG)IJP

LANGBEIN 73 NP B53 251          LANGBEIN,WAGNER                    (MUNICH)IJP
AYED     74 PRIVATE COMMCTN.    AYED,BAREYRE                         (SACL)IJP
    ALSC 73 AIX CONFERENCE      AYED,BAREYRE                         (SACL)IJP

CRAWFORD 75 NP B97 125          R L CRAWFORD                         (GLAS)IJP
DEANS    75 NP B96 90           +MITCHELL,MONTGOMERY,+       (SFLA,ALABAMA)IJP

BARBOUR  76 SBMTD. TO NP        I. M. BARBOUR,R. L. CRAWFORD         (GLAS)IJP

                                PAPERS NOT REFERRED TO IN DATA CARDS.

DONNACHI 69 NP 10B 433          A DONNACHIE, R KIRSOPP         (GLAS+EDIN)
AYED     70 PL 31B 598          +BAREYRE+VILLET                    (SACLAY)
APLIN    71 NP B32 253          +COWAN,GIBSON,GILMORE++      (RHEL,BRISTOL)

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1950 MEV REGION – PRODUCTION AND σ_{TOTAL} EXP'TS

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                70  N*3/2(1950, JP=     ) I=3/2   PRODUCTION EXPERIMENTS


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                70  N*3/2(1950) MASS (MEV) (PROD. EXP.)

M           (1922.0)       APPROX      COOL       56 CNTR    PI+ P TOTAL       7/66
M           (1912.0)    (15.0)         BRISSON    61 CNTR    PI+ P TOTAL       7/66
M           (1900.0)     (9.0)         DEVLIN     65 CNTR    PI+ P TOTAL
M    N      (2080.0)    (12.0)         YOON       67 HBC  +  3 BEV/C PI-P      8/67
M    N       THIS BUMP IS NOT SEEN BY CHUNG 68 AT 3.2 GEV/C
M           (1860.0)                   COLTCN     72 HBC  ++ PP TO PI+PN 7GEV  1/73
M           (1895.)     (15.)          COLLEY     74 HBC  ++ K+P TO K+PPI+PI- 10/74*
M           (1890.)      5. TO 10.     BRAUN2     75  BC     PBAR P AND D,5.7 11/75*
M    C      (1881.)      (6.)          CHUNG      75 HBC  ++ PI+ P AND K+ P    1/76*
M    C    MOST PROBABLE JP ASSIGNMENT IS 7/2+.                                  1/76*
M           (1880.)     (10.)          GAIDOS     75 HBC  ++ PI+P TO N* 2PI    1/76*

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                70  N*3/2(1950) WIDTH (MEV) (PROD. EXP.)

W            (256.0)    (39.0)         DEVLIN     65 CNTR
W             (40.0)    (20.0)         YOON       67 HBC  +                    8/67
W            (180.0)                   COLTCN     72 HBC  ++ PP TO PI+PN 7GEV  1/73
W            (230.)     (50.)          COLLEY     74 HBC  ++ K+P TO K+PPI+PI- 10/74*
W            (120.)      10. TO 20.    BRAUN2     75  BC     PBAR P AND D,5.7 11/75*
W    C       (219.)     (23.)          CHUNG      75 HBC  ++ PI+ P AND K+ P    1/76*
W            (180.)     (30.)          GAIDOS     75 HBC  ++ PI+P TO N* 2PI    1/76*

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                7C  N*3/2(1950) PARTIAL DECAY MODES (PROD. EXP.)

                                                              DECAY MASSES
P1      N*3/2(1950) INTO PI N                                 139+ 938
P2      N*3/2(1950) INTO SIGMA K                             1189+ 493
P3      N*3/2(1950) INTO N*3/2(1232) PI                      1232+ 139
P4      N*3/2(1950) INTO Y*1(1385) K                         1384+ 493
P5      N*3/2(1950) INTO N*3/2(1232) RHO                     1232+ 773
P6      N*3/2(1950) INTO NEUTRON PI+ PI+                      939+ 139+ 139
P7      N*3/2(1950) INTO N*3/2(1232) PI PI (NOT RHO)         1232+ 139+ 139

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                70  N*3/2(1950) BRANCHING RATIOS (PROD. EXP.)

R1      N*3/2(1950) INTO (PI N)/TOTAL                        (P1)
R1            (0.57)    (0.12)         DEVLIN     65 CNTR

R2      N*3/2(1950) INTO (SIGMA K)/(PI N)                    (P2)/(P1)
R2             0.059     0.024         CHINOWSKY 68 HBC  ++ PP TO P SIG K     11/68

R3      N*3/2(1950) INTO N*3/2(1232) PI PI (NOT RHO)       (P7)
R3             SEEN                    CHINOWSKY 68 HBC  ++ PP TO (P 3PI) N  11/68
R3             SEEN                    BOGGILD   70  HBC    PP TC N3PI(NTRL)  6/70

R4      N 3/2(1950) INTO (PI N)/(N*3/2(1232) PI)           (P1)/(P3)
R4           (0.55) OR LESS            LEE       67 HBC     PI-P 3.63 BEV/C  11/67

R5      N*3/2(1950) INTO ((PI N)*(NEUTRON PI+ PI+))/TOTAL**2
R5                                                          (P1*P6)
R5             0.05      0.013         GALLOWAY  68 RVUE ++ PI+P TO N 2PI+     6/68

R6      N*3/2(1950) INTO (Y*1(1385) K)/(PI N)              (P4)/(P1)
R6             0.035     0.015         CHINOWSKY 68 HBC  ++ PP TO P LAM K PI 11/68

R7      N*3/2(1950) INTO (N*3/2(1232) RHO)/(PI N)          (P5)/(P1)
R7           (0.45)    APPROX          CHINOWSKY 68 HBC  ++ PP TO (P 3PI) N  11/68
R7      THIS INCLUDES CORRECTION FOR UNSEEN DECAY (ISPIN FACTOR 5/3).

R8      N*3/2(1950) INTO (N*3/2(1232) RHO)/TOTAL           (P5)
R8             SEEN                    YOON      67 HBC  +                    8/67
R8             NOT SEEN                BOGGILD   70  HBC    PP TO N3PI(NTRL)  6/70

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REFERENCES FOR N*3/2(1950) (PROD. EXP.)


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COOL     56 PR 103 1082         R COOL, O PICCIONI, D CLARK            (BNL) I
BRISSON  61 NC 19 210           +DETOEUF,FALK-VAIRANT,VAN ROSSUM,+ (SACLAY) I
DEVLIN   65 PRL 14 1031         T J DEVLIN,J SOLOMON,G BERTSCH  (PRINCETON) I
LEE      67 PR 159 1156         +MOEBS,ROE,SINCLAIR,VANDER VELDE      (MICH)
YOON     67 PL 24B 307          +BERENYI,KEY,PRENTICE, +      (TORONTO,WISC)

CHINOWSK 68 PR 171 1421         CHINOWSKY,CONDON,KINSEY,KLEIN,+  (LRL,SLAC)
CHUNG    68 PR 165 1491         S U CHUNG,DAHL,KIRZ,MILLER             (LRL)
GALLCWAY 68 PL 26B 334          K F GALLOWAY                      (INDIANA) I

BOGGILD  70 NP B16 503          +KOREA-AHO+JACOBSEN+ (BOHR+ HELS+OSLO+STOH)
COLTCN   72 PR D6 95            E COLTON, A KIRSCHBAUM                 (LBL)
COLLEY   74 NP B69 205          COLLEY,HUQ,JOBES,KINSON,MILNE,+ (BIRM+GLAS)I
BRAUN2   75 NP B95 503          +GERBER,MAURER,MICHALON,SCHIBY+ STBRB,LPNP I
CHUNG    75 PL 57B 384          +PROTOPOPESCU,EISNER+   (BNL+CASE+LBL+UCSC)IJP
    ALSO 75 PRD 12 693          CHUNG,PROTOPOPESCU,EISNER+  (BNL+CASE+UCSC)IJP
GAIDOS   75 PRD 12 2565         GAIDOS,MILLER                          (PURD)IJP

                                PAPERS NOT REFERRED TO IN DATA CARDS.

DEUTSCHM 75 NP B99 397          DEUTSCHMANN+(AACH+BONN+BERL+CERN+CRAC+HEID)

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Δ(2160) →

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                 9  N*3/2(2160,         ) I=3/2

               EARLY ANALYSES FOUND EVIDENCE FOR A RESONANCE
               NEAR THIS MASS IN THE P33 PARTIAL WAVE, AND UNLESS
               STATED OTHERWISE, ALL DATA CARDS BELOW APPLY TO THIS
               WAVE.  IN ADDITION, ROYCHOUDHURY 71 FIND POSSIBLE
     EVIDENCE FOR P31, D33, AND D35 RESONANCES IN THIS MASS REGION.  IN A
     SIMILAR ANALYSIS BRANSDEN 71 FOUND SOME EVIDENCE FOR S31, D33, AND D35
     RESONANCES IN THIS REGION.  VON SCHLIPPE 72 SUGGESTS A G39.
        THE MOST RECENT PI N ANALYSIS FINDS A G39 RESONANCE IN THIS MASS
     REGION.  THE EFFECT SEEN IN K SIG PROD. IS 100 MEV LOWER IN MASS.
        A PRONOUNCED SHARP DIP IS OBSERVED IN PI+ P BACKWARD SCATTERING AT
     2200 MEV BY REY 74.
        DUAL INTERFERENCE MODEL ANALYSIS OF MA 75 FINDS SIGNAL FOR P33,
     P31, AND D35, BUT NOT FOR G39.


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                 9  N*3/2(2160) MASS  (MEV)

M   3      (2160.)                       KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
M          (2120.)                       ROYCHOUD  71 DPWA                      3/72
M   7      (2150.)                       ALMEHED   72 IPWA                      2/72
M    1     (1980.)                       LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
M    1  NOT SEEN IN SOLUTION 2 OF LANGBEIN73                                    9/73
M   2      (2174.)                       AYED      74 IPWA                      2/74
M   2   AYED 74 RESULT IS A G39 RESONANCE.                                      2/74
M   4      (2196.)    (46.)     (41.)    REY       74 MPWA ++ PI+ P 180 DEG CS 10/74*
M   4   BAKER 74 AND REY 74 FIND NEGATIVE PARITY (SPIN UNDETERMINED).

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                 9  N*3/2(2160) WIDTH (MEV)

W   3      (260.)                        KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
W   7      (200.)                        ALMEHED   72 IPWA                      2/72
W    1     (190.)                        LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
W   2      (205.)                        AYED      74 IPWA                      2/74
W   4      (302.)     (143.)             REY       74 MPWA ++ PI+ P 180 DEG CS 10/74*
        SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                 9  N*3/2(216C) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      N*3/2(2160) INTO PI N                                139+ 938
P2      N*3/2(2160) INTO K SIGMA                             493+1189

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                 9  N*3/2(216C) BRANCHING RATICS

R1      N*3/2(2160) INTO (PI N)/TOTAL                     (P1)
R1  3         (.25)                      KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
R1  7        (0.3)                       ALMEHED   72 IPWA                      2/72
R1  2         (.045)                     AYED      74 IPWA                      2/74
R1  4   REY74 FINDS (J+1/2)X=.81+/-(.54/.39)                                   10/74*

R2      N*3/2(2160) FROM PI N TO K SIGMA                  SQRT(P1*P2)           9/73
R2   1        (.08)                      LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
R2  5         (.048)TO  .120             DEANS     75 DPWA    PI N TO K SIGMA  11/75*
R2  5   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                               11/75*

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REFERENCES FOR N*3/2(2160)


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KIRSOPP  68 THESIS              R G KIRSOPP                          (EDIN)
ROYCHOUD 71 NP B27 125          R K ROYCHOUDHURY,B H BRANSDEN        (DURH)IJP

ALMEHED  72 NP B40 157          +LOVELACE                       (LUND,RUTG)IJP
LANGBEIN 73 NP B53 251          LANGBEIN,WAGNER                    (MUNICH)IJP
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Data Card Listings
For notation, see key at front of Listings.

Baryons
Δ(2160), Δ(2420), Δ(2850)

AYED 74 PRIVATE COMMCTN. AYED,BAREYRE (SACL)IJP
ALSO 73 AIX CONFERENCE AYED,BAREYRE (SACL)IJP
REY 74 PRL 32 908 REY,LENNOX,POIRIER,PRETZL (NDAM+MPIM)IP
ALSO 74 PRL 33 250 REY,LENNOX,POIRIER,PRETZL (NDAM+MPIM)IP
ALSO 75 PRD 11 1777 LENNOX,POIRIER,REY,SANDER+ (NDAM+FNAL+ANL)IP
DEANS 75 NP 896 90 +MITCHELL,MONTGOMERY,+ (SFLA,ALABAMA)IJP

PAPERS NOT REFERRED TO IN DATA CARDS.

DONNACHI 69 NP 108 433 A DONNACHIE,R KIRSOPP (GLAS+EDIN)
BRANSDEN 71 NP 826 511 ,OGDEN (DURH)IJP
ALSO 70 NP 816 461 RCYCHOUDHURY,PERRIN,BRANSDEN (DURH)IJP
VON SCHL 72 LNC 4 767 VON SCHLIPPE (LOWC)IJP
BAKER 74 PRL 32 251 BAKER,EARTLY,PRETAL,PRLSS,+ (FNAL,ANL,NDAM)P
MA 75 PRD 11 1832 MA,SHAW (UCSB,SLAC)IJP

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Δ(2420)

84 N*3/2(2420, JP=11/2+) I=3/2 $H_{3\ 11}$

BOTH ROYCHOUDHURY 71 AND BRANSDEN 71 SEE A POSSIBLE RESONANT F35 IN THIS MASS REGION. IN ADDITION BRANSDEN 71 FIND A RESONANT P33 AT 2600 MEV.

84 N*3/2(2420) MASS (MEV)

M 6	(2312.0)		AYED	70	IPWA			1/71
M 6	FROM ENER. DEP. FIT OF ARGAND DIAGRAM							
M	(2400.)		BRANSDEN	71	CPWA			3/72
M	(2400.)		ROYCHOUD	71	CPWA			3/72
M	(2440.)		OTT	72	MPWA	0 PI-P BKWD ELSTC		2/73
M	(2392.)		AYED	74	IPWA			2/74
M 1	(2404.)	(63.)	REY	74	MPWA	++ PI+ P 180 DEG CS		10/74*

84 N*3/2(2420) WIDTH (MEV)

W 6	(347.0)		AYED	70	IPWA		1/71
W	(289.)		AYED	74	IPWA		2/74
W 1	(484.)	(75.)	REY	74	MPWA	++ PI+ P 180 DEG CS	10/74*

84 N*3/2(2420) PARTIAL DECAY MODES

		DECAY MASSES
P1	N*3/2(2420) INTO PI N	139+ 938
P2	N*3/2(2420) INTO SIGMA K	1197+ 493

84 N*3/2(2420) BRANCHING RATIOS

R1 N*3/2(2420) INTO (PI N)/TOTAL (P1)

R1 6	(0.113)			AYED	70	IPWA		1/71
R1 7	(.4)			OTT	72	MPWA	0 PI-P BKWD ELSTC	2/73
R1	(.109)			AYED	74	IPWA		2/74
R1 1	(.157)	(.070)	(.035)	REY	74	MPWA	++ PI+ P 180 DEG CS	10/74*

R1 1 REY 74 DETERMINES (J+1/2)X ONLY, WE HAVE DIVIDED BY 6. 10/74*

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REFERENCES FOR N*3/2(2420)

AYED 70 KIEV CONF R AYED,P BAREYRE, G VILLET (SACL)IJP

BRANSDEN 71 NP 826 511 ,OGDEN (DURH)IJP
ALSO 70 NP 816 461 ROYCHOUDHURY,PERRIN,BRANSDEN (DURH)IJP
ROYCHOUD 71 NP 827 125 R K ROYCHOUDHURY,B H BRANSDEN (DURH)IJP
OTT 72 PL 42B 133 +TRISCHUK,VAVRA,RICHARDS,+ (MCGI,STLO,IOWA)IJP
ALSO 72 MCGILL THESIS J. VAVRA (MCGI) JP
AYED 74 PRIVATE COMMCTN. AYED,BAREYRE (SACL)IJP
ALSO 73 AIX CONFERENCE AYED,BAREYRE (SACL)IJP
REY 74 PRL 32 908 REY,LENNOX,POIRIER,PRETZL (NDAM+MPIM)IP
ALSO 74 PRL 33 250 REY,LENNOX,POIRIER,PRETZL (NDAM+MPIM)IP
ALSO 75 PRD 11 1777 LENNOX,POIRIER,REY,SANDER+ (NDAM+FNAL+ANL)IP

PAPERS NOT REFERRED TO IN DATA CARDS.

BELLAMY 67 PRL 19 476 +BUCKLEY,DOBINSON, + (WESTFIELD,LOUC) JP

AYED 70 PL 31B 598 +BAREYRE+VILLET (SACLAY)

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2420 MEV REGION – PRODUCTION AND σ_{TOTAL} EXP'TS

69 N*3/2(2420, JP=) I=3/2 PRODUCTION EXPERIMENTS

69 N*3/2(2420) MASS (MEV) (PROD. EXP.)

M	(2360.0)		DIDDENS	63	CNTR	PI+ P TOTAL	
M	(2520.0)	(40.0)	ALVAREZ	64	CNTR	PI PHOTOPROD	7/66
M	(2440.0)		HOHLER	64	RVUE	DATA + DISP REL	
M	(2400.0)	APPROX	WAHLIG	64	OSPK	0 PI-P CH EX	
M B	(2452.0)		BARGER	66	RVUE	TOTAL + CH EX	11/67

M B USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
M B FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.

M	2423.0	10.0	CITRON	66	CNTR	PI+ P TOTAL	7/66

69 N*3/2(2420) WIDTH (MEV) (PROD. EXP.)

W	(200.0)		DIDDENS	63	CNTR		
W	(245.0)		HOHLER	64	RVUE		7/66
W B	(275.0)		BARGER	66	RVUE	TOTAL + CH EX	11/67
W	310.0	20.0	CITRON	66	CNTR		7/66

69 N*3/2(2420) PARTIAL DECAY MODES (PROD. EXP.)

		DECAY MASSES
P1	N*3/2(2420) INTO PI N	139+ 938
P2	N*3/2(2420) INTO SIGMA K	1197+ 493
P3	N*3/2(2420) INTO N*3/2(1232) PI	1232+ 139
P4	N*3/2(2420) INTO NEUTRON PI+ PI+	939+ 139+ 139

69 N*3/2(2420) BRANCHING RATIOS (PROD. EXP.)

R1 N*3/2(2420) INTO (PI N)/TOTAL (P1)

R1	(0.067)	APPROX	DIDDENS	63	CNTR	ASSUMING J=11/2	7/66
R1	0.113	0.0036	CITRON	66	CNTR	ASSUMING J=11/2	7/66
R1 B	(0.12)		BARGER	67	FIT	ASSUMING J=11/2	11/67
R1 D	(0.163)		DIKMEN	67	FIT	ASSUMING J=11/2	11/67

R1 D USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES

R1	(0.06)		KORMANYOS	67	CNTR	ASSUMING J=11/2	11/67

R2 N*3/2(2420) INTO (PI N)*(NEUTRON PI+ PI+)/(TOTAL**2)
R2 (P1*P4)

R2	0.0195	0.0048	GALLOWAY	68	RVUE	6/68

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REFERENCES FOR N*3/2(2420) (PROD. EXP.)

DIDDENS 63 PRL 10 262 +JENKINS, KYCIA, RILEY (BNL) I
ALVAREZ 64 PRL 12 710 +BAR-YAM,KERN,LUCKEY,OSBORNE, + (MIT,CEA)
HOHLER 64 PL 12 149 G HOHLER, J GIESECKE (KARLSRUHE) I
WAHLIG 64 PRL 13 103 +MANNELLI,SODICKSON,FACKLER,WARD, + (MIT)
BARGER 66 PR 151 1123 V BARGER, M OLSSON (WISC)
CITRON 66 PR 144 1101 +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, + (BNL) I

BARGER 67 PR 155 1792 V BARGER, D CLINE (WISC) P
DIKMEN 67 PRL 18 798 F N DIKMEN (MICH)
KORMANYO 67 PR 164 1661 KORMANYOS, KRISCH, OFALLON, + (MICH,ANL) P
GALLOWAY 68 PL 26B 334 K F GALLOWAY (INDIANA) I

PAPERS NOT REFERRED TO IN DATA CARDS.

BAACKE 67 NC 51A 761 J BAACKE, M YVERT (KARLSRUHE,ORSAY)J-L
DOBROWOL 67 PL 24B 203 DOBROWOLSKI,GUSKOV,LIKHACHEV, + (DUBNA) P
DOLEN 68 PR 166 1768 R DOLEN, D HORN, C SCHMID (CIT)
WAHLIG 68 PR 168 1515 M A WAHLIG, I MANNELLI (MIT,PISA)
FINAL VERSION OF DATA USED IN WAHLIG 64. IN CONJUNCTION WITH CITRON 66 TOTAL CROSS SECTIONS, THIS CHARGE EXCHANGE DATA GIVES COMPLEX ELASTIC SCATTERING AMPLITUDE AT 0 DEGREES.

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Δ(2850) BUMPS

85 N*3/2(2850, JP= +) I=3/2 PRODUCTION EXPERIMENTS

85 N*3/2(2850) MASS (MEV) (PROD. EXP.)

M	(2870.0)			HOHLER	64	RVUE	DATA + DISP REL	
M	(2700.0)	APPROX		WAHLIG	64	OSPK	0 PI-P CH EX	
M	(2850.0)			BARDADIN	66	HBC	++ N* TO P + 3 PIS	7/66
M	2850.0	12.0		CITRON	66	CNTR	PI+ P TOTAL	7/66
M	(2883.)	(26.)	(28.)	REY	74	MPWA	++ PI+ P 180 DEG CS	10/74*

85 N*3/2(2850) WIDTH (MEV) (PROD. EXP.)

W	(150.0)			BARDADIN	66	HBC	++	7/66
W	400.0	40.0		CITRON	66	CNTR		7/66
W	(380.)	(141.)	(201.)	REY	74	MPWA	++ PI+ P 180 DEG CS	10/74*

85 N*3/2(2850) PARTIAL DECAY MODES (PROD. EXP.)

		DECAY MASSES
P1	N*3/2(2850) INTO PI N	139+ 938
P2	N*3/2(2850) INTO P PI PI PI	938+ 139+ 139+ 139
P3	N*3/2(2850) INTO N PI PI	938+ 139+ 139

85 N*3/2(2850) BRANCHING RATIOS (PROD. EXP.)

R1 N*3/2(2850) INTO (PI N)/TOTAL (P1)
R1 ONLY (J+1/2)*(PI N/TOTAL) MEASURED FOR THIS STATE

R1 B	(0.224)	(0.016)		BARGER	66	RVUE	TOTAL + CH EXC.	11/67
R1	0.261	0.048		CITRON	66	CNTR	TOTAL CROSS.SEC.	11/67
R1 B	(0.40)			BARGER	67	RVUE	USES KORMANYOS66	11/67

R1 B USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
R1 B FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.

R1 C	(0.49)			DIKMEN	67	RVUE	USES KORMANYOS67	11/67

R1 C USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES

R1	(0.39)			DOBROWOLS	67	CNTR	PI+P AT 180 DEG	
R1	(0.10)			KORMANYOS	67	CNTR	PI-P AT 180 DEG.	11/67
R1 D	(0.06) OR LESS	CL=.95		HALDORSE	72	HBC	PP 19 GEV/C	12/72

R1 D UPPER LIMIT ON ELASTICITY.ALSO FIND J=9/2 OR MORE.

R1	(.28)	(.13)	(.19)	REY	74	MPWA	++ PI+ P 180 DEG CS	10/74*

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REFERENCES FOR N*3/2(2850) (PROD. EXP.)

HOHLER 64 PL 12 149 G HOHLER, J GIESECKE (KARLSRUHE) I
WAHLIG 64 PRL 13 103 +MANNELLI,SODICKSON,FACKLER,WARD, + (MIT)
BARDADIN 66 PL 21 357 BARDADIN-OTWINOWSKA,DANYSZ, + (WARSAW)
BARGER 66 PR 151 1123 V BARGER, M OLSSON (WISC)
CITRON 66 PR 144 1101 +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, + (BNL) I

BARGER 67 PR 155 1792 V BARGER, D CLINE (WISC) P
DIKMEN 67 PRL 18 798 F N DIKMEN (MICH)
DOBROWOL 67 PL 24B 203 DOBROWOLSKI,GUSKOV,LIKHACHEV, + (DUBNA) P
KORMANYO 67 PR 164 1661 KORMANYOS, KRISCH, OFALLON, + (MICH,ANL) P
HALDORSE 72 NC 10A 468 HALDORSEN,JACOBSEN (OSLO) IJ
REY 74 PRL 32 908 REY,LENNOX,POIRIER,PRETZL (NDAM+MPIM)IP
ALSO 74 PRL 33 250 REY,LENNOX,POIRIER,PRETZL (NDAM+MPIM)IP
ALSO 75 PRD 11 1777 LENNOX,POIRIER,REY,SANDER+ (NDAM+FNAL+ANL)IP

Baryons

Δ(2850), Δ(3230), EXOTIC NUCLEONS, Z*'s

Data Card Listings

For notation, see key at front of Listings.

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                              PAPERS NOT REFERRED TO IN DATA CARDS.

BAACKE    67 NC 51A 761       J BAACKE, M YVERT              (KARLSRUHE,ORSAY)J-L
DOLEN     68 PR 166 1768      R DOLEN, D HORN, C SCHMID                   (CIT)
WAHLIG    68 PR 168 1515      M A WAHLIG, I MANNELLI                 (MIT,PISA)
    FINAL VERSION OF DATA USED IN WAHLIG 64.  IN CONJUNCTION WITH
    CITRON 66 TOTAL CROSS SECTIONS, THIS CHARGE EXCHANGE DATA GIVES
    COMPLEX ELASTIC SCATTERING AMPLITUDE AT 0 DEGREES.

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Δ(3230) BUMPS

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          86  N*3/2(3230, JP=     ) I=3/2  PRODUCTION EXPERIMENTS

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             86  N*3/2(3230) MASS (MEV) (PRCD. EXP.)

M        (3230.0)                    CITRCN    66 CNTR    PI+ P TOTAL      7/66
M        (3296.)    (79.)     (78.)  REY       74 MPWA ++ PI+ P 180 DEG CS 10/74*

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             86  N*3/2(3230) WIDTH (MEV) (PROD. EXP.)

W         (440.0)                    CITRCN    66 CNTR                     7/66
W         (687.)  (1043.)    (323.)  REY       74 MPWA ++ PI+ P 180 DEG CS 10/74*

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             86  N*3/2(3230) PARTIAL CECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1     N*3/2(3230) INTC PI N                            139+ 938
P2     N*3/2(3230) INTO N PI PI                         938+ 139+ 139

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             86  N*3/2(3230) BRANCHING RATIOS

R1     N*3/2(3230) INTO (PI N)/TOTAL                        (P1)
R1    CNLY (J+1/2)*( PI N/TOTAL) MEASURED FOR THIS STATE
R1  B        (0.03)   (0.01)         BARGER    66 RVUE    TOTAL + CH EXC.  11/67
R1           (0.06)                  CITRON    66 CNTR    TOTAL CROS. SEC. 11/67
R1  B        (0.03)  TO  0.1         BARGER    67 CNTR    USES KORMANYOS66 11/67
R1  B  USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
R1  B  FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
R1  D        (0.25)                  DIKMEN    67 RVUE    USES KORMANYOS67 11/67
R1  C  USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES
R1            (.45)    (.09)    (.13) REY      74 MPWA ++ PI+ P 180 DEG CS 10/74*

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                              REFERENCES FOR N*3/2(3230) (PROD. EXP.)

BARGER    66 PR 151 1123      V BARGER, M CLSSON                     (WISC)
CITRON    66 PR 144 1101      +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, +  (BNL) I
BARGER    67 PR 155 1792      V BARGER, D CLINE                      (WISC) P
DIKMEN    67 PRL 18 798       F N DIKMEN                             (MICH)
REY       74 PRL 32 908       REY,LENNOX,POIRIER,PRETZL          (NDAM+MPIM)IP
    ALSO 74 PRL 33 250        REY,LENNOX,POIRIER,PRETZL          (NCAM+MPIM)IP
    ALSC 75 PRD 11 1777       LENNCX,POIRIER,REY,SANDER+    (NDAM+FNAL+ANL)IP

                              PAPERS NOT REFERRED TO IN DATA CARDS

KORMANYO 67 PR 164 1661       KORMANYCS, KRISCH, OFALLON, +     (MICH,ANL) P
DOLEN     68 PR 166 1768      R DOLEN, D HORN, C SCHMID                 (CIT)

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EXOTIC NUCLEONS – 1640 MEV REGION

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     THIS IS NOT A COMPLETE LIST. WE WILL TABULATE EXOTICS FROM NOW CN

                  EX(1640, JP=    ) I=5/2

              THIS IS NOT A COMPLETE LIST.  WE TABULATE
              ONLY FRCM 1970 CN.

              IN A MISSING MASS EXPERIMENT, PI+ P TO PI- X+++,
    BIRULEV 71 FIND NO EVIDENCE FOR EXOTIC (I=5/2) RESONANCES IN THE
    MASS INTERVAL 1.2 TO 2.2 GEV.

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                  EX(1640) MASS (MEV)

M   A   29 1627.      12.          PRICE      70 DBC  -- K-D AT 4.91GEV/C  3/71
M   A  FOUR S. D. EFFECT

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                  EX(1640) WIDTH (MEV)

W   B   29    30.   OR LESS  CL=.90  PRICE      70 CBC  -- PI-PI-N BUMP      3/71
W   B  CROSS SECTION 13.0+-3.9 MICROBARNS

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                  EX(1640) CROSS SECTION LIMITS (MICROBARN)

CS  B       40.    OR LESS         BANNER    70 OSPK +++ PI+P,1.9 GEV/C    7/70
CS  B    I=5/2 LIMIT GIVEN ABOVE IS FOR MASS RANGE 1540-1750 MEV

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                              REFERENCES FOR EX(1640)

BANNER    70 NP B15 205       +CHEZE,HAMEL,TEIGER,ZACCONE +      (SACLAY)
PRICE     70 PL 33B,533       +BERG,SALANT,WATERS,WEBSTER,WEINBERG (VAND)

                              PAPERS NOT REFERRED TO IN DATA CARDS

AMMANN    71 PL   34B 533     +CARMONY,GARFINKEL,GLTAY,MILLER,YEN  (PURD)
BIRULEV   71 SJNP 12  536     +VOVENKO,GUSKOV,DOBROVOLSKII,++      (JINR)
JOHNSCN   71 PL   34B 428     D JCHNSCN                             (ANL)

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Note on the S = +1 Baryon System

Models based on states of three quarks have been successful in the description of the spectrum and decay of the known baryon resonances. Three quarks cannot produce S = +1 baryon resonances (Z*'s), and this has probably been the primary motivation for the great amount of experimental effort that has gone into S = +1 baryon physics below ~ 2 GeV/c during the last several years. In addition, the S = +1 system offers an opportunity to study single and double pion production in a small number of rather distinct quasi-two-body channels ($K\Delta$, K^*N, and $K^*\Delta$). Recent developments in the field are summarized below.

I = 1 System

The most recent K^+p total cross-section data are from BNL (CARROLL 73; 0.41 to 1.06 GeV/c) and Arizona-Michigan (BOWEN 73; 0.57 to 1.16 GeV/c). Neither measurement exhibits the dip of approximately 1.5 mb at 0.7 GeV/c reported by BUGG 68 and BOWEN 70. Recent differential elastic cross-section measurements (including extensions and final results of previously reported results) have come from Glasgow-Bologna-Trieste (CAMERON 74; 0.13-0.76 GeV/c), Birmingham-RHEL (ADAMS 73; 0.43 to 0.94 GeV/c), Bristol-RHEL-Aarhus-Southampton (CHARLES 73; 0.7 to 1.9 GeV/c), Maryland-ANL (ABE 75; 0.86 to 2.12 GeV/c), Washington (ADAMS 75; 1.0-1.5 GeV/c at 180°), UCL-RHEL (BARBER 73; 1.37-2.26 GeV/c), Yale-BNL (PATTON 75; 1.7-3.0 GeV/c near 0° and 180°), and ANL (YUTA 74; 2.53, 2.76, and 3.20 GeV/c). Below 750 MeV/c (where the inelastic cross section is less than 0.1 mb), the total elastic cross sections from the first three above experiments also fail to exhibit the dip seen in earlier total cross-section experiments. Coulomb interference effects are observed by CAMERON 74 and ADAMS 73; both confirm the early conclusion of GOLDHABER 62 that the low energy S-wave interaction is repulsive. The most recent polarization measurements are those of Maryland-ANL-Northwestern-FNAL (BARNETT 73; 1.37-2.31 GeV/c) and Yale-BNL (PATTON 75; 1.7-3.0 GeV/c near 0° and 180°). Recent studies of pion production in K^+p interactions are those of CERN-Saclay (BERTHON 73; $KN\pi$, 1.21-1.69 GeV/c), CIT-UCLA (LOKEN 72; $KN\pi$ and $KN\pi\pi$, 1.37-2.17 GeV/c),

Data Card Listings

For notation, see key at front of Listings.

Baryons
Z*'s

France-Saclay-IC-Westfield (BRUNET 72 and LEWIS 73; KNπ, KNππ, and KNπππ, 2.11-2.72 GeV/c), and ANL (MUSGRAVE 75; KNπ, 2.53-3.20 GeV/c). The general conclusion is that most pion production is associated with Δ(1232) and/or K*(892) production, though other resonances are also produced at the higher energies. The I = 1 total and partial cross sections are shown as dashed lines in Fig. 1.

Five partial-wave analyses of K^+p elastic scattering have been carried out since 1973. CAMERON 74 performed an elastic energy-independent analysis of data at momenta up to 870 MeV/c, including their new high-statistics cross-section data below 755 MeV/c. S and P waves were kept up to 400 MeV/c with D waves being added at higher momenta, and solutions at different energies were linked by the shortest-path method, yielding a unique overall solution. An energy-dependent fit, with an effective-range parametrization for the S wave and a zero-effective-range scattering-length parametrization for P and D waves, was also performed and agreed well with the energy-independent analysis. The χ^2 per data point (χ^2/ND) was well below 1.0 at most momenta in both fits. Threshold parameters were extracted, the dominant threshold effect being a repulsive S wave. The energy-dependent ADAMS 73 analysis included data at momenta up to 1.5 GeV/c, but was aimed primarily at determining the amplitudes below 1.0 GeV/c. Below about 0.5 GeV/c a zero-effective-range scattering-length parametrization was used for S and P waves, with D and F waves set to zero; at higher energies the η and δ parameters of the S, P, D, and F waves were taken to be polynomials in c.m. momentum. Waves with $\ell \geq 4$ were set to the values calculated from two- and three-pion exchange by ALCOCK 73. The best χ^2 values obtained were about 2250 for 1600 degrees of freedom, of which an estimated 300 comes from inconsistent data. Two solutions were found; they are essentially identical below 1 GeV/c but differ significantly at higher energies. MARTIN 75 have performed an energy-dependent analysis of K^+p scattering up to 1.5 GeV/c as part of a simultaneous fit of I = 1 and I = 0 KN scattering. Below the inelastic threshold the inverse amplitudes for waves with $J \leq 5/2$ were parametrized as rational functions of the c.m. momentum which obeyed elastic unitarity and had correct elastic threshold behavior. To allow for inelasticity a (fitted) negative term was added to the imaginary part of the inverse amplitudes above the inelastic threshold. The F_{17}, G_{17}, and G_{19} waves were also kept, and set to the values calculated by ALCOCK 73. Two similar solutions were found with χ^2/ND = 1.1. ARNDT 74

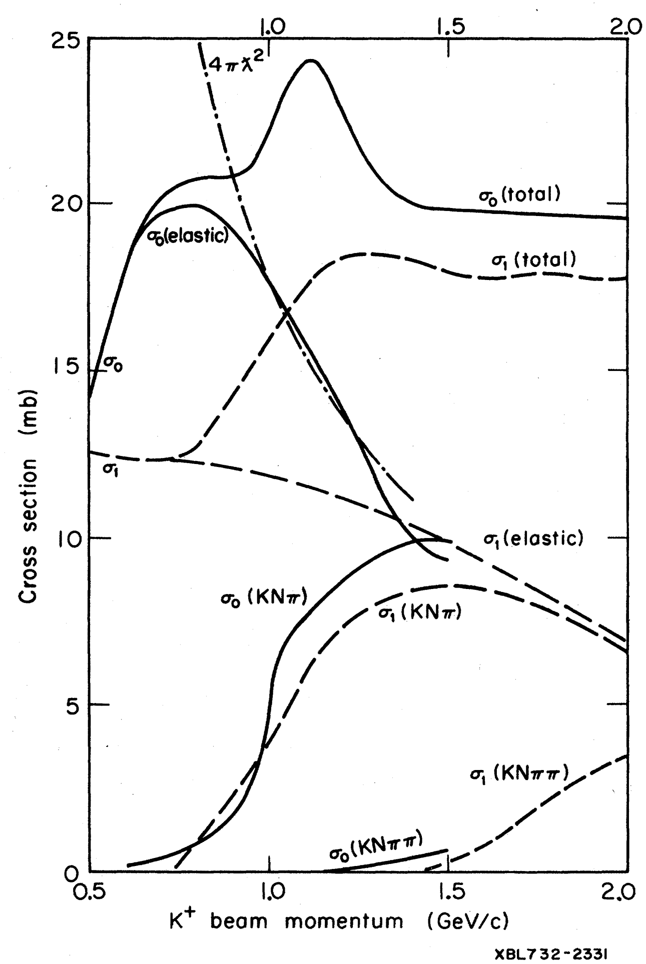
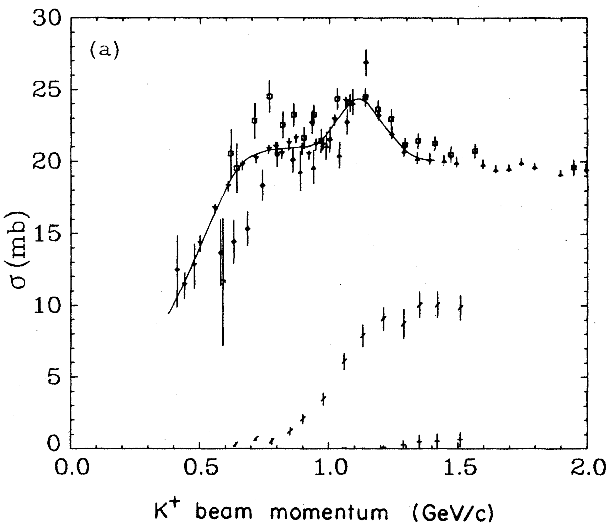


Fig. 1. KN total and partial cross sections. Subscripts indicate isospin; I = 1 (I = 0) cross sections are indicated by dashed (solid) curves. The total cross-section curves are from CARROLL 73, who use their recent data and that of BOWEN 73 as well as older data. The elastic I = 1 curve is hand drawn through new and old elastic data. The inelastic I = 1 curves are taken from LOKEN 72. The inelastic I = 0 curves are taken from GIACOMELLI 72, and the elastic I = 0 curve is obtained by subtracting these from the I = 0 total cross-section curve of CARROLL 73.

Baryons
Z^{*}'s

Data Card Listings
For notation, see key at front of Listings.

have analyzed data up to 2.0 GeV/c using an energy-dependent, two-channel K-matrix formalism in which the inelastic channel coupling to the S wave is taken to be K^*N, and that coupling to higher waves (with $\ell \leq 4$) is taken to be $K\Delta$. A unique solution



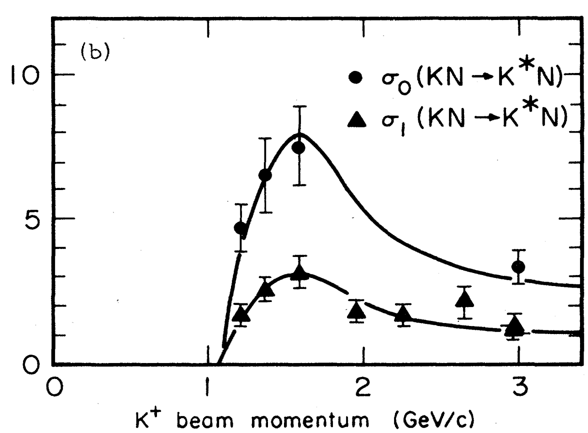


Fig. 2. (a) Unfolded I = 0 cross sections as quoted by the various authors discussed in this mini-review:
- ◊ BOWEN 73 σ_T
- □ BUGG 68 σ_T (as unfolded by CARROLL 73)
- ∇ CARROLL 73 σ_T
- Δ COOL 70 σ_T
- / GIACOMELLI 72 $\sigma(\pi KN)$
- \- GIACOMELLI 72 $\sigma(\pi\pi KN)$

(b) Energy dependence of the I = 0 and I = 1 cross sections for the reaction $KN \to K^*N$ (HIRATA 70).

with a χ^2 per degree of freedom (χ^2/DF) of 1.33 for 3822 data points was found, and it was possible to decrease this to 1.16 by dropping 70 data points with $\chi^2 > 8$ in the original fit. The parametrized P_{13} partial wave had a resonance pole at (1787 - 100i) MeV. The CUTKOSKY 76 analysis included data from 0.8 to 2.5 GeV/c. The ACE parametrization (see MILLER 72) was used along with contributions from P, ρ, A_2, Λ, Σ, and low mass di-pion exchange, the latter being based on the results of ALCOCK 73. An iterative fitting procedure was followed in which energy-independent fitting was alternated with energy smoothing using a parametrization based on partial-wave dispersion relations which included $K\Delta$, K^*N, and $K^*\Delta$ threshold effects for all waves with $J \leq 7/2$. Typical χ^2/DF values were 1.0 to 1.1.

The question of the existence of a Z_1^* in the elastic channel cannot yet be considered settled. The most likely candidate has long been considered to be the P_{13} wave around 1900 MeV. ARNDT 74 found such an effect, but the three other analyses described above which reached high enough energy to observe the effect (ADAMS 73, MARTIN 75, and CUTKOSKY 76) failed to do so. See KELLY 75 for a discussion of the experimental implications of this discrepancy.

Results of the analyses of ADAMS 73 and CUTKOSKY 76 are shown in Figs. 3 and 4. Solution 2 of ADAMS 73 is plotted below 1.0 GeV/c with errors[1] on real and imaginary parts ranging from 3% to 50% for the various waves. The data set used for the results plotted included a preliminary version of the CAMERON 74 data, and the results are similar to those of CAMERON 74. This solution also agrees qualitatively with CUTKOSKY 76 at higher energies; solution 1 disagrees. The results[2] of CUTKOSKY 76 are plotted from 0.8 to 2.5 GeV/c. These results are quantitatively quite different from those of MARTIN 75 and ARNDT 74.

Two multi-channel partial-wave analyses of the I = 1 KN, $K\Delta$, and K^*N channels at 1.21, 1.29, 1.38, and 1.69 GeV/c have been performed by LESQUOY 75. One analysis used a quasi-two-body approach, and the other the isobar model approach. It was not possible to draw any firm conclusions about the

K^*N channel or to discriminate between results of other analyses of the elastic channel alone. Results on the $K\Delta$ channel indicate four comparably large waves: SD_{11}, PP_{11}, PP_{13}, and either DD_{13} or DD_{15} depending on the method of analysis. This is in contrast to earlier analyses (e.g., GRIFFITH 72) which found this channel to be dominated by the PP_{13} wave over most of the 1.0 to 1.5 GeV/c region. BERTHON2 73 find (like GRIFFITH 72) no indication in the $K\Delta$ channel of rapid phase variation signaling possible resonant effects.

I = 0 System

The experiments of CARROLL 73 and BOWEN 73 (see above) measured K^+d total cross sections in the same energy ranges as their K^+p measurements. These experiments agree rather well with each other and with older data except that the CARROLL 73 cross sections are systematically higher than those of BOWEN 70 (0.36 to 0.72 GeV/c). Unfolded I = 0 cross sections, new and old, are shown in Fig. 2(a); the disagreement between CARROLL 73 and BOWEN 73 at low energies is primarily due to differences in the unfolding procedure. The I = 0 cross section unfolded from the newer K^+p and K^+d data rises to a plateau in the 0.7 to 0.9 GeV/c region and has a hump of about 3 mb in the 0.9 to 1.3 GeV/c region. Older data had indicated a hump of comparable size in the plateau region. As shown in Figs. 1 and 2(b), the plateau is associated with a broad peak in the elastic cross section, while the hump is associated with a rising K^*N cross section.

In a partial-wave analysis of the I = 0 elastic channel GIACOMELLI 74 fit data in the 0.38 to 1.51 GeV/c region, including the new K^+n differential cross-section data of the BGRT collaboration (GIACOMELLI 73; 0.64 to 1.51 GeV/c). Three types of partial-wave analysis (all with S, P, and D waves only) were used to analyze these data: an energy-dependent analysis (ED) using the parametrization of LEA 68 and I = 1 partial waves from previous solutions of GIACOMELLI 70, ALBROW 71, and LOVELACE 71; an energy-independent analysis (EI-1) which included K^+p data and determined both the I = 0 and I = 1 partial waves; and an energy-independent analysis (EI-2) in which the I = 1 partial waves were fixed at the values of ALBROW 71's solution γ. In analyses EI-1 and EI-2 several variants of the LOVELACE 71 shortest-path technique were used to link solutions at different energies. The solutions found by these different methods fell into three main families denoted A, C, and D, the best χ^2/ND values being 1.4-1.9, 1.6-1.7, and 1.5-1.8, respectively. Examples of each class from an ED analysis using the I = 1 partial waves of GIACOMELLI 70 are shown in Fig. 5. Some criteria for choice between these solutions are offered by comparison with particular features of the data. The single existing measurement of $K^+n \to K^0p$ polarization (RAY 69; 0.60 GeV/c) is consistent with classes C and D only. The I = 0 total cross sections of CARROLL 73 and BOWEN 73 were not included in the fitting, but comparison is made with CARROLL 73 and the data are found to be consistent with class D only. LONDON 74 has calculated $K_Lp \to K_Sp$ amplitudes by combining the best (i.e., lowest χ^2) energy-dependent solution from each of GIACOMELLI 74's classes with existing I = 1 KN and $\bar{K}N$ solutions and compared the results with $K_Lp \to K_Sp$ cross-section data. He finds that the class D solution is preferred. Similar calculations have been made more recently, and with much more regeneration data, by ALEXANDER 75 and CAMERON 75. The former favors class A, while the latter favors classes C and D but is unable to distinguish between them. No conclusive evidence for Z^*'s emerges from the analysis of GIACOMELLI 74; the most likely candidate is the class-D P_{01} wave, but GIACOMELLI 74 point out that the resonance interpretation is questionable for some of the class-D solutions and for all of the class-C solutions. A Breit-Wigner plus quadratic background fit to the class-D P_{01} wave yields the following parameters: M = 1740 MeV, Γ = 300 MeV, x = 0.85.

A more recent effort is the energy-dependent simultaneous I = 0 and I = 1 analysis of MARTIN 75, which makes use of the new K^+n elastic and charge-exchange data of DAMERELL 75. The parametrization used is described above. Two qualitatively similar solutions are found. Both are quite different from all the GIACOMELLI 74 solutions, but the P_{01} wave most resembles that of the class-C solution (see Fig. 5). MARTIN 75 find no significant evidence for resonance-like energy dependence.

Baryons
Z*'s

Data Card Listings
For notation, see key at front of Listings.

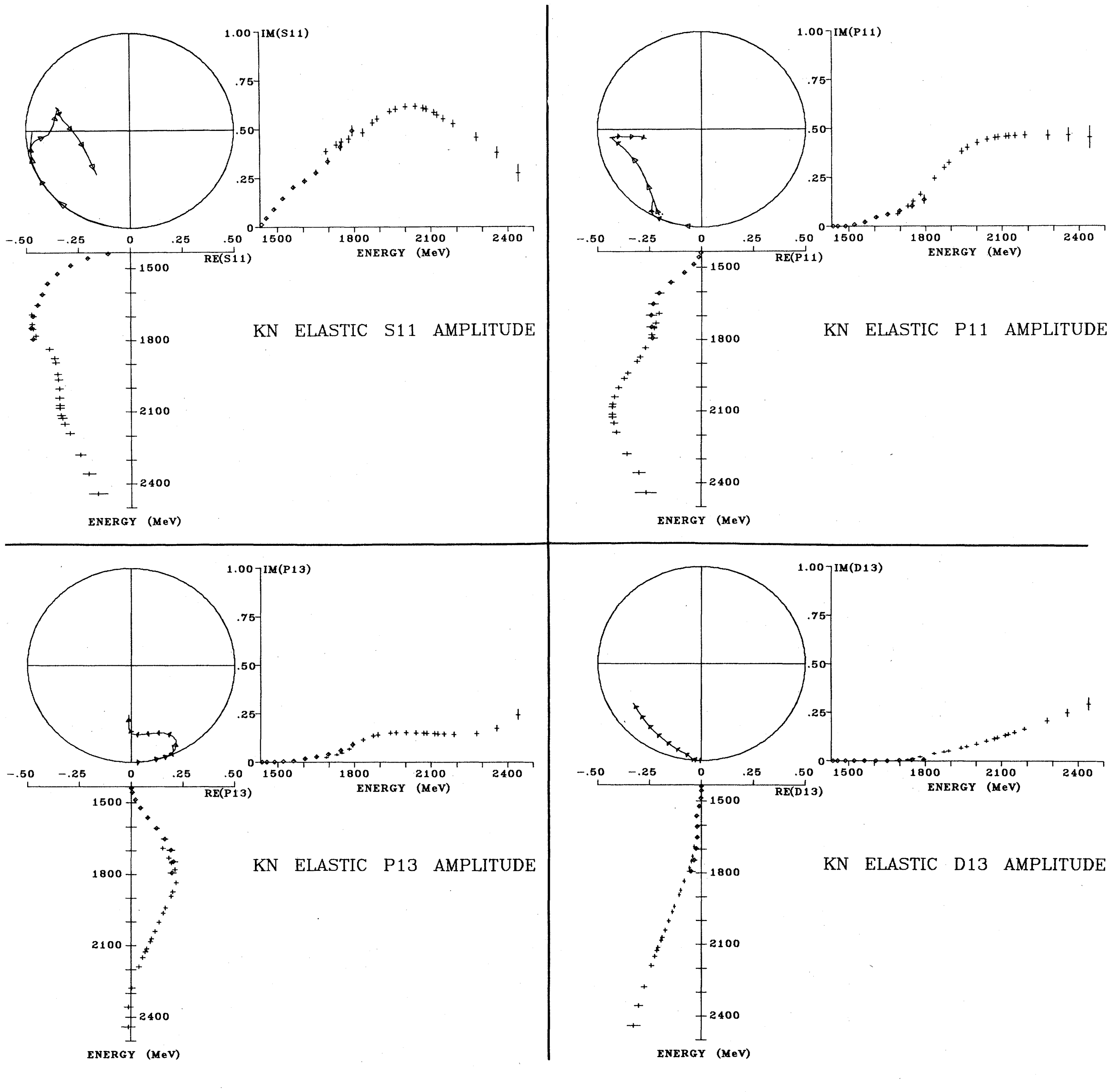


Fig. 3. Amplitudes for I = 1 KN elastic scattering in the J = 1/2 and J = 3/2 waves from ADAMS 73 (ϕ) and CUTKOSKY 76 (†). The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows are plotted on the Argand plots with bases positioned at integer multiples of 100 MeV and a base-to-tip length of 20 MeV. All the energy axes run from elastic threshold to 2500 MeV.

Data Card Listings

For notation, see key at front of Listings.

Baryons

Z^*'s

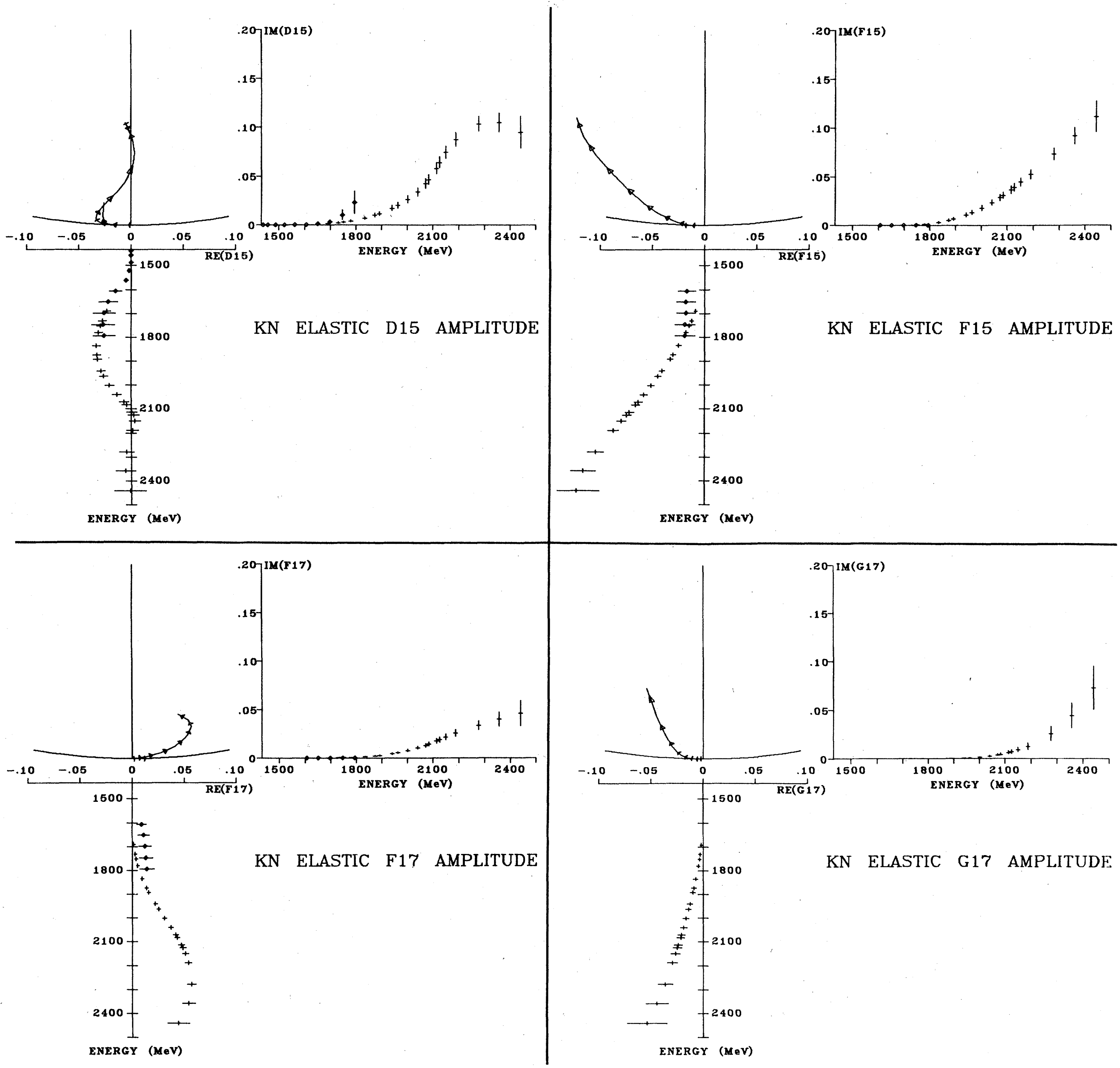


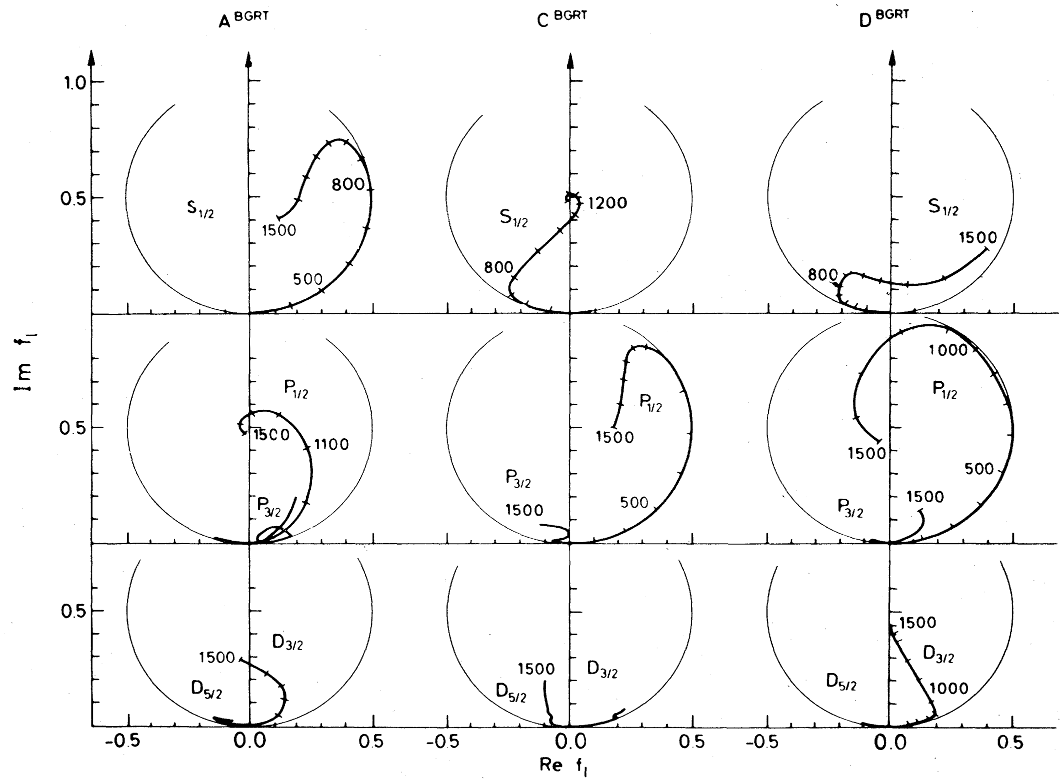
Fig. 4. Amplitudes for I = 1 KN elastic scattering in the J = 5/2 and J = 7/2 waves from ADAMS 73 (ϕ) and CUTKOSKY 76 (†). The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows are plotted on the Argand plots with bases positioned at integer multiples of 100 MeV and a base-to-tip length of 20 MeV. All the energy axes run from elastic threshold to 2500 MeV.

Baryons

Z*'s

Data Card Listings

For notation, see key at front of Listings.



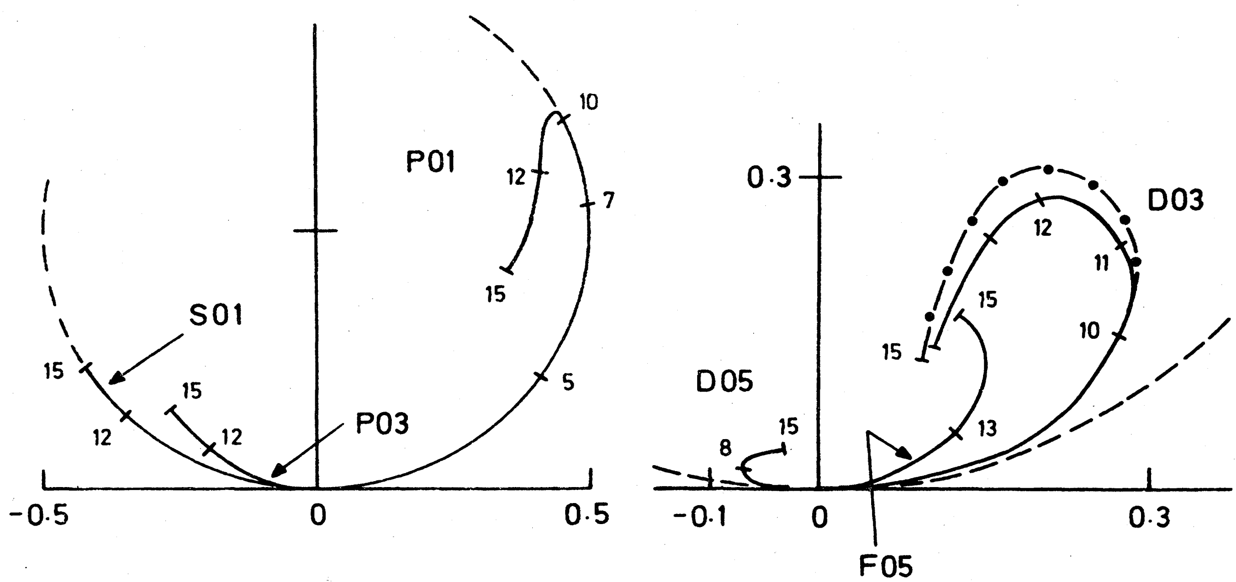


Fig. 5. Amplitudes for I = 0 KN elastic scattering from GIACOMELLI 74 (upper plots) and MARTIN 75 (lower plots). The GIACOMELLI 74 results are from the energy-dependent analysis and exemplify the three main classes of solutions found in the complete analysis; the energy dependence of the amplitudes is displayed by tick marks at integral multiples of 100 MeV. The MARTIN 75 results are from the preferred solution 2, with the solution-1 D_{03} wave (which exhibited the largest difference between solutions 1 and 2 of any wave) shown as a broken line for comparison; the energy dependence of the amplitudes is displayed by tick marks at the indicated integral multiples of 100 MeV.

Data Card Listings

For notation, see key at front of Listings.

Baryons

Z^{*}'s, $Z_0(1780)$, $Z_0(1865)$, $Z_1(1900)$

Production Experiments

There are no new developments in production experiments, and the observation of ERNE 70 that present upper limits for Z^* production are not small still holds. Cross-section limits for the production of broad Z^*'s are comparable to the observed N^* and Y^* production cross sections.

References

1. J. D. Dowell, private communication.

2. R. E. Cutkosky, private communication.

See the Data Card Listings for other references.

S=1 I=0 EXOTIC STATES (Z_0)

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$Z_0(1780)$ 95 Z*0(1780, JP=1/2+) I=0 **P_{01}**

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SEE THE MINI-REVIEW PRECEDING THIS LISTING.

WILSON 72 AND GIACOMELLI 74 FIND SOME SOLUTIONS
WITH RESONANT-LIKE BEHAVIOR IN THE P01 PARTIAL WAVE.
THE EFFECT SEEN IN THE I=0 TOTAL CROSS SECTIONS,
IF A RESONANCE, MUST HAVE SPIN=1/2, BECAUSE THE
INELASTIC CROSS SECTION IS VERY SMALL AND THE TOTAL
CROSS SECTION IS ABOUT 4*PI/K**2.

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                    95  Z*0(1780) MASS (MEV)

M           1780.0     10.0            COOL      70 CNTR +  K+P, D TOTAL      1/71
M    D      SEEN                       DOWELL    70 CNTR     K+P,D TOTAL      7/70
M    D      SEE ALSO DISCUSSION OF LYNCH 70                                   7/70
M    W     (1800.)                     WILSON    72 PWA     K+N P01 WAVE      3/72
M    W   ESTIMATE OF PARAMETERS FROM BW + QUADRATIC BACKGROUND FIT TO P01.    3/72
M     1    (1750.)                     CARROLL   73 CNTR    KN I=0 TCS,FIT 1  9/73
M     1    (1825.)                     CARROLL   73 CNTR    KN I=0 TCS,FIT 2  9/73
M     1  FIT 1=FIT OF SINGLE L=1 BW+BACKGROUND TO I=0 TCS FROM .4-1.1 GEV/C   9/73
M     1  FIT 2=FIT OF L=1 AND L=2 BWS TO SAME DATA,SEE Z0(1865) FOR L=2 PART  9/73
M          (1740.)                     GIACCMEL  74  PWA     .38-1.51 GEV/C   10/74*

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                    95  Z*C(1780) WIDTH (MEV)

W           (565.0)                    COOL      70 CNTR +  K+P, D TOTAL      1/71
W    W      (300.)                     WILSON    72 PWA     K+N P01 WAVE      3/72
W     1     (600.)                     CARROLL   73 CNTR    KN I=0 TCS,FIT 1  9/73
W     1     (845.)                     CARROLL   73 CNTR    KN I=0 TCS,FIT 2  9/73
W           (300.)                     GIACOMEL  74  PWA     .38-1.51 GEV/C   10/74*

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                    95  Z*0(1780) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      Z*0(1780) INTO K N                               493+ 939

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                    95  Z*0(1780) BRANCHING RATIOS

R1      Z*0(1780) INTO (K N)/TOTAL                     (P1)
R1          (0.95)                     COOL      70 CNTR +  K+P, D TOTAL      1/71
R1   W      (0.85)                     WILSON    72 PWA     K+N P01 WAVE      3/72
R1    1      (.75)                     CARROLL   73 CNTR    IF J=1/2,FIT 1    9/73
R1    1      (.91)                     CARROLL   73 CNTR    IF J=1/2,FIT 2    9/73
R1           (.85)                     GIACOMEL  74  PWA    .38-1.51 GEV/C    10/74*

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                       REFERENCES FOR Z*0(1780)

COOL      70 DUKE CONF 47      R L COOL                               (BNL)
     ALSO 69 PL 30B 564        ABRAMS,COOL,GIACOMELLI,KYCIA,LI +      (BNL)
     ALSC 70 PR D1 1887        COOL,GIACOMELLI,KYCIA,LEONTIC,LI +     (BNL)
DOWELL    70 DUKE 53           J.D. DOWELL                           (BIRM)
WILSON    72 NP B42 445        +GRIFFITHS,HIRATA +   (BGNA+GLAS+RCMA+TRST)
CARRCLL   73 PL 45B 531        +KYCIA,LI,MICHAEL,MOCKETT,RAHM+        (BNL)I
GIACCMEL  74 NP B71 138        GIACOMELLI,+            (BGNA+GLAS+ROMA+TRST)IJP

                       PAPERS NOT REFERRED TO IN DATA CARDS

LYNCH     70 DUKE 9            G LYNCH (REVIEWER OF CR.SEC. DATA)     (LRL)
HIRATA    71 NP B30 157        +GOLDHABER,HALL,SEEGER,THRILLING,WOHL  (LBL)IJP
BCWEN     73 PR D7 22          +JENKINS,KALBACH,PETERSEN +       (ARIZ+MICH)
JOHNSCN   74 PL 50B 343        JOHNSON,VLASSOPULOS               (CERN,DURH)
CAMERON   75 PALERMC CONF.     +CAPILUPPI+        (BGNA+EDIN+GLAS+PISA+RHEL)IJP

     EXPERIMENTS MAINLY ABOUT ELASTIC CHANNELS --
GOLDHABE 62 PRL 9 135          GOLDHABER,CHINOWSKY,GOLDHABER+    (LRL+UCLA)IJP
RAY      69 PR 183 1183        RAY,BURRIS,FISK,KRAEMER,HILL+     +CAPN+BNL
ARMITAGE 72  NAL PAPER 391     +ASTON,DUERDOTH,ELLISON,  +       (MCHS+DARE)
GIACOME1 72 NP B42 437         GIACGMELLI +            (BGNA+GLAS+RCMA+TRST)
GIACCMEL 73 NP B56 346         GIACOMELLI,+            (BGNA+GLAS+RCMA+TRST)
    ALSO 73 BGNA PPT. AE-73/4  GIACOMELLI,GRIFITHS,+  (BGNA+GLAS+ROMA+TRST)
LCNDCN   74 PRD 9 1569         LCNDCN                                 (BNL)IJP
ALEXANDE 75 PL 58B 484         ALEXANDER,BAR-NIR,BENARY+         (TELA+HEID)IJP
DAMERELL 75 NP B94 374         +HOTCHKISS,WICKENS,BENTLEY+       (RHEL,BIRM)

     EXPERIMENTS MAINLY ABOUT INELASTIC CHANNELS --
GIACOMEL 72 NP B37 577         GIACOMELLI +            (BGNA+GLAS+ROMA+TRST)

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$Z_0(1865)$ 96 Z*0(1865, JP=3/2-) I=0 **D_{03}**

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THIS EFFECT IS STRONGLY ASSOCIATED WITH THE K* N
THRESHOLD.  SEE HIRATA 68 AND 70.  WILSON 72 AND
GIACCMELLI2 73 REPORT PARTIAL WAVE ANALYSES.
AARCN 73 CLAIMS A RESONANCE IN A MODEL DEPENDENT
PWA.  SEE ALSO Z*0(1780).

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                    96  Z*0(1865) MASS (MEV)

M          (1860.0)   (15.0)           CARTER    67 THEO    DISPERSICN REL.   8/67
M          (1868.0)   (10.0)           COOL      70 CNTR    K+P, D TOTAL      8/67
M          (1830.)                     AARCN     73 MPWA    I=0 KN .6-1.6G/C  9/73
M     1    (1840.)                     CARROLL   73 CNTR    KN I=0 TCS,FIT 2  9/73
M     1  FIT2=FIT OF L=1 AND L=2 BWS TO I=0 TCS FROM .4-1.1 GEV/C.           9/73
M     1  SEE Z0(1780) FOR FIT 1 AND L=1 PART OF FIT 2.                       9/73

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                    96  Z*0(1865) WIDTH (MEV)

W          (200.0)    (50.0)           CARTER    67 THEO                      8/67
W          (160.0)    (30.0)           COOL      70 CNTR                      8/67
W          (100.)                      AARON     73 MPWA    I=0 KN .6-1.6G/C  9/73
W     1     (75.)                      CARRCLL   73 CNTR    KN I=0 TCS,FIT 2  9/73

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                    96  Z*0(1865) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      Z*0(1865) INTO K N                               493+ 939
P2      Z*0(1865) INTO N K*(892)                         938+ 892

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                    96  Z*C(1865) BRANCHING RATICS

R1      Z*0(1865) INTO (K N)/TOTAL                     (P1)
R1            (.155)    (.025)         CARTER    67 THEO    IF J=3/2          9/73
R1            (.115)    (.025)         COOL      70 CNTR    IF J=3/2          9/73
R1    1       (.085)                   CARROLL   73 CNTR    IF J=3/2,FIT 2    9/73

R2      Z*0(1865) INTO N K*(892)                       (P2)
R2             MAIN INELASTIC DECAY    HIRATA    68 HBC                      11/68

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                       REFERENCES FOR Z*0(1865)

CARTER    67 PRL 18 801        A A CARTER                       (CAVENDISH)
HIRATA    68 PRL 21 1485       HIRATA, WOHL, GOLDHABER, TRILLING      (LRL)
COOL      70 PR D1 1887        COOL,GIACCMELLI,KYCIA,LEONTIC,LI +     (BNL)
     ALSO 66 PRL 17 102        +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+  (BNL) I
     ALSC 69 PL 30B 564        ABRAMS,COOL,GIACOMELLI,KYCIA,LI +      (BNL)
AARON     73 PRD 7 1401        AARCN,RICH,HOGAN,SRIVASTAVA      (LASL+NEAS)IJP
CARROLL   73 PL 45B 531        +KYCIA,LI,MICHAEL,MOCKETT,RAHM+        (BNL)I

                       PAPERS NOT REFERRED TO IN CATA CARDS

HIRATA    70 DUKE   429        +GCLDHABER,SEEGER,TRILLING+WOHL        (LRL)
AARON     71 PRL 26 407        +AMADO+SILBAR               (NEAS,PENN,LASL)IJP
HIRATA-1  71 NP B33 445        +GOLDHABER,HALL,SEEGER,TRILLING,WOHL   (LBL)
GIACOMEL  72 NP B37 577        GIACOMELLI +            (BGNA+GLAS+ROMA+TRST)
WILSON    72 NP B42 445        +GRIFFITHS,HIRATA +     (BGNA+GLAS+ROMA+TRST)

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S=1 I=1 EXOTIC STATES (Z_1)

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$Z_1(1900)$ 97 Z*1(1900, JP=3/2+) I=1 **P_{13}**

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THIS EFFECT IS STRONGLY ASSOCIATED WITH THE K-DELTA
THRESHOLD.  SEE THE MINIREVIEW PRECEDING Z*0(1780)

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                    97  Z*1(1900) MASS (MEV)

M     1    (1932.0)                    AYED      70 IPWA    P13,SOL.I         6/70
M     1    (1899.0)                    AYED      70 IPWA    P13,SOL.II        6/70
M     1    (2030.0)                    AYED      70 IPWA    S11,SOL.III       6/70
M     1     THREE SOLNS IN ORDER OF DECREASING SIGNIFICANCE. THOUGH AYED 70
M     1     GIVE PARAMETERS,THEY CONCLUDE RESONANT INTERPRETATION DOUBTFUL.
M      2   (1830.)                     BARNETT   70 IPWA    P13,SCLN III      9/73
M     2     RESONANCE SIGNAL BARELY ABOVE BACKGROUND DUE TO THE LARGE ERRORS
M     2     IN THE AMPLITUDES RESULTING FROM THE ANALYSIS
M           1900.0     10.0            COOL   -- 70 CNTR ++ K+P TOTAL         1/71
M          (1880.)                     ALBROW    71 IPWA ++  SOL. GAMMA       10/71
M     K    (1890.)                     KATO      71 IPWA    SOL  I(FIT BW)    10/71
M     K    (2040.)                     KATO      71 IPWA    SOL II(FIT BW)    10/71
M     K  KATO 71 ESTIMATE RESONANCE PARAMETERS -- UPDATED PHASE SHIFTS        3/72
M     K  PUBLISHED IN MILLER 72.                                              3/72

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Baryons

$Z_1(1900)$, $Z_1(2150)$, $Z_1(2500)$

Data Card Listings

For notation, see key at front of Listings.

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                   97  Z*1(1900) WIDTH (MEV)

W    1      (520.0)                      AYED      70 IPWA     K+P               6/70
W    1      (397.0)                      AYED      70 IPWA     K+P               6/70
W    1      (557.0)                      AYEC      70 IPWA     K+P               6/70
W     2     (120.)                       BARNETT   70 IPWA     P13,SCLN III      9/73
W           (240.0)                      COOL      70 CNTR ++ K+- TOTAL          1/71
W           (190.)                       ALBRCW    71 IPWA ++ SOL. GAMMA        10/71
W    K      (280.)                       KATO      71 IPWA     SCL  I(FIT BW)   10/71
W    K      (260.)                       KATO      71 IPWA     SOL II(FIT BW)   10/71
       SEE THE NOTES ACCOMPANYING MASSES QUOTED.

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                   97  Z1*(1900) REAL PART OF PCLE PCSITION                      4/75*

REE        (1787.)                       ARNDT       74 DPWA     K+ P ELASTIC    4/75*

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                   97  Z1*(1900) IMAGINARY PART OF POLE POSITION                 4/75*

IME         (100.)                       ARNDT       74 DPWA     K+ P ELASTIC    4/75*

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                   97  Z*1(1900) PARTIAL DECAY MODES

                                                                DECAY MASSES
P1      Z*1(1900) INTO K N                                    493+ 938
P2      Z*1(19C0) INTO N*3/2(1232) K                          1232+ 493

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                   97  Z*1(1900) BRANCHING RATIOS

R1      Z*1(1900) INTO (K N)/TCTAL                          (P1)
R1            (0.10) OR LESS             CARTER    67 THEO     DISPERSION REL.   8/67
R1   1        (0.16)                     AYED      70 IPWA                       6/70
R1   1        (0.20)                     AYED      70 IPWA                       6/70
R1   1        (0.17)                     AYED      70 IPWA                       6/70
R1    2        (.12)                     BARNETT   70 IPWA     P13,SCLN III      9/73
R1            (0.12) (ASSUMING J=3/2)    COOL      70 CNTR ++ K+P TOTAL          1/71
R1            (0.15)                     ALBROW    71 IPWA ++ SOL. GAMMA        10/71
R1   K        (0.22)                     KATO      71 IPWA     SCL  I(FIT BW)   10/71
R1   K        (0.27)                     KATO      71 IPWA     SOL II(FIT BW)   10/71

        SEE NOTES ACCOMPANYING THE MASSES QUOTED.

R2      Z*1(19C0) INTO K N*3/2(1232)                        (P2)
R2               MAIN INELASTIC DECAY    BLAND     67 HBC   ++                   8/67
R2       NO EVIDENCE, SPEED HAS MINIM. GRIFFITHS 72 HBC      K+P .9-1.5 GEV/C    3/72

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                               REFERENCES FOR Z*1(1900)

BLAND     67 PRL 18 1077        +BOWLER,BRCWN,G+S GOLCHABER,SEEGER,+  (LRL)
CARTER    67 PRL 18 801         A A CARTER                      (CAVENDISH)

AYED      70 PL 32B 404         +BAREYRE, FELTESSE, VILLET          (SACLAY)IJP
BARNETT   70 U MD,RPT 70-101    BARNETT,GOLDMAN,LAASANEN,STEINBERG     (UMD)IJP
   ALSO 70 DUKE 443             BARNETT,GOLDMAN,LAASANEN,STEINBERG     (UMD)IJP
COOL      70 PR D1 1887         +GIACOMELLI, KYCIA, LEONTIC, LI, +     (BNL) I
   ALSO 66 PRL 17 102           COOL,GIACOMELLI,KYCIA,LEONTIC,LI +     (BNL)

ALBROW    71 NP  B30 273        +ANDERSON,ALMEHED,...,UDO,WAGNER      (CERN)IJP
   ALSO 70 DUKE  375            ERNE,SENS,WAGNER                      (CERN)IJP
KATO      71 H.E.PHEN.,MORIOND +KOEHLER,...,YOKOSAWA+BURLESON   (ANL,NWES)IJP
   ALSO 70 DUKE 367             A. YOKOSAWA                            (ANL)IJP
   ALSO 70 PRL 24 615           KATC,KOEHLER,NOVEY,YOKOSAWA+      (ANL,NWES)IJP

GRIFFITH 72 NP B38 365          +HIRATA,HUGHES +       (BGNA+GLAS+ROMA+TRST)
MILLER    72 NP B37 401         +NOVEY,YOKOSAWA,CUTKOSKY +  (ANL+CARN+NWES)IJP

ARNDT     74 PRL 33 987         ARNDT,HACKMAN,ROPER,STEINBERG       (VPI,UMD)IJP

                               PAPERS NOT REFFERED TO IN Z*1 DATA CARDS

     TOTAL-CROSS-SECTION EXPERIMENTS ---
BUGG      68 PR 168 1466        +GILMORE,KNIGHT, +           (RHEL,BIRM,CAVE) I
BOWEN     70 PR D2 2599         +CALDWELL, DIKMEN, JENKINS, KALBACH,+(ARIZ) I
BCWEN     73 PR D7 22           +JENKINS,KALBACH,PETERSEN +       (ARIZ+MICH)
CARROLL   73 PL 45B 531         +KYCIA,LI,MICHAEL,MOCKETT,RAHM+         (BNL)

     A K-MATRIX ANALYSIS OF SOME OF THE EARLY K+P DATA ---
HITE      67 THESIS             G E HITE                            (ILLINOIS)

     THEORETICAL AND MCDEL DEPENDENT ANALYSES
CARRERAS 70 NP B19 349          B CARRERAS, A DCNNACHIE   (DARESBURY, MCHS)
ALCOCK    73 NP B56 301         ALCOCK,COTTINGHAM                      (BRIS)IJP

     EXPERIMENTS MAINLY ABCUT INELASTIC CHANNELS ---
BLAND     68 UCRL-18131 THESIS R W BLAND                                (LRL)
BLAND     69 NP B13 595         +BOWLER, BROWN, KADYK, GOLDHABER, +     (LRL)
BLAND     70 NP B18 537         +BOWLER, BRCWN, GOLDHABER,              (LRL)
   BLAND 69 AND BLAND 70 REPLACE BLAND 67 AND BLAND 68.
HIRATA-1 71 NP B33 445          +GOLDHABER,HALL,SEEGER,TRILLING,WOHL  (LBL)
BRUNET    72 NP B37 114         BRUNET,NARJOUX,DANYSZ+(CDEF+SACL+LOIC+LOWC)
GRIFFITH 72 NP B38 365          +HIRATA,HUGHES,JACOBS+(BGNA,GLAS,ROMA,TRST)IJP
LCKEN     72 PR D6 2346         +BARISH,GCMEZ,DAVIES,SCHLEIN,+    (CIT,UCLA)
BERTHCN   73 NP B63 54          BERTHON,MCNTANET,PAUL,SAETRE+    (CERN+SACL)
LEWIS     73 NP B60 283         LEWIS,ALLEN,JACOBS,DANYSZ+ (LOWC+LOIC+CDEF)
LESQUOY   75 NP B99 346         +MULLER,TRIANTIS,BERTHON+        (SACL+CERN)IJP
MUSGRAVE 75 NP B87 365          +PEETERS,SCREINER,WHITMORE,YUTA         (ANL)

     THE MAIN ELASTIC SCATTERING AND POLARIZATION EXPERIMENTS --
CARROLL   68 PRL 21 1282        +FISCHER, LUNDBY, PHILLIPS, +     (BNL,ROCH)
ANDERS-1 69 PL 28B 611          ANDERSSCN, DAUM, ERNE, LAGNAUX, +    (CERN)
ANDERS-2 69 PL 30B 56           ANDERSSON, DAUM, EPNE, LAGNAUX, +    (CERN)
ASBURY    69 PRL 23 194         +DOWELL, KATO, LUNDQUIST, NOVEY, +(ANL,UMD)
BLAND     69 PL 29B 618         R W BLAND, G GCLDHABER, G H TRILLING  (LRL)
BARBER    70 PL 32B 214         +BROOME, DUFF, HEYMANN, IMRIE,+ (LOUC,RHEL)IJP
GIACCMEL 70 NP B20 301          GIACOMELLI, GRIFFITHS,(BGNA,GLAS,ROMA,TRST)IJP
HALL      70 DUKE   435         +BLAND,GOLDHABER,TRILLING               (LRL)
REBKA     70 PRL 24 160         +ROTHBERG, ETKINS, GLODIS, +           (YALE)IJP
ADAMS     71 PR  D4 2637        +DAVIES,DOWELL,GRAYER,HATTERS+  (BIRM+RHEL)
BARNETT   71 PL 34B 655         +LAASANEN,STEINBERG  +  (UMD+ANL+NWES+FNAL)
EHRLICH   71 PRL 26 925         +ETKIN,GLODIS,HUGHES,KONDO,LU,MORI+  (YALE)
WHITMORE 71 PR D3 1092          +ABRAMS,EISENSTEIN,KIM,CHALLORAN,+      (ILL)
ADAMS     72  NAL PAPER 326     +COX,DAVIES,DOWELL,GRAYER +       (BIRM+RHEL)
CHARLES   72 PL 40B 289         +COWAN,ECWARDS,GIBSON,+      (BRIS,RHEL,SHMP)
   ALSO 72  NAL PAPER 287       CHARLES,COWAN,ECWARDS +      (BRIS+RHEL+SHMP)
DANYSZ    72 NP B42 29          +PENNEY,STEWART,THOMPSON,+ (LOIC,CDEF,LOWC)
ADAMS     73 NP B66 36          ADAMS,COX,DAVIES,DOWELL,+        (BIRM+RHEL)IJP
BARBER    73 NP B61 125         BARBER,BRCCME,BUSZA,DAVIES,DUFF+(LOUC+RHEL)
BARNETT   73 PRD 8 2751         BARNETT,LAASANEN+        (UMD+ANL+NWES+FNAL)
CHARLES   73 PURDUE CONF. 179  CHARLES,EDWARDS,+      (SHMP+AARH+RHEL+BRIS)
CAMERCN   74 NP B78 93          CAMERON,HIRATA,JENNINGS,+  (GLAS,BGNA,TRST)IJP
YUTA      74 NP B81 189         YUTA,BOCK,MUSGRAVE,PEETERS,SCHREINER,+(ANL)I
ABE       75 PRD 11 1719        +BARNETT,GOLDMAN,LAASANEN+          (UMD,ANL)
ADAMS     75 NP B87 41          +CARTER,COOK,GLASS,GREEN                (WASH)
PATTON    75 PRL 34 975         +BARLETTA,EHRLICH,ETKIN+      (YALE,TOKY,BNL)

     PARTIAL-WAVE ANALYSES (SEE ALSC ADAMS 73 ANC CAMERCN 74)
CARRERA1 70 NP B23 525          B CARRERAS, A DONNACHIE                (DARE)IJP
   ALSO 70 DUKE 447             +DCNNACHIE,KIRSOPP           (DARE+MCHS+EDIN)
ERNE      7C DUKE 375           +SENS,WAGNER                           (CERN)IJP
LEA       71 NP  B26 413        +MARTIN,THOMPSON                  (RHEL,LOUC)IJP
LOVELACE 71 NP  B28 141         +WAGNER                                (CERN)IJP
CUTKOSKY 72  NAL PAPER 210      +HICKS,KELLY,SHIH,JOHNSON    (CARN+ILL+ANL)
EHRLICH   72  NAL PAPER 447     +ETKIN,GLODIS,HUGHES,LU,PATTON +       (YALE)
MARTIN    72  PREPRINT          B.R.MARTIN, C.E.MILLER                 (LOUC)
MARTIN    75 NP B94 413         B R MARTIN                             (LOUC)
CUTKOSKY 76 NP B102 139         CUTKOSKY,HICKS,KELLY,+        (CARN+IIT+ANL)IJP

     EARLIER ANALYSES THAT CO NOT INCLUDE RECENT POLARIZATION DATA --
LEA       68 PR 165 1770        LEA, MARTIN, OADES             (RHEL,BNL,CERN)
MARTIN    68 PRL 21 1286        B R MARTIN                              (BNL)
CUTKCSKY 70 PR D1 2547          R E CUTKOSKY, B B DEO      (CARNEGIE-MELLCN) I

     LATEST REVIEW TALKS AND PAPERS
LEVISETT 69 LUND CCNF 341       R LEVI SETTI  (RAPPORTEUR)          (CHICAGO)
GOLDHABE 70 DUKE   407          G.GOLDHABER (REVIEWER)                  (LRL)
DOWELL    72  NAL REVIEW        REVIEW TALK IN BARYON SESSION          (BIRM)
LOVELACE 72  NAL REVIEW         RAPPORTEUR'S TALK                      (RUTG)
DOWELL    73 PURDUE CONF. 157  DCWELL                                  (BIRM)
CUTKOSKY 74 LONDON CONF II-54 CUTKOSKY                                 (CARN)
KELLY     75 ANL-HEP-CP-75-58  REVIEW TALK IN BARYON SESSION            (LBL)
URBAN     75 PL 60B 77          URBAN                                   (LBL)

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$Z_1(2150)$ BUMPS →

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93  Z*1(2150, JP=     ) I=1

A SMALL BUMP IN TOTAL CROSS SECTION AT
PK=1.8 GEV/C

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                   93  Z*1(2150) MASS (MEV)

M          2150.        20.              ABRAMS     70 CNTR ++ K+P TOTAL        10/71

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                   93  Z*1(2150) WIDTH (MEV)

W          (175.)                        ABRAMS     70 CNTR +  K+P TOTAL        10/71

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                   93  Z*1(215C) PARTIAL DECAY MODES

                                                                DECAY MASSES
P1      Z*1(2150) INTO K N                                    493+ 938

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                   93  Z*1(2150) BRANCHING RATICS

R1      Z*1(2150) INTO (K N)/TOTAL                       (P1)
R1        J IS NOT KNOWN, THE FOLLOWING IS (J+1/2)*P1
R1              (0.04)                   ABRAMS     70 CNTR +  K+P TOTAL        10/71

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                               REFERENCES FCR Z*1(2150)

ABRAMS    70 PR  D1 1917        +COOL,GIACCMELLI,KYCIA,LEONTIC,LI +   (BNL)
   ALSO 67 PRL 19 257           ABRAMS,COOL,GIACOMELLI,KYCIA,LEONTIC+ (BNL)

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$Z_1(2500)$ BUMPS →

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94  Z*1(250C, JP=     ) I=1

A SMALL BUMP IN TOTAL CROSS SECTICN AT
PK=2.7 GEV/C

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                   94  Z*1(2500) MASS (MEV)

M          2500.        20.              ABRAMS     70 CNTR ++ K+P TOTAL        10/71

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                   94  Z*1(2500) WIDTH (MEV)

W          (160.)                        ABRAMS     70 CNTR ++ K+P TOTAL        10/71

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                   94  Z*1(2500) PARTIAL CECAY MODES

                                                                DECAY MASSES
P1      Z*1(2500) INTO K N                                    493+ 938

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                   94  Z*1(2500) BRANCHING RATIOS

R1      Z*1(2500) INTO (K N)/TOTAL                       (P1)
R1        J IS NOT KNOWN, THE FOLLOWING IS (J+1/2)*P1
R1              (0.03)                   ABRAMS     70 CNTR ++ K+P TOTAL        10/71

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                               REFERENCES FCR Z*1(2500)

ABRAMS    70 PR  D1 1917        +COOL,GIACOMELLI,KYCIA,LEONTIC,LI +   (BNL)
   ALSO 67 PRL 19 257           ABRAMS,COOL,GIACOMELLI,KYCIA,LEONTIC+ (BNL)

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Data Card Listings
For notation, see key at front of Listings.

Z_1 CROSS SECTION LIMITS

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      SEE MINIREVIEW PRECEDING Z*0

CS  UNITS MICROBARNS
CS          LESS THAN  50.                BASSOMPIE 68 HBC    K+P TO Z*+ PI+   10/69
CS  A LESS THAN .2      +.3       -.1    ANDERSON  69 ASPK +  PI-P TO K-Z*+    10/69
CS  A       ABOVE LIMIT FOR  M=1.2 TO 1.4 GEV -  CL= 99 P.C.
CS  B LESS THAN 1.4    +1.9       -.5    ANDERSON  69 ASPK +  PI-P TO K-Z*+    10/69
CS  B       ABOVE LIMIT FOR  M=1.5 TO 2.5 GEV

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                            REFERENCES FOR Z*1 CROSS SECTION LIMITS

BASSOMPI 68 PL 27B 468      BASSOMPIERRE, +              (CERN,BRUXELLES)
ANDERSON 69 PL 29B 136      +BLESER, BLIEDEN, COLLINS, + (BNL,CARNEGIE)

                            PAPERS NOT REFERRED TO IN DATA CARDS

TYSON    67 PRL 19 255      +GREENBERG,HUGHES,LU,MINEHART,MORI,  (YALE)
MORI     68 PL 28B 152      +GREENBERG,HUGHES,LU,ROTHBERG, +     (YALE)
MORI     69 PR 185 1687     +GREENBERG, HUGHES, LU, MINEHART, +  (YALE)
    MORI 69 REPLACES TYSON 67 AND MORI 68.

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Note on Λ's and Σ's

The number of confirmed Y^* states has not increased greatly in the last few years, although there has been a larger increase in the number of proposed, but unconfirmed, possible new resonances. Since our last edition (1974) we have made only one addition to the Y^* portion of the Baryon Table, the Λ(1860), but have entered four new states into the Data Card Listings, and encountered several further indications that some of the states we list may really be more than one resonance. New high-statistics experiments are needed to clarify the situation.

Just as the recently discovered N^*'s are only weakly coupled to the $\pi N \to \pi N$ reaction, so also are the recently proposed Y^*'s only weakly coupled to the $\bar{K}N \to \bar{K}N$, $\bar{K}N \to \Lambda\pi$, and $\bar{K}N \to \Sigma\pi$ reactions. For this reason the newer Y^*'s are more difficult to uncover; in invariant mass distributions they usually appear as small peaks or make no appearance at all. Rather, when the 2-body reactions are partial-wave analyzed, some of the amplitudes are found to traverse resonance-like counterclockwise circles. The results of partial-wave analysis give J^P information, whereas a peak seen in an invariant mass distribution or a total cross section often cannot be analyzed for its quantum numbers. We will keep information coming from formation experiments and from production experiments separate whenever necessary.

Formation Experiments

Partial-wave analyses have been performed on $\bar{K}N$, $\Lambda\pi$, $\Sigma\pi$, ΞK, and $\Lambda\omega$, plus some quasi-two-body channels. Given the present accuracy of the data it is not possible to perform a completely energy-independent analysis, that is, solve for the partial-wave amplitudes at each energy in a model-independent way.

For the great majority of the analyses done so far, the energy range covered was rather limited, corresponding usually to a single bubble chamber experiment. A disturbing feature that appears when examining the partial waves obtained in a particular analysis is that they do not join smoothly with the partial waves given in analyses done for the same channel in a different energy range. One way to avoid this lack of continuity is to analyze the data in as large an energy range as possible. This has been done by six analyses which are described below and three of which are illustrated in Figs. 1-11. See the Data Card Listings for information on other analyses covering limited energy ranges.

Four of the analyses described below (RLIC 76, LEA 73, LANGBEIN 72, and KIM 71) have attempted a multi-channel approach using data on the three 2-body reactions $\bar{K}N$, $\Lambda\pi$, and $\Sigma\pi$, with a fictitious channel sometimes being introduced to account for the global effect of the remaining final states. The latter have large cross sections, so the present multi-channel analyses do not really impose any more stringent unitarity constraints than those already contained in the single-channel fits. However, there is an advantage in the determination of resonance parameters (masses, widths, and branching fractions) since they are fit simultaneously to data in all three channels. The other two analyses (BAILLON 75 and VAN HORN 75) deal only with the $\Lambda\pi$ channel which is, in principle, the easiest to handle as only one isospin has to be considered and both the differential cross section and baryon polarization are measured simultaneously in bubble chamber experiments. These two analyses cover the mass range 1540-2200 MeV and make use of the Legendre polynomial expansion of the angular distributions.

Baryons
Λ's and Σ's

Data Card Listings
For notation, see key at front of Listings.

a) The most recent analysis is the work done by the Rutherford Laboratory-Imperial College collaboration, RLIC 76. Here the $\bar{K}N$, $\Sigma\pi$, and $\Lambda\pi$ channels have been considered in the mass range 1480-2170 MeV. It is a conventional energy-dependent analysis, the presence of a resonance in a partial wave being detected by comparing the goodness of the fit when this wave is parametrized as a smooth background to the alternative fit when a Breit-Wigner is added to the background. The data used have been carefully selected in order to eliminate inconsistencies (usually the older and statistically less accurate points have been rejected). Angular distributions were directly used in the fit except when the quality of the data was such that no loss of information occurred by using Legendre coefficients (e.g., $K^-p \to \Sigma^0\pi^0$). Internal consistency is introduced by requiring that the mass and width of the resonances be the same for each of the three channels; a "weighted average" of the three values has been done when necessary and used as a fixed parameter in the final fit. Argand diagrams from the final solution are given in Figs. 1-11. Some suspected resonances are confirmed by this analysis, but many other reported "resonant effects" are not found and new possible resonances are proposed. The situation, in particular for the low partial waves, is still very confused even for masses as low as $\sim$ 1600 MeV.

b) The most recent $\Lambda\pi$ analysis, BAILLON 75, is a semi-energy-independent analysis. The D_{15} and F_{17} partial waves were constrained to lie near the well known $D_{15}(1765)$ and $F_{17}(2030)$ resonances, with their generally accepted parameters, in the energy region where they are important. This constraint was found necessary in order to reduce the number of possible solutions and to fix the arbitrary phase. The latter is undetermined, as in all the inelastic channels, and if unconstrained would make it difficult to join amplitudes at neighboring energies. Above a mass of 1750 MeV only one solution is found. Below this mass, two possible solutions are proposed; one of them (solution 1) has a much greater number of "new resonant structures" and is somewhat preferred on the basis of the behavior of the S and P waves for very low masses (around 1580 MeV). Using the method of Barrelet-zeroes[1,2] it is found that only these 2 solutions are possible if resonances are required to exist in the D_{15} and F_{17} waves. To extract the resonance parameters, the amplitudes were fitted to a combination of Breit-Wigner's plus background. The parameters corresponding to both solutions are given in the data cards, and Argand diagrams are shown in Figs. 1-6.

c) VAN HORN 75 has done an energy-dependent fit of the $\Lambda\pi$ channel. In addition to the best fit, VAN HORN 75 also presents all the other ambiguous solutions that can be generated by the method of Barrelet-zeroes. Among the "ambiguous" solutions, seven of them are found to preserve the established resonances $D_{13}(1670)$, $D_{15}(1765)$, $F_{15}(1915)$, and $F_{17}(2030)$, but with couplings to the $\Lambda\pi$ channel which are sometimes very different from their generally accepted values (cf., BAILLON 75). Also, new resonant structures appear in all the waves, particularly in the lower spins. This analysis is instructive in so far as indicating that there could be an entire constellation of other possible resonances beyond those which appear at the primitive stage of the analysis. However, one should keep in mind that these possible resonances do not necessarily correspond to a simple or even plausible parametrization of the amplitudes. (The values we have listed on the data cards correspond to the average of the 20 best original fits of this analysis, all containing the established, plus a few probable, resonances).

d) The analysis of LEA 73 is a multi-channel energy-dependent partial-wave analysis with parametrized K-matrix elements. The momentum range covered is 440 to 1190 MeV/c, and 99 parameters were used in the fit. Established resonances were constrained to have parameters near their generally accepted values, taken from a previous edition of these tables (for this reason we do not list the results of LEA 73 for these resonances in the following data cards). New resonances are identified using poles of the K-matrix. The procedure used to get the resonance parameters is not described, the values of the fitted K-matrix elements are not given, and no explicit comparison of the results with alternative parametrizations is made.

e) LANGBEIN 72 performed single-energy fits at 40 momenta between 436 and 1226 MeV/c. This work is the nearest approximation to an energy-independent partial-wave analysis existing for the S=-1 system. The partial waves corresponding to established resonances were, however, constrained to have Breit-Wigner forms. Approximately 90 acceptable single-energy fits per energy were generated and were used in shortest-path searches. Several candidates for acceptable shortest paths were generated and a preferred path was chosen by rejecting those that failed to reproduce known resonance behavior. Resonances in this solution were identified by loops in Argand diagrams correlated with peaks in the ≥3-body final-state cross section. Resonance parameters were then extracted by fitting Breit-Wigner's with both multiplicative and additive background. A disturbing characteristic of this work is that the amplitudes which were not specifically chosen to be resonant (sometimes even those, as in the case $D_{15}(1765) \to \Lambda\pi$) show an erratic behavior which cannot be justified simply by the fluctuation of the data.

f) KIM 71 fit data from threshold to 1226 MeV/c using the Ross and Shaw[3] effective-range expansion of the inverse multi-channel K-matrix. The data in each of seven energy intervals bounded by 0, 534, 658, 806, 916, 1022, 1117, and 1226 MeV/c, were fit with a constant effective-range matrix. Only the $F_{15}(1915)$ was fixed to a Breit-Wigner form, all other waves included being parametrized by the K-matrix formalism. Resonances were identified by a method involving the appearance of loops in the Argand diagram, peaks in the speed plot, and poles of the K-matrix, the exact procedure not being reported.

None of the three older multi-channel fits above extend beyond a mass of 1.9 GeV (the highest-energy data from the only high-statistics experiment existing before 1971, ARMENTEROS 68). These analyses do not join smoothly with either older (LITCHFIELD 71) or more recent (HEMINGWAY 75) partial-wave analyses at higher energies. The three more recent analyses extend to 2.2 GeV, and for masses higher than 2.2 GeV, the only existing work is an energy-dependent analysis of the $\Lambda\pi$ and $\Sigma\pi$ channels for momenta between 1.93 and 2.5 GeV/c by the Saclay-College de France collaboration (BELLEFON1 75 and BELLEFON 76).

Production Experiments

This type of experiment is often difficult to analyze. Information on I=0 states is possible only when there is no I=1 state at a similar mass. The main controversies at the present time concern resonances in the 1600 to 1700 MeV region. See the mini-reviews on Σ(1620) and Σ(1670) in these Listings.

Figures

Argand plots of 15 S=-1 partial waves are shown in Figs. 1-11. The analyses shown were picked largely for illustrative purposes rather than on the basis of our judgment of their quality; as discussed above there are a number of analyses extant and no clear choice of the "best" ones is possible.

Errors on Masses and Widths

Often the quoted errors in partial-wave analyses are only statistical, and the values of masses and widths can change by more than these errors when a new parametrization is used. For this reason we report the values of M, Γ, and x_i obtained by different authors even if they analyze the same data. The spread of these masses and widths is certainly a better estimate of the uncertainties than the statistical errors. Sometimes the errors quoted are obtained by the inspection of various fits done with different hypotheses (see, for example, BERTHON 70, GALTIERI 70, VAN HORN 75, RLIC 76). For three states, Λ(1520), Λ(1815), and Σ(1765), there are enough data available perform an overall fit of the various x_i of the type discussed in the main text (Sec. VII B). In this case we are forced to use the errors, however small they may be, but we warn the reader that the final errors are not to be taken seriously.

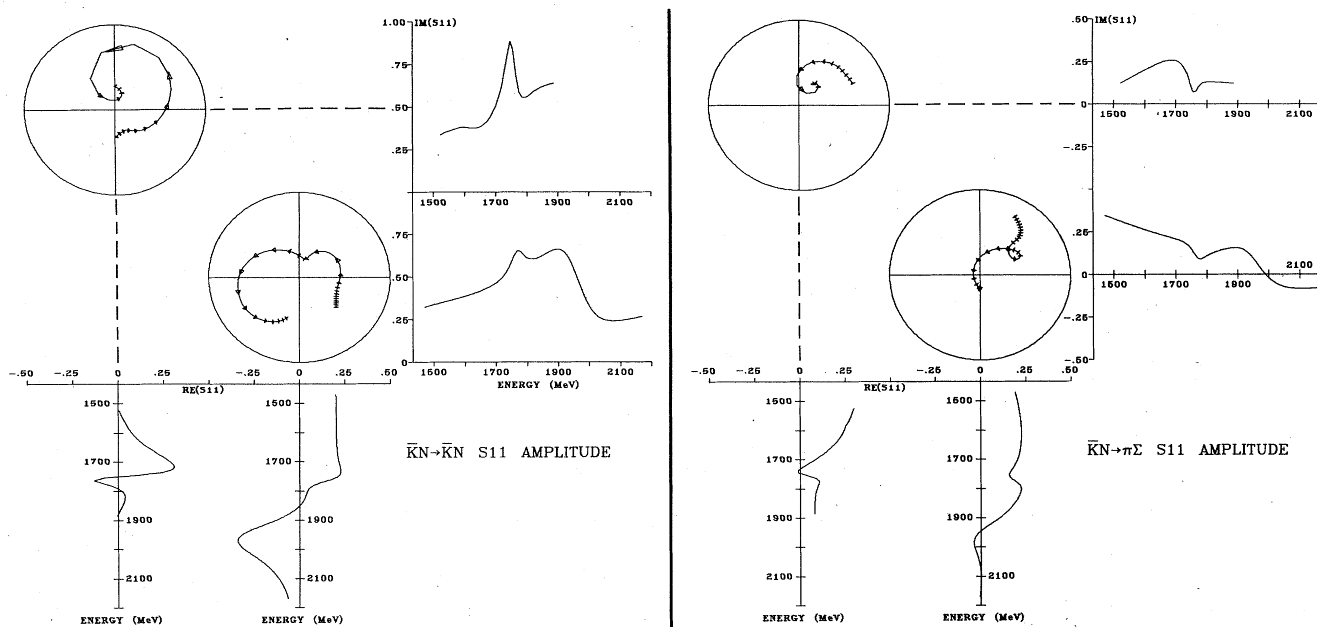
In conclusion, in the Baryon Table we choose not to give errors on masses and total widths determined primarily by partial-wave analyses, but, whenever necessary, to show a range of values. As for the branching ratios, we use the errors when needed to perform an overall fit, but we caution the reader.

Baryons

Λ's and Σ's

Data Card Listings

For notation, see key at front of Listings.



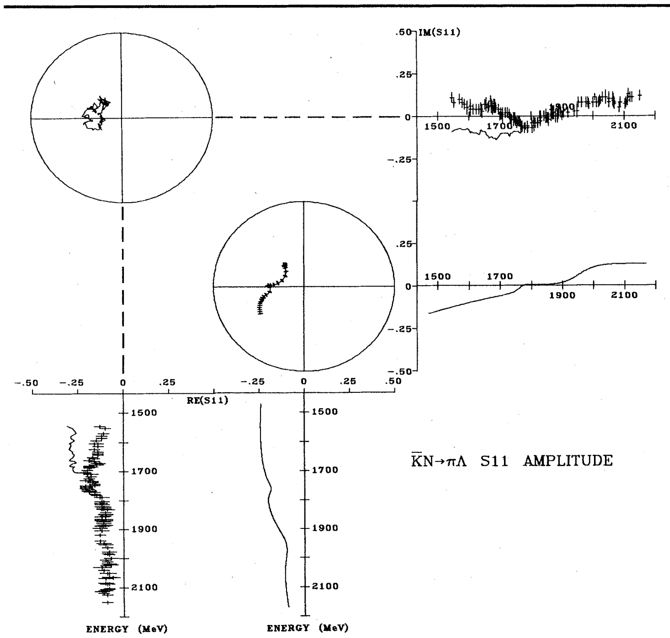


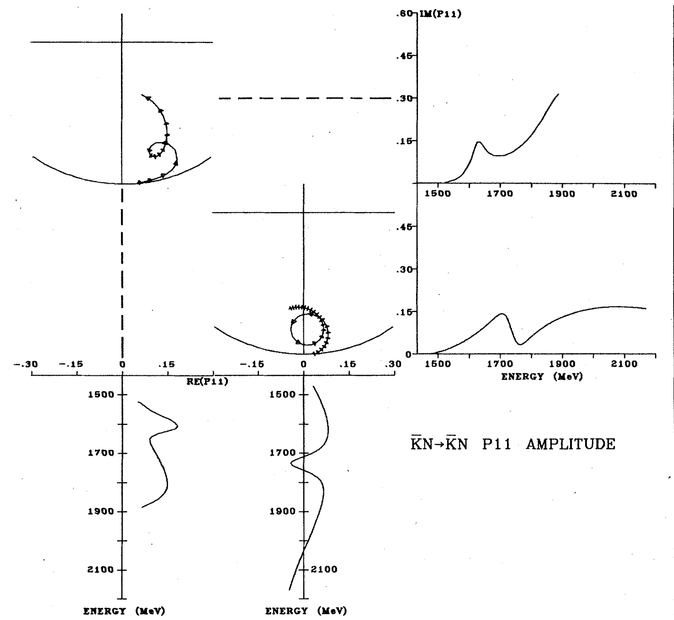
Fig. 1. Amplitudes for $\bar{K}N$ scattering in the S_{11} partial wave. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots except that of BAILLON 75. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each channel is from RLIC 76. The upper plot is from LEA 73 for the elastic and $\pi\Sigma$ channels, and from BAILLON 75 for the $\pi\Lambda$ channel. The Argand plot and the real-and-imaginary-part data with error bars for BAILLON 75 are from their solution 1; below 1770 MeV the real and imaginary parts of their solution 2 are also shown as a solid line. The only established resonance in this wave is the $\Sigma(1750)$; see the Data Card Listings for other possible resonances in the S_{11} wave.

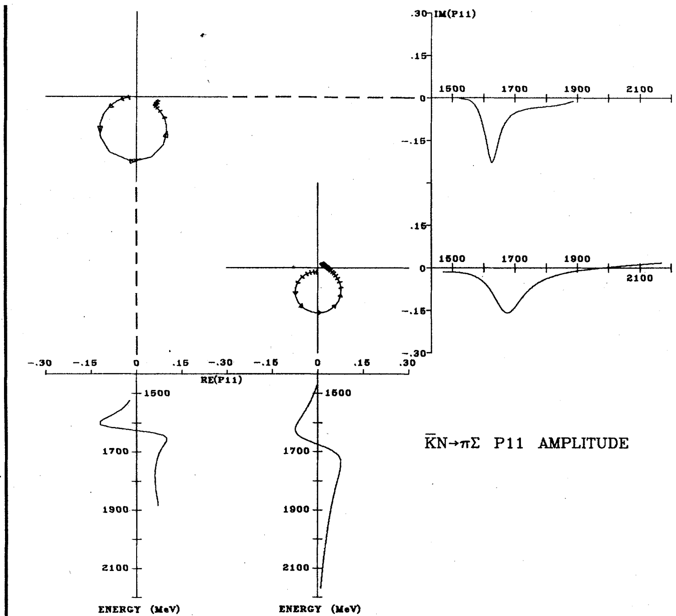
Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ's and Σ's





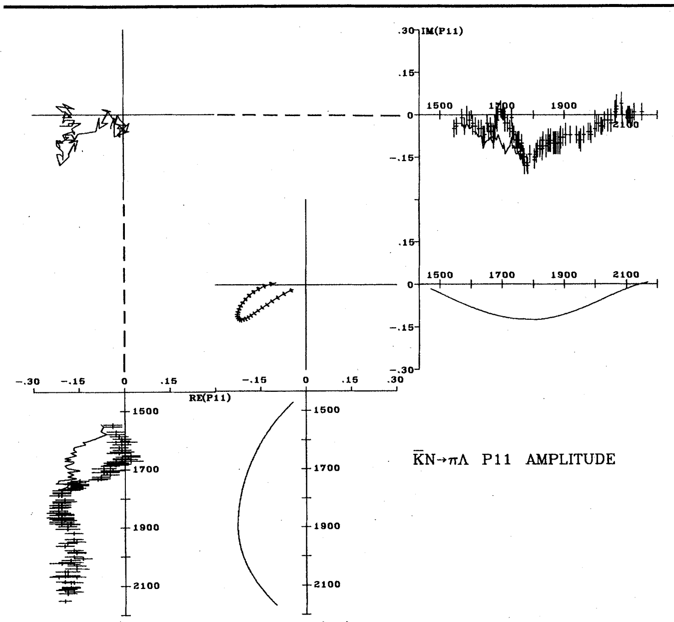


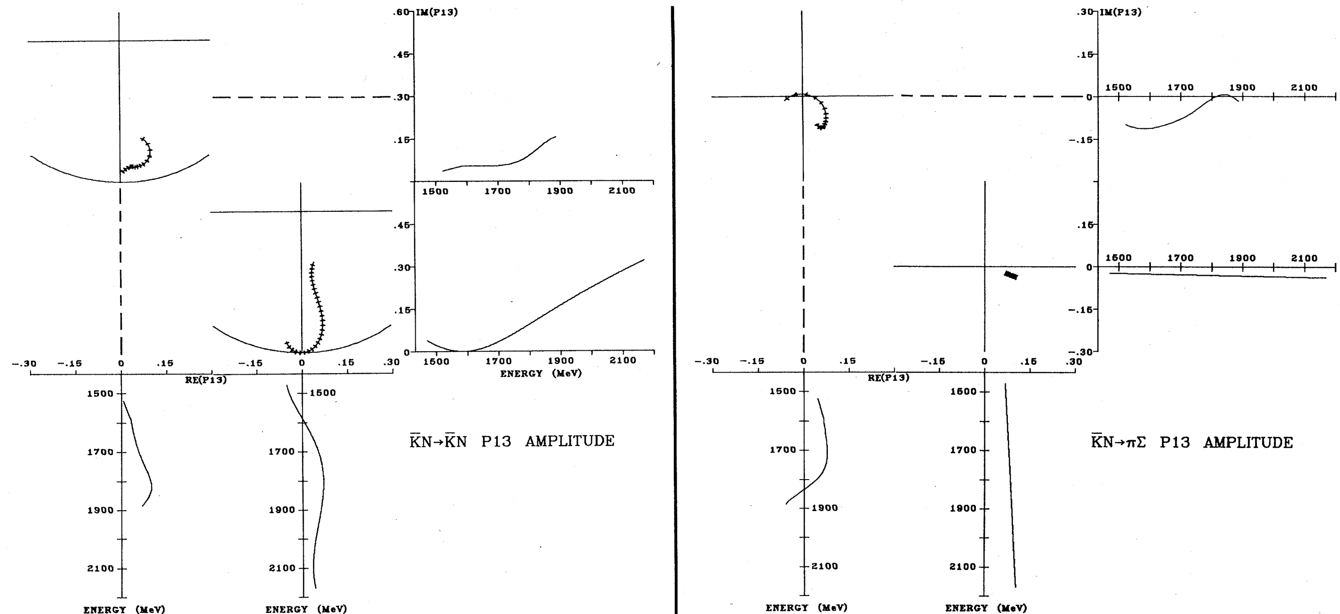
Fig. 2. Amplitudes for $\bar{K}N$ scattering in the P_{11} partial wave. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots except that of BAILLON 75. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each channel is from RLIC 76. The upper plot is from LEA 73 for the elastic and $\pi\Sigma$ channels, and from BAILLON 75 for the $\pi\Lambda$ channel. The Argand plot and the real-and-imaginary-part data with error bars for BAILLON 75 are from their solution 1; below 1770 MeV the real and imaginary parts of their solution 2 are also shown as a solid line. This wave contains the Σ pole but no established resonances; see the Data Card Listings for possible resonances in the P_{11} wave.

Baryons

Λ's and Σ's

Data Card Listings

For notation, see key at front of Listings.



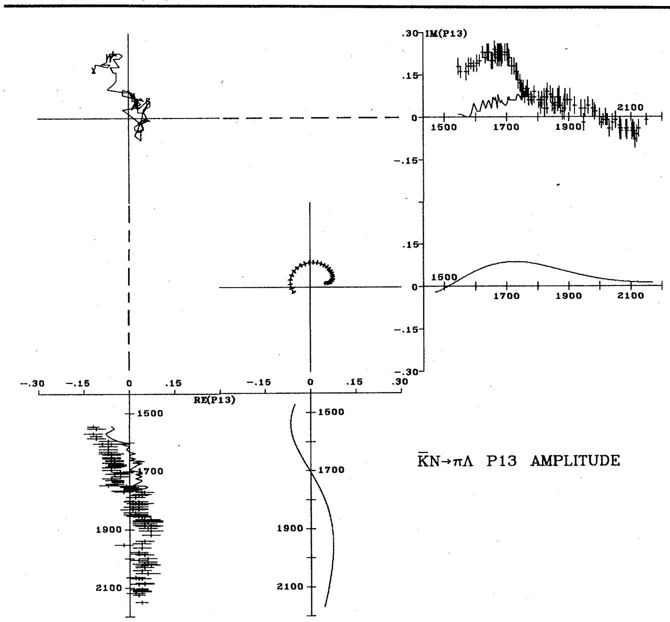


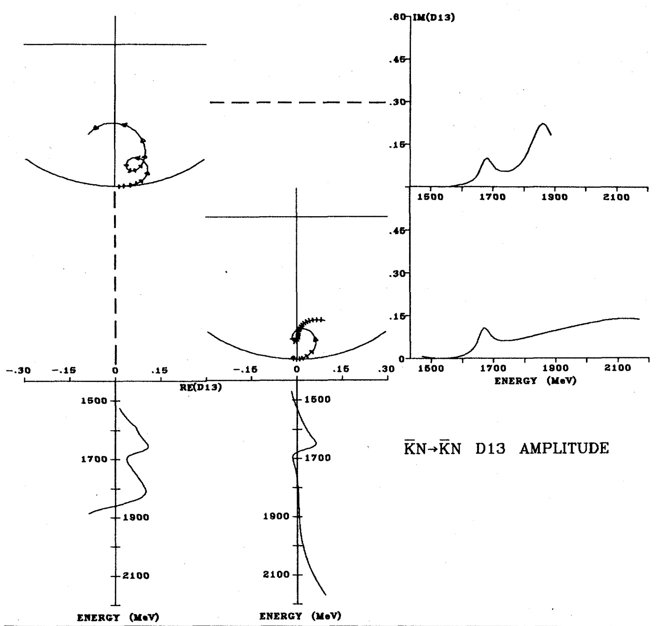
Fig. 3. Amplitudes for $\bar{K}N$ scattering in the P_{13} partial wave. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots except that of BAILLON 75. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each channel is from RLIC 76. The upper plot is from LEA 73 for the elastic and $\pi\Sigma$ channels, and from BAILLON 75 for the $\pi\Lambda$ channel. The Argand plot and the real-and-imaginary-part data with error bars for BAILLON 75 are from their solution 1; below 1770 MeV the real and imaginary parts of their solution 2 are also shown as a solid line. The only established resonance in this wave is the $\Sigma(1385)$ which lies below elastic threshold and does not appear here; see the Data Card Listings for other possible resonances in the P_{13} wave.

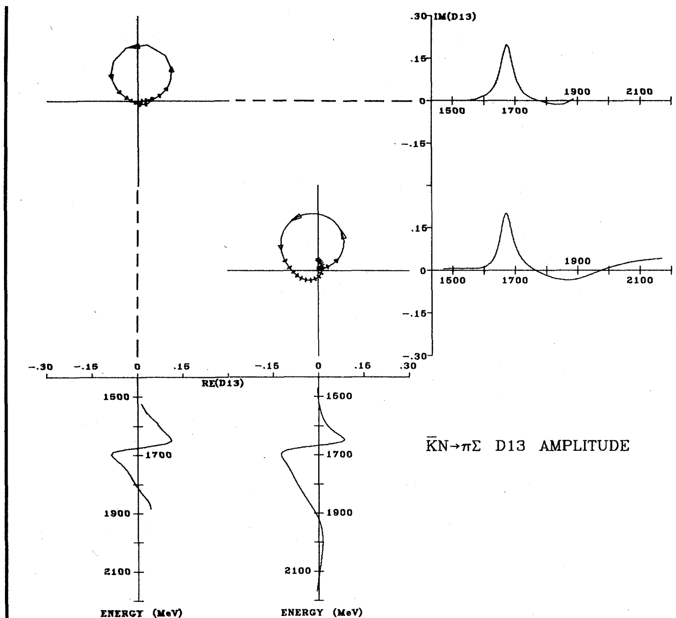
Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ's and Σ's





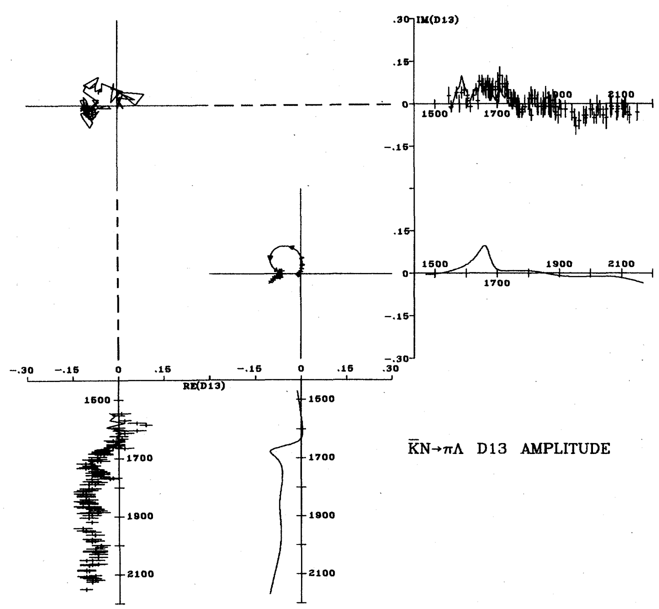


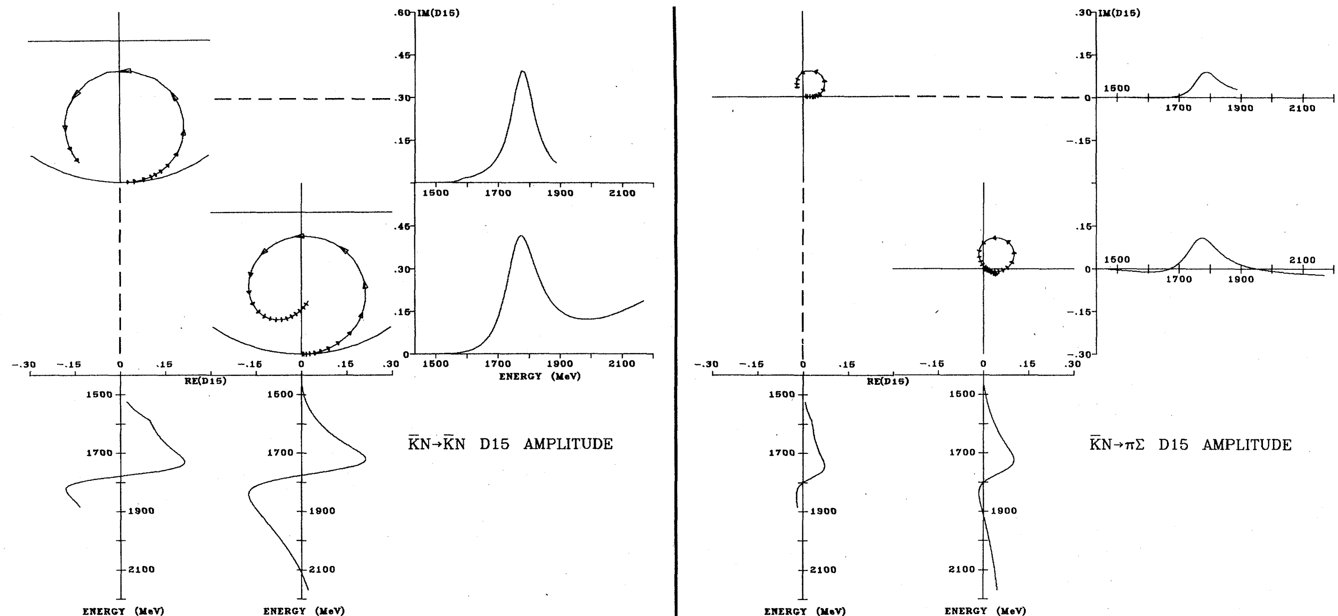
Fig. 4. Amplitudes for $\bar{K}N$ scattering in the D_{13} partial wave. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots except that of BAILLON 75. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each channel is from RLIC 76. The upper plot is from LEA 73 for the elastic and $\pi\Sigma$ channels, and from BAILLON 75 for the $\pi\Lambda$ channel. The Argand plot and the real-and-imaginary-part data with error bars for BAILLON 75 are from their solution 1; below 1770 MeV the real and imaginary parts of their solution 2 are also shown as a solid line, which is barely visible because the two solutions agree well in this wave. Established resonances in this wave are the $\Sigma(1670)$ and the $\Sigma(1940)$; see the Data Card Listings for another possible resonance in the D_{13} wave.

Baryons

Λ's and Σ's

Data Card Listings

For notation, see key at front of Listings.



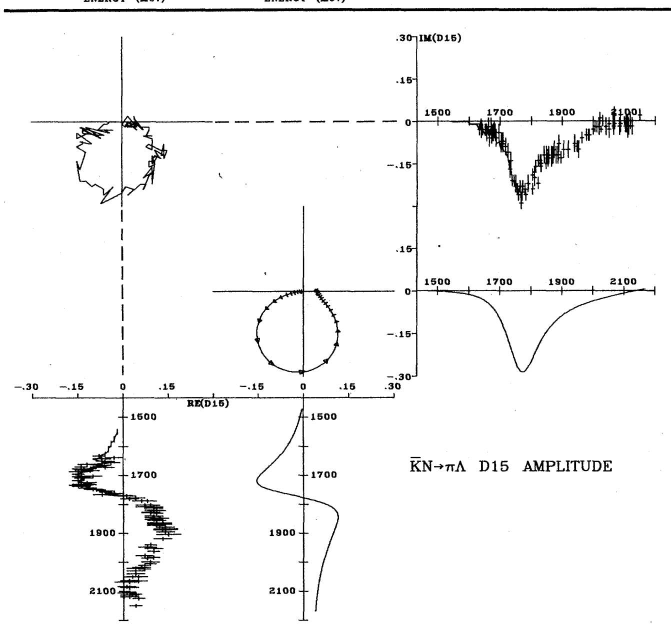


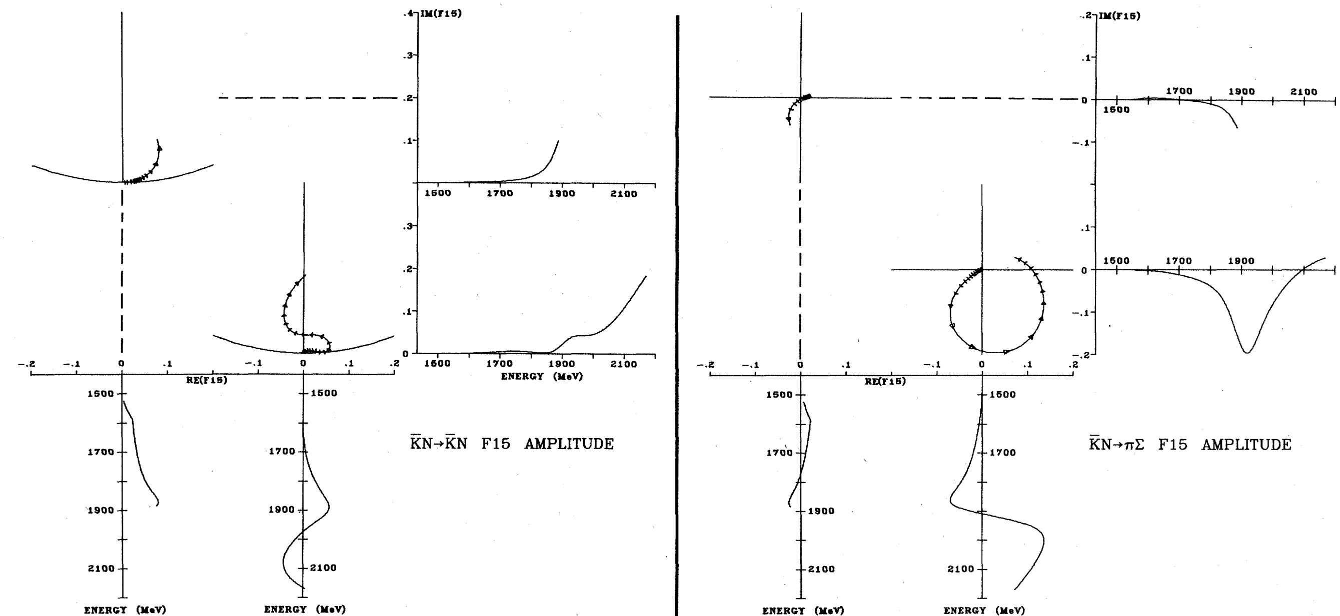
Fig. 5. Amplitudes for $\bar{K}N$ scattering in the D_{15} partial wave. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots except that of BAILLON 75. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each channel is from RLIC 76. The upper plot is from LEA 73 for the elastic and $\pi\Sigma$ channels, and from BAILLON 75 for the $\pi\Lambda$ channel. The Argand plot and the real-and-imaginary-part data with error bars for BAILLON 75 are from their solution 1; below 1770 MeV the real and imaginary parts of their solution 2 are also shown as a solid line, which is barely visible because the two solutions agree well in this wave. The only established resonance in the D_{15} wave is the $\Sigma(1765)$.

Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ's and Σ's



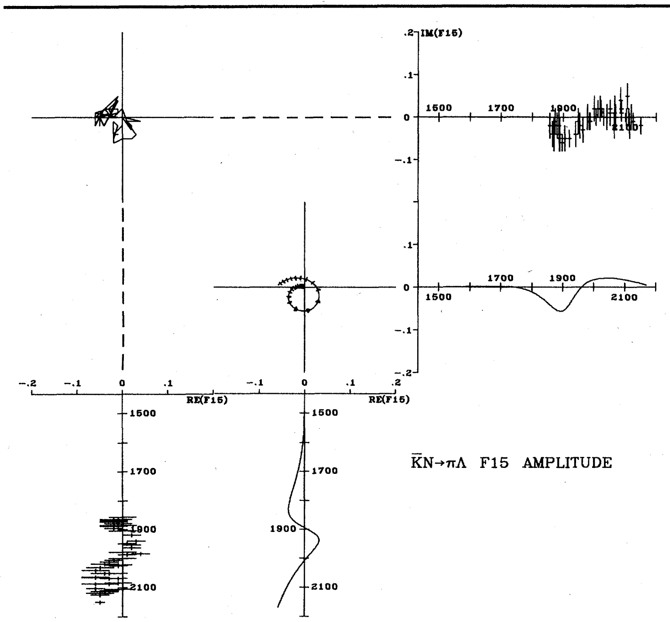


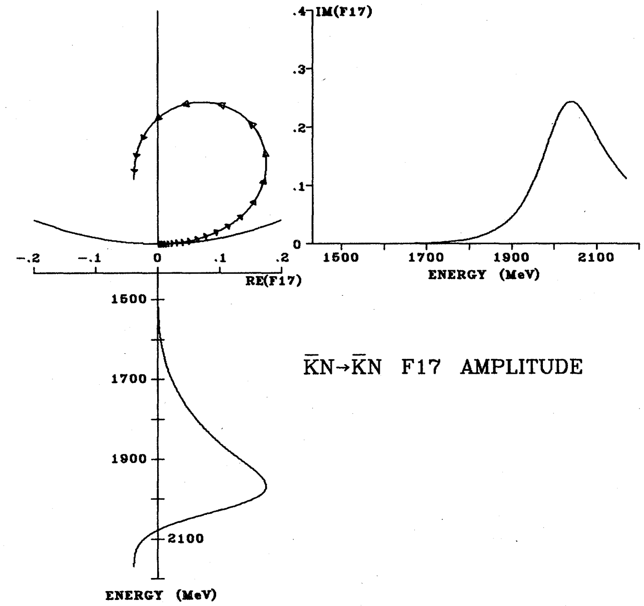
Fig. 6. Amplitudes for $\bar{K}N$ scattering in the F_{15} partial wave. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots except that of BAILLON 75. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each channel is from RLIC 76. The upper plot is from LEA 73 for the elastic and $\pi\Sigma$ channels, and from BAILLON 75 for the $\pi\Lambda$ channel. The only established resonance in this wave is the Σ(1915); see the Data Card Listings for another possible resonance in the F_{15} wave.

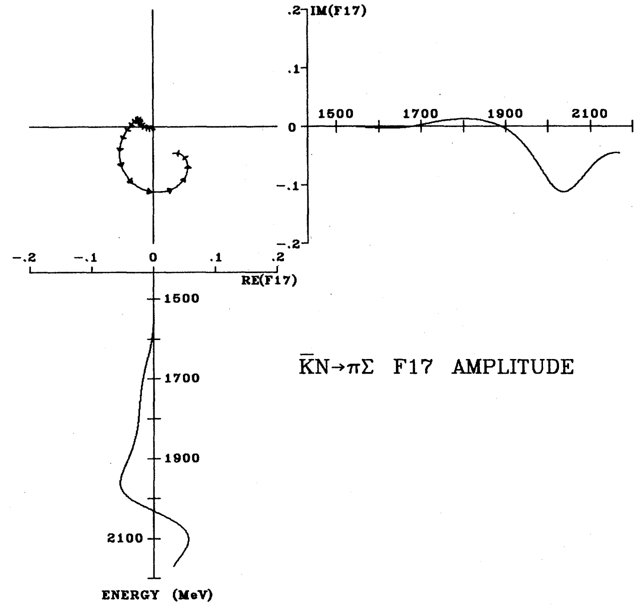
Baryons

Λ's and Σ's

Data Card Listings

For notation, see key at front of Listings.





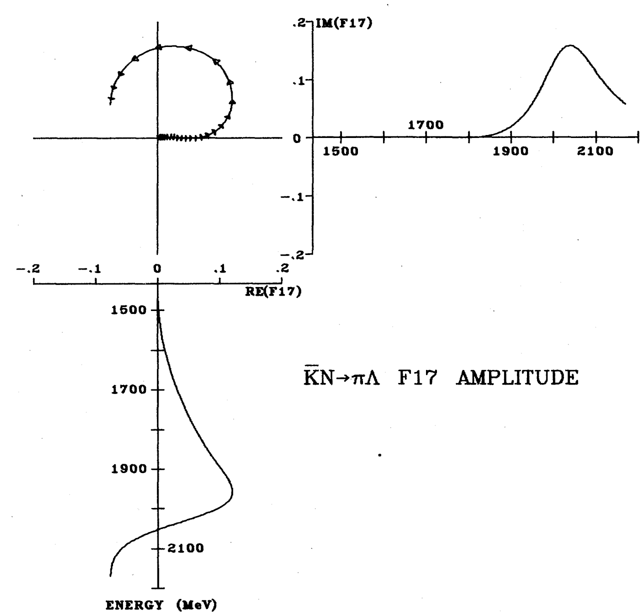


Fig. 7. Amplitudes for $\bar{K}N$ scattering in the F_{17} partial wave. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots. The energy axes run from elastic threshold to 2200 MeV. All the results shown are from RLIC 76. The only established resonance in the F_{17} wave is the $\Sigma(2030)$.

Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ's and Σ's

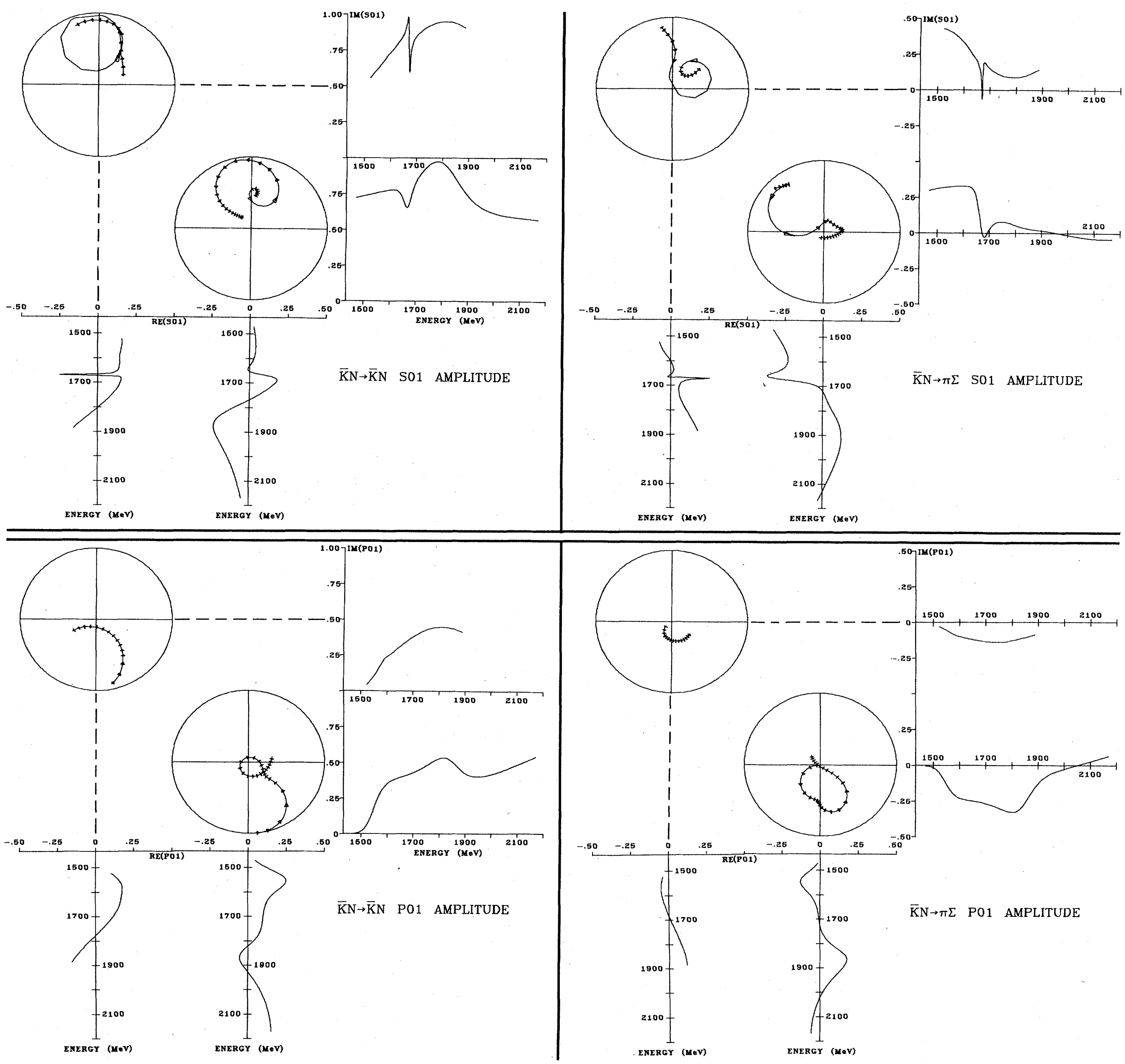


Fig. 8. Amplitudes for $\bar{K}N$ scattering in the S_{01} and P_{01} partial waves. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each amplitude is from RLIC 76; the upper plot is from LEA 73. Established resonances in the S_{01} wave are the Λ(1405) (which lies below threshold and does not appear here), the Λ(1670), and the Λ(1870); the P_{01} wave contains the Λ pole but no established resonances. See the Data Card Listings for possible resonances in the P_{01} wave.

Baryons

Λ's and Σ's

Data Card Listings

For notation, see key at front of Listings.

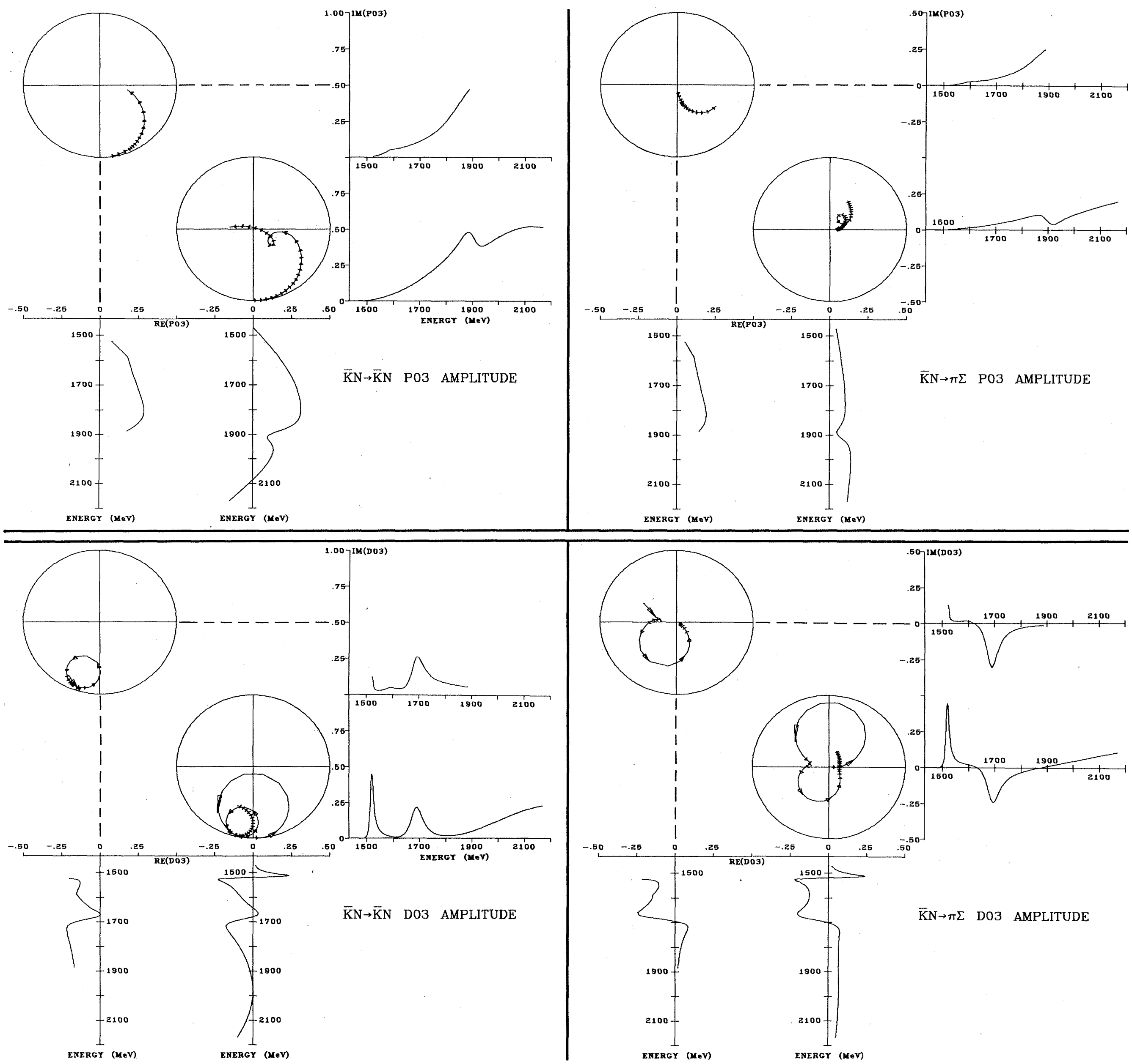


Fig. 9. Amplitudes for K̄N scattering in the P_{03} and D_{03} partial waves. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each amplitude is from RLIC 76; the upper plot is from LEA 73. Established resonances in these waves are the Λ(1860) in the P_{03} wave and the Λ(1520) and Λ(1690) in the D_{03} wave. See the Data Card Listings for another possible resonance in the D_{03} wave.

Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ's and Σ's

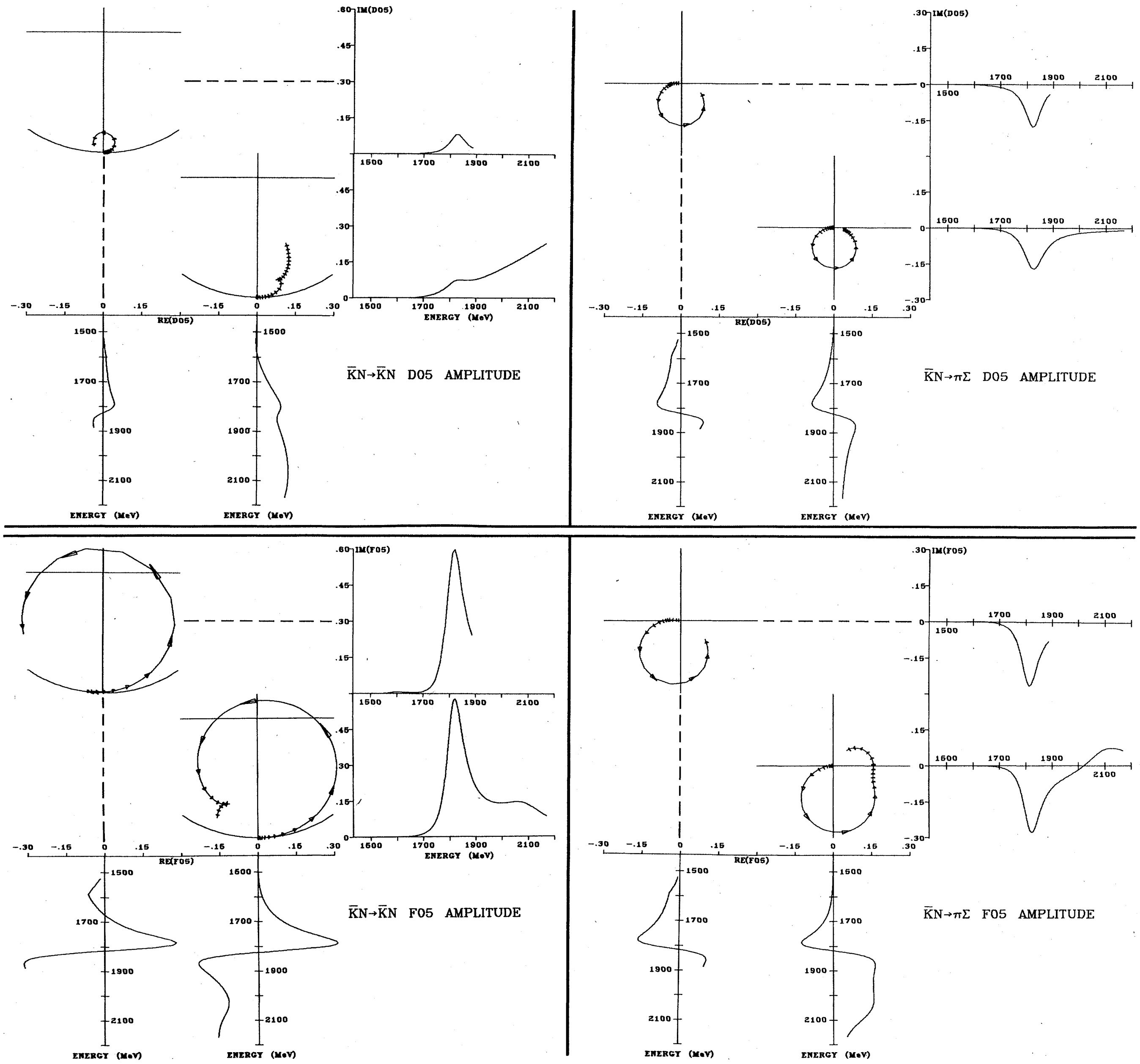


Fig. 10. Amplitudes for $\bar{K}N$ scattering in the D_{05} and F_{05} partial waves. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each amplitude is from RLIC 76; the upper plot is from LEA 73. Established resonances in these waves are the $\Lambda(1830)$ in the D_{05} wave and the $\Lambda(1815)$ in the F_{05} wave. See the Data Card Listings for another possible resonance in the F_{05} wave.

Baryons
Λ's and Σ's

Data Card Listings
For notation, see key at front of Listings.

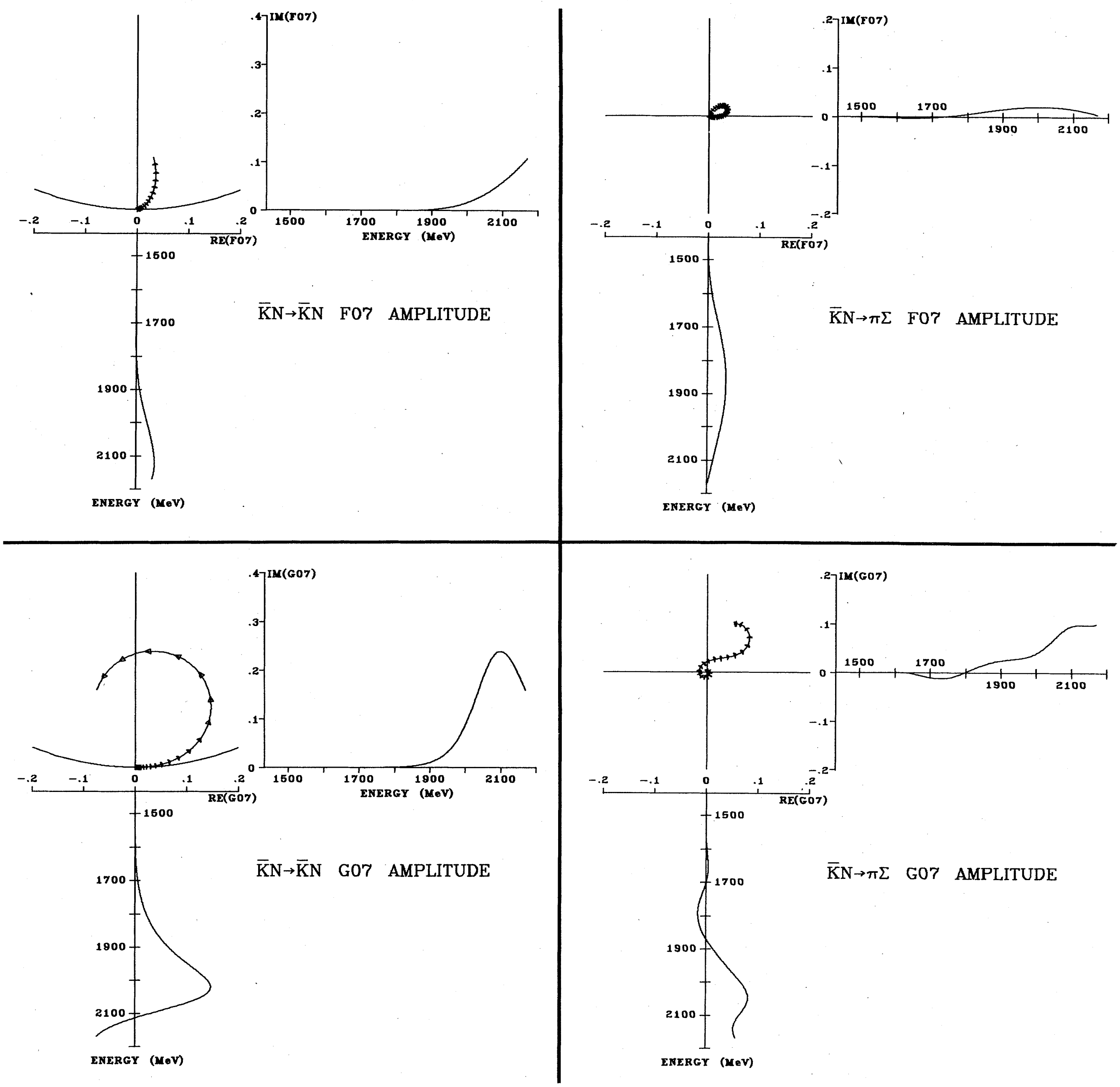


Fig. 11. Amplitudes for $\bar{K}N$ scattering in the F_{07} and G_{07} partial waves. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots. The energy axes run from elastic threshold to 2200 MeV. All the results shown are from RLIC 76. The only established resonance in these waves is the Λ(2100) in the G_{07} wave. See the Data Card Listings for a possible resonance in the F_{07} wave.

Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ's and Σ's, Λ, Λ(1330), Λ(1405)

Conclusions

Table I is an attempt to evaluate the status of the various Y^*'s. The evaluations are of course partly subjective. A blank indicates that there is no corresponding evidence at all. This may mean either that the relevant couplings are small or that the resonance does not really exist. The Baryon Table includes only the well-established resonances. It seems clear, however, that whereas any particular one of the questionable resonances may disappear with the next analysis, there are probably many new resonances underlying those already established.

References

1. E. Barrelet, Nuovo Cimento 8A, 331 (1972).
2. P. Litchfield, Proceedings of the IInd Aix-en-Provence Conference (1973).
3. M. Ross and G. Shaw, Ann. Phys. (N.Y.) 13, 147 (1961).

For other references see the Data Card Listings.

TABLE I. STATUS OF Y* RESONANCES
THOSE WITH AN OVERALL STATUS OF *** OR **** ARE INCLUDED IN THE MAIN BARYCN TABLE. THE OTHERS AWAIT CCNFIRMATION.

PARTICLE	LIJ	OVERALL STATUS	STATUS AS SEEN IN -- TOTAL≠ CR. SEC.	KBAR N	LAM PI	SIG PI	OTHER CHANNELS
LAM(1115)	P01	****					WEAK TO N PI
LAM(1330)		DEAD					
LAM(1405)	S01	****		****	F	****	
LAM(1520)	D03	****	****	****	O	****	LAM2PI,LAM GAM
LAM(1600)	P01	*		*		*	
LAM(1670)	S01	****		****	R	****	LAM ETA
LAM(1690)	D03	****	****	****	B	****	LAM2PI,SIG2PI
LAM(1800)	P01	**		***	I	**	
LAM(1800)	G09	*		*		*	
LAM(1815)	F05	****	****	****	D	****	SIG(1385) PI
LAM(1830)	D05	****		***	D	****	
LAM(1860)	P03	***	**	***	E	**	
LAM(1870)	S01	**		***	N	*	
LAM(2010)		**			F	*	LAM CMG
LAM(2020)	F07	*		*	O	*	
LAM(2100)	G07	****	****	****	R	***	XI K,LAM CMG
LAM(2110)	F05	**		**	B	*	LAM CMG
LAM(2350)		****	****	****	I		
LAM(2585)		***	***	*	D		
SIG(1190)	P11	****					WEAK TO N PI
SIG(1385)	P13	****			****	****	
SIG(1440)	PE	DEAD					
SIG(1480)	PE	*		*	*	*	
SIG(1580)	D13	**	**	*	**		
SIG(1620)	S11	**		**	*	*	
SIG(1660)	P11	**		**	*	**	
SIG(1670)	D13	****	**	***	****	****	SEVERAL OTHERS
SIG(1670)	PE	**		**	**	**	SEVERAL OTHERS
SIG(1690)	PE	**	*	*	**	*	LAM 2-PI
SIG(1750)	S11	***		**	**	*	SIG ETA
SIG(1765)	D15	****	****	****	****	***	SEVERAL OTHERS
SIG(1770)	P11	*		*	*		
SIG(1840)	P13	*		*	**	*	
SIG(1880)	P11	**		**	**		
SIG(1915)	F15	****	***	***	****	***	
SIG(1940)	D13	***		*	***	**	
SIG(2000)	S11	*			*		
SIG(2030)	F17	****	****	****	****	**	XI K
SIG(2070)	F15	*				*	
SIG(2080)	P13	**			**		
SIG(2100)	G17	*			*	*	
SIG(2250)		****	****	*	*	*	
SIG(2455)		***	***	*			
SIG(2620)		***	***	*			
SIG(3000)		**		*	*		

**** GOOD, CLEAR, AND UNMISTAKABLE.
*** GOOD, BUT IN NEED OF CLARIFICATION OR NOT ABSOLUTELY CERTAIN.
** NEEDS CCNFIRMATICN.
* WEAK.

≠ ATTRIBUTED TO THE STATE CLOSEST TO WHERE THE CROSS SECTION PEAKS.

S=−1 I=0 HYPERON STATES (Λ)

****** ********* ********* ********* ********* ********* ********* ********
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Λ

18 LAMBCA(1115,JP=1/2+) I=0

SEE STABLE PARTICLE DATA CARD LISTINGS

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****** ********* ********* ********* ********* ********* ********* ********

Λ(1330) BUMPS

87 Y*0(1330, JP=) I=0 PROCUCTICN EXPERIMENTS

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

→ A PEAK WAS SEEN NEAR 1330 MEV IN THE LAMBCA GAMMA SPECTRUM IN THREE PI-PROPANE EXPERIMENTS (YUNG-CHANG 64, BUBELEV 67, AND BOZOKI 68). ALL MORE RECENT RESULTS INDICATE THAT THERE IS NO RESCNANACE NEAR THIS MASS VALUE.

****** ********* ********* ********* ********* ********* ********* ********

REFERENCES FOR Y*0(1330) (PROD. EXP.)

Y-CHANG	64 DUBNA CONF I 615	YUNG-CHANG, IN, KLACNITSKAYA, +	(DUBNA)
BUBELEV	67 PL 24B 246	+CHADRAA, CHUVILO, +	(JINR,BUCHAREST,CERN)
DAHL	67 PR 163 1377	CAHL, HARDY, HESS, KIRZ, MILLER	(LRL)
BOZOKI	68 PL 28B 360	+FENYVES, GEMESY, +	(BUDAPEST,DUBNA)
TAN	69 PRL 23 101	T H TAN	(SLAC)
MAYEUR	70 PL 33B 441	+VAN BINST,WILQUET+++	(BRUX,CERN,TUFT)
COLAS	75 NP B91 253	COLAS,FARWELL,FERRER,SIX	(ORSA)

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Λ(1405)

37 Y*0(1405, JP=1/2-) I=0 PRODUCTICN EXPERIMENTS **S'_{01}**

THIS RESONANCE CAN BE IDENTIFIED WITH THE VIRTUAL BOUND STATE IN THE KBAR-N SYSTEM FOUND IN THE ANALYSIS OF LOW ENERGY K-P INTERACTION. WE LIST SUCH EXPERIMENTS SEPARATELY BELOW. WE USE CNLY PRODUCTION EXPERIMENTS FOR AVERAGING CF MASSES AND WIDTHS.

37 Y*C(1405) MASS (MEV) (PROD. EXP.)

M		(1405.0)		ALSTCN	61	HBC	K-P 1.15 BEV/C	
M		(1410.0)		ALEXANDER	62	HBC	PI-P 2.1 BEV/C	
M		(1405.0)		ALSTON	62	HBC	K-P 1.2-.5 BEV/C	
M		(1382.0)	(8.0)	ENGLER	65	HDBC	PI-P, PI+D 1.68	7/66
M		1400.0	24.0	MUSGRAVE	65	HBC	PBAR P 3-4 BEV/C	7/66
M	67	1400.0	5.0	BIRMINGHA	66	HBC	K-P 3.5	9/67
M	120	1405.0	5.0	GALTIERI	68	CBC	K-D 2.1-2.7BEV/C	6/68
M		. . . .						
M	AVG	1402.4	3.5	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)				
M	STUDENT	1402.4	3.9	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT				

37 Y*0(1405) WIDTH (MEV) (PROD. EXP.)

W		(20.0)		ALSTCN	61	HBC		7/66
W		35.0	5.0	ALEXANDER	62	HBC		
W		(50.0)		ALSTON	62	HBC		
W		(89.0)	(20.0)	ENGLER	65	HCBC		7/66
W		60.0	20.0	MUSGRAVE	65	HBC		7/66
W	67	50.0	10.0	BIRMINGHA	66	HBC	K-P 3.5	9/67
W	120	35.0	8.0	GALTIERI	68	CBC	K-C 2.1-2.7BEV/C	6/68
W		. . . .						
W	AVG	38.1	3.9	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)				
W	STUDENT	37.9	4.3	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT				

37 Y*0(1405) PARTIAL DECAY MODES (PROD. EXP.)

		DECAY MASSES
P1	Y*0(1405) INTO SIGMA PI	1197+ 139

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REFERENCES FOR Y*0(1405) (PROD. EXP.)

ALSTON	61 PRL 6 698	+ALVAREZ,EBERHARD,GOCD,GRAZIANO, +	(LFL) I
ALEXANDE	62 PRL 8 447	ALEXANDER,KALBFLEISCH,MILLER,SMITH	(LRL) I
ALSTON	62 CERN CCNF 311	+ALVAREZ,FERRO-LUZZI,ROSENFELD, +	(LRL) I
ENGLER	65 PRL 15 224	+FISK,KRAEMER,MELTZER,WESTGARD,+	(CARN,BNL) IJ
MUSGRAVE	65 NC 35 735	+PETMEZAS,+	(BIRM,CERN,EPOL,LOIC,SACLAY)
BIRMINGH	66 PR 152 1148	BIRMINGHAM,GLASGOW,LOIC, CXFORD,RUTHERFORD	
GALTIERI	68 PRL 21 573	BARBARO-GALTIERI,CHADWICK +	(LRL,SLAC)

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Baryons
Λ(1405), Λ(1520)

Data Card Listings
For notation, see key at front of Listings.

1405 MEV REGION: EXTRAPOLATIONS BELOW THRESHOLD

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                    24  Y*0(1405, JP=1/2-) I=0
                        EXTRAPOLATION BELOW THRESHOLD

                    SEE NOTE IN Y*0(1405) PRODUCTION EXPERIMENTS -THE DIF-
                    FICULTIES IN EXTRAPOLATING FROM THE PHYSICAL REGION TO
                    THE RESONANCE LOCATION ARE DISCUSSED BY DALITZ 67.

                    THE QUESTION ON WHETHER Y*(1405) IS A KBAR-N BOUND
   STATE OR A CDD POLE (DALITZ 70, RAJASEKARAN 72 HAS BEEN INVESTIGATED
   BY CLINE 71, MARTIN 71, GALTIERI 72, AND DOBSON 72.  THE LAST TWO
   PAPERS CONCLUDE THAT THE DATA CANNOT TELL THE DIFFERENCE.

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                    24  Y*0(1405) MASS (MEV)

M          1410.7      (1.0)           KIM        65 HBC     0-EFF-RANGE FIT   7/66
M          1409.6      (1.7)           SAKITT     65 HBC     0-EFF-RANGE FIT   7/66
M                            DATA OF SAKITT ARE USED IN FIT BY KITTEL.
M          1407.5      (1.2)           KITTEL     66 HBC     0-EFF-RANGE FIT   7/66
M          1403.0      (3.0)           KIM        67 HBC     K MATRIX FIT(KP)  8/67
M          1416.0      (4.0)           MARTIN     69 HBC     CONST. K MATRIX  10/69
M         (1421.0)                     MARTIN     70 RVUE    CONST. K MATRIX   6/70
M    1    (1406.)                      CHAO       73 DPWA    0-RNG. FIT.SOL B  9/73
M    1  SEE ALSO THE ACCOMPANYING PAPER OF THOMAS73.                           9/73

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                    24  Y*0(1405) WIDTH (MEV)

W            37.0      (3.2)           KIM        65 HBC                       7/66
W            28.2      (4.1)           SAKITT     65 HBC                       7/66
W            34.1      (4.1)           KITTEL     66 HBC                       7/66
W            50.0      (5.0)           KIM        67 HBC     K MATRIX FIT(KP)  8/67
W            29.0      (6.0)           MARTIN     69 HBC     CONST. K MATRIX  10/69
W           (20.0)                     MARTIN     70 RVUE    CONST. K MATRIX   6/70
W    1      (55.)                      CHAO       73 DPWA    0-RNG. FIT.SOL B  9/73
W    1  ASYMMETRIC RESONANCE SHAPE,W/2=41 MEV BELOW RESONANCE,14 MEV ABOVE.   9/73

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                                REFERENCES FOR Y*0(1405) (FROM EXTRAPOLATIONS)

KIM      65 PRL 14 29          J K KIM                              (COLUMBIA)IJP
SAKITT   65 PR 139 B719        +DAY,GLASSER,SEEMAN,FRIEDMAN, +       (UMD,LRL)IJP
KITTEL   66 PL 21 349          W KITTEL, G OTTER, I WACEK             (VIENNA)IJP
KIM      67 PRL 19 1074        J KIM                                    (YALE)JP
MARTIN   69 PR 183 1352        B R MARTIN, M SAKITT                 (LOUC+BNL)
MARTIN   70 NP B16 479         A D MARTIN, G G ROSS                   (DURHAM)IJP
CHAO     73 NP B56 46          CHAO,KRAEMER,THOMAS,MARTIN (RHEL+CARN+LOUC)IJP
   ALSO  73 NP B56 15          THOMAS,ENGLER,FISK,KRAEMER               (CARN)IJ

                                PAPERS NOT REFERRED TO IN DATA CARDS

ABRAMS   65 PR 139 B454        G S ABRAMS, B SECHI-ZORN                  (UMD)IJP
DONALD   66 PL 22 711          + EDWARDS, LYS, NISAR, MOORE     (LIVERPOOL)
KADYK    66 PRL 17 599         +CREN, G+S GOLDHABER, TRILLING            (LRL)IJP
   FIT SOLUTIONS GIVING AN I≠0 S1                            (2 RESONANCE.)
   ABRAMS 65, KADYK 66, AND DONALD 66 SUPPORT THOSE EFFECTIVE-RANGE-
DALITZ   67 PR 153 1617        DALITZ, WONG, RAJASEKARAN   (OXFORD,BOMBAY)
DALITZ   70 DUKE-HR 70 03      R D DALITZ                               (OXF)
CLINE    71 PRL 26 1194        D CLINE,R LAUMANN,J MAPP                (WISC)
MARTIN   71 PL 35B 62          A D MARTIN,B R MARTIN,ROSS (DURH+LOUC+RHEL)
DOBSON   72 PR D6 3256         P N DOBSON,R MCELHANEY                  (HAWA)
GALTIERI 72 LBL 555            A.BARBARO-GALTIERI                       (LBL)
RAJASEKA 72 PR D5 610          RAJASEKARAN                             (TATA)
   ALSO EARLIER PAPERS CITED IN RAJASEKARAN72
SHAW     73 PURDUE CONF. 417   SHAW                                     (UCI)IJP

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Λ(1520)

D'_{03}

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                    38  Y*0(1520, JP=3/2-) I=0

                    PRODUCTION AND FORMATION EXPERIMENTS AGREE QUITE WELL
                    WITH EACH OTHER, THERFORE, THEY HAVE NOT BEEN SEPARATED
                    FOR THIS PARTICLE.
                      THE DECAY MODE LAMBDA PI PI IS LARGELY DUE TO
   Y*1(1385) PI.  ONLY THE VALUES OF (Y*1(1385) PI)/(LAMBDA PI PI) GIVEN
   BY MAST 72 AND CORDEN 75 ARE BASED ON REAL 3-BODY PARTIAL WAVE ANLAYSES
   (THE OLDER RESULTS BEING OBTAINED USING CRUDER METHODS).  THE
   DISCREPANCY BETWEEN THE 2 RESULTS IS ESSENTIALLY DUE TO THE DIFFERENT
   HYPOTHESIS MADE CONCERNING THE SHAPE OF THE EPSILON MESON.

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                    38  Y*0(1520) MASS (MEV)

M      145 1517.2      3.0            GALTIERI  63 DBC     K-D 1.51 BEV/C
M          1519.4      2.0            WATSON    63 HBC     K-P ALL CHANNELS
M       29 1520.0      4.0            ALMEIDA   64 HBC     K-P 1.45 BEV/C
M         (1511.0)   (15.0)           MUSGRAVE  65 HBC     PBAR P 3-4 BEV/C   7/66
M       30(1510.0)    (2.0)           BIRMINGHA 66 HBC     K-P 3.5            9/67
M    B     1517.2      1.2            BURKHARDT 69 HBC     K-P .8-1.2 GEV/C  10/69
M    B            QUOTED ERROR INCREASED TO ACCOUNT FOR DISAGREEMENT BETWEEN
M    B            TWO MEASUREMENTS DONE BY SAME AUTHORS (K-P AND SIGMA PI)
M         (1519.)                     KIM       71 DPWA    K-MATRIX ANAL.     3/71
M     1669 1517.+/-1. TO 1521.+/-1.   BERTHON   74 HBC   0 QUASI 2 BODY CS   10/74*
M     2000 1519.4       .3            CORDEN    75 DBC     K- D 1.4-1.8GV/C   4/75*
M          1519.       1.             RLIC      76 DPWA    KBAR N MULTICHNL   1/76*
M           . . . . . . . . .
M    AVG    1519.24    0.29     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    STUDENT1519.26    0.31     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    38  Y*0(1520) WIDTH (MEV)

W            16.4      2.0            WATSON    63 HBC
W           (19.0)   (19.0)           MUSGRAVE  65 HBC                        7/66
W       30  (50.0)   (10.0)           BIRMINGHA 66 HBC     K-P 3.5            9/67
W           (18.0)  OR LESS           DAHL      67 HBC                        9/66
W            14.7      1.8            BURKHARDT 69 HBC     K-P .8-1.2 GEV/C  10/69
W           (16.)                     KIM       71 DPWA    K-MATRIX ANAL.     3/71
W     2000   15.5      1.6            CORDEN    75 DBC     K- D 1.4-1.8GV/C   4/75*
W            15.        .5            RLIC      76 DPWA    KBAR N MULTICHNL   1/76*
W           . . . . . . . . .
W    AVG     15.09     0.45     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W    STUDENT 15.09     0.49     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    38  Y*0(1520) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      Y*0(1520) INTO KBAR N                               497+ 939
P2      Y*0(1520) INTO SIGMA PI                             1197+ 139
P3      Y*0(1520) INTO LAMBDA PI PI                         1115+ 139+ 139
P4      Y*0(1520) INTO LAMBDA GAMMA                         1115+   0
P5      Y*0(1520) INTO SIGMA0 GAMMA                         1192+   0
P6      Y*0(1520) INTO SIGMA PI PI                          1197+ 139+ 139
P7      Y*0(1520) INTO (Y*1(1385)+PI)                       1384+ 139
P8      Y*0(1520) INTO Y*1(1385) PI INTO LAMBDA PI PI       1115+ 139+ 139
          NOTE THAT P8/P7 IS THE BRANCHING FRACTION FOR Y*1(1385) INTO LM PI   9/73
P9      Y*0(1520) INTO LAMBDA EPSILON                       1518+1200

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

	P 1	P 2	P 3	P 4	P 5	P 6
P 1	.4548+-.0056					
P 2	-.6145	.4145+-.0063				
P 3	-.2207	-.4080	.0950+-.0043			
P 4	-.0704	-.1138	-.0453	.0079+-.0014		
P 5	-.1806	-.2920	-.1162	-.0248	.0192+-.0034	
P 6	-.0269	-.0434	-.0173	-.0037	-.0095	.0086+-.0005

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                    38  Y*0(1520) BRANCHING RATIOS

R1      Y*0(1520) INTO (SIGMA PI)/(KBAR N)                  (P2)/(P1)
R1            1.72      .78            MUSGRAVE  65 HBC                       8/67
R1            0.96      0.20           DAHL      67 HBC     PI-P 1.6-4 GEV/C  9/66
R1            0.73      0.11           DAUBER    67 HBC     K-P AT 2.GEV/C    8/67
R1            1.06       .14           SCHEUER   68 DBC   0 K-N 3 GEV/C      10/69
R1            0.82      0.08           BURKHARDT 69 HBC     K-P .8-1.2 GEV/C 10/69
R1           (1.06)     (.12)          BERTHON   74 HBC   0 QUASI 2 BODY CS  10/74*
R1   4         .96       .06           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R1   4  KBAR N TO SIGMA PI AMPLITUDE AT RESONANCE IS +.46 +/- .01            1/76*
R1           . . . . . . . . .
R1   AVG      0.902     0.049     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R1   STUDENT  0.905     0.050     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1   FIT      0.911     0.023   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R2      Y*0(1520) INTO (LAMBDA PI PI)/(KBAR N)              (P3)/(P1)
R2            0.17      0.05           DAHL      67 HBC     PI-P 1.6-4 GEV/C  9/66
R2            0.21      0.18           DAUBER    67 HBC     K-P AT 2.GEV/C    8/67
R2             .19       .04           SCHEUER   68 DBC   0 K-N 3 GEV/C      10/69
R2            0.22      0.03           BURKHARDT 69 HBC     K-P .8-1.2 GEV/C 10/69
R2           (0.2)                     KIM       71 DPWA    K-MATRIX ANAL.    3/71
R2           (.27)      (.13)          BERTHON   74 HBC   0 QUASI 2 BODY CS  10/74*
R2           . . . . . . . . .
R2   AVG      0.202     0.021     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2   STUDENT  0.202     0.024     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2   FIT      0.209     0.010   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R3      Y*0(1520) INTO (SIGMA PI)/(LAMBDA PI PI)            (P2)/(P3)
R3            4.5       1.0            ARMENTERO 65 HBC                       7/66
R3            3.3       1.1            BIRMINGHA 66 HBC     K-P 3.5           9/67
R3            3.9       1.0            UHLIG     67 HBC     K-P .9-1.0 BEV/C  9/66
R3           . . . . . . . . .
R3   AVG      3.94      0.59      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3   STUDENT  3.94      0.65      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R3   FIT      4.36      0.23    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R4      Y*0(1520) INTO (LAMBDA GAMMA)/TOTAL (PERCENT)       (P4)
R4   238      0.80      0.14           MAST      68 HBC   0 USING ELAST=.45  11/68
R4           . . . . . . . . .
R4   FIT      0.79      0.14    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5      Y*0(1520) INTO (SIGMA0 GAMMA)/TOTAL (PERCENT)       (P5)
R5   S        2.0        .35           MAST      68 HBC     SEE NOTE S       10/69
R5   S    RATIOS CALCULATED FROM R4,ASSUMING SU(3). NEEDED TO CONSTRAIN
R5   S    ALL THE Y*0(1520) BRANCHING RATIOS TO BE UNITY.
R5           . . . . . . . . .
R5   FIT      1.92      0.34    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6      Y*0(1520) INTO (KBAR N)/TOTAL                       (P1)
R6            0.29      0.05           WATSON    63 HBC     K-P ALL CHANNELS 10/71
R6             .447      .018          GALTIERI  69 HBC     K- P .28-.45 G/C 10/69
R6            0.47      0.03           COLLEY    71 CBC     K-N 1.5 GEV PROD 10/71
R6           (0.45)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
R6             .448      .014          CORDEN    75 CBC     K- D 1.4-1.8GV/C  4/75*
R6            (.42)                    MAST      76 HBC   0 K- P CEX          1/76*
R6             .47       .01           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R6           . . . . . . . . .
R6   AVG      0.4570    0.0071    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R6   STUDENT  0.4582    0.0085    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R6   FIT      0.4548    0.0056  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R7      Y*0(1520) INTO (SIGMA PI)/TOTAL                     (P2)
R7            0.55      0.09           WATSON    63 HBC     K-P ALL CHANNELS 10/71
R7            0.418      .017          GALTIERI  69 HBC   0 K-P .28-.45GEV/C  6/69
R7            0.43      (0.03)         COLLEY    71 CBC     K-N 1.5 GEV PROD 10/71
R7           (0.46)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
R7   3         .426      .014          CORDEN    75 CBC     K- D 1.4-1.8GV/C  4/75*
R7   3  SUPERSEDES COLLEY 71                                                  1/76*
R7           . . . . . . . . .
R7   AVG      0.425     0.011     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R7   STUDENT  0.424     0.012     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R7   FIT      0.4145    0.0063  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R8      Y*0(1520) INTO (SIGMA PI PI)/TOTAL                  (P6)
R8             .010      .0015         GALTIERI  69 HBC   0 K-P .28-.45GEV/C 10/69
R8   2         .0085     .0006         MAST2     73 MPWA    K-P TO 2PI SIG    9/73
R8   2  BASED ON ASSUMED ELASTICITY OF .46                                    9/73
R8 A           .007      .002          CORDEN    75 DBC     K- D 1.4-1.8GV/C  4/75*
R8 A    CONSIDERABLE FRACTION OF THE SIGMA PI PI DECAY PROCEEDS VIA THE       4/75*
R8 A    Y*1(1385) PI INTERMEDIATE STATE.                                      4/75*
R8           . . . . . . . . .
R8   AVG      0.00858   0.00054   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R8   STUDENT  0.00858   0.00059   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R8   FIT      0.00857   0.00054 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
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Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ(1520), Λ(1600), Λ(1670)

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R9      Y*0(1520) TO Y*1(1385) PI TO LM PI PI/LM PI PI    (P8)/(P3)             9/73
R9          MORE THAN    0.10              CLINE      69 DBC     K-D TO 2PI LAM N  9/69
R9    B        0.39      C.10              BURKHARDT 71 HBC     LAM. 3PI PROD.    3/71
R9    C       (1.0)                        CHAN       72 IPWA    K-P TO LAM 2PI    2/73
R9    M        0.82      0.10              MAST       73 IPWA    K-P TO 2PI LAM   12/72
R9              .58       .22              CORDEN     75 CBC     K- D 1.4-1.8GV/C  4/75*
R9    B  CENTRAL BIN(1514-1524) GIVES .74+-.10 -- OTHER BINS LCWER BY 2-5SIG
R9    C  CNLY THE Y*(1385)DS03 SEEMS TC CONTRIBUTE
R9    M  BOTH Y*(1385)DS03 AND SIGMA (PI PI)DP03 CCNTRIBUTE
R9           . . . . . . . . . .
R9   AVERAGE MEANINGLESS (SCALE FACTOR = 2.2)

R10     Y*0(1520) INTO (Y*1(1385) PI)/TOTAL                  (P7)
R10            0.041     0.005             CHAN       72 HBC     K-P TO LAM 2PI    3/71

R11     Y*0(1520) INTO (LAMECA PI PI)/TOTAL                  (P3)
R11            0.10     (0.02)             COLLEY     71 CBC     K-N 1.5 GEV PROD 10/71
R11   1         .11       .01              MAST       73 IPWA    K-P TO 2PI LAM    9/73
R11   1  BASED ON ASSUMEC ELASTICITY OF .46+/-.02                                  9/73
R11   3         .091      .006             CCRDEN     75 CBC     K- D 1.4-1.8GV/C  4/75*
R11   3  SUPERSEDES COLLEY 71                                                      1/76*
R11          . . . . . . . . . .
R11 AVG        0.0960    0.0084  AVERAGE (ERRCR INCLUDES SCALE FACTOR OF 1.6)
R11 STUDENT    0.0956    0.0062  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R11 FIT        0.0950    0.0043 FROM FIT (ERRCR INCLUDES SCALE FACTOR OF 1.1)

R12     Y*0(1520) INTO (LAMBCA EPSILON)/TOTAL                (P9)                  4/75*
R12             .20       .08              CORDEN     75 CBC     K- D 1.4-1.8GV/C  4/75*


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REFERENCES FOR Y*0(1520)


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GALTIERI 63 PL 6 296             A BARBARO-GALTIERI,A HUSSAIN,RD TRIPP (LRL)
WATSCN   63 PR 131 2248          M B WATSON, M FERRO-LUZZI, R D TRIPP  (LRL)IJP
ALMEIDA  64 PL 9 204             S P ALMEIDA, G R LYNCH                 (CERN)
ARMENTER 65 PL 19 338            ARMENTEROS,F-LUZZI, +     (CERN,HEID,SACLAY)
MUSGRAVE 65 NC 35 735            +PETMEZAS,+     (BIRM,CERN,EPOL,LOIC,SACLAY)

BIRMINGH 66 PR  152  1148        BIRMINGHAM,GLASGOW,I.C., OXFORD,RUTHERFORD
DAHL     67 PR 163 1377          DAHL,HARDY,HESS,KIRZ,MILLER             (LRL)
DAUBER   67 PL 248 525           +MALAMUD,SCHLEIN,SLATER,STCRK          (UCLA)
UHLIG    67 PR 155 1448          +CHARLTCN,CCNDCN,GLASSER,YODH,+    (UMD,NRL)
MAST     68 PRL 21 1715          MAST,ALSTCN,BANGERTER,GALTIERI+         (LRL)
SCHEUER  68 NP B8 503            SABRE COLLAB.     (SACL+AMST+BGNA+REHO+EPOL)

BURKHARD 69 NP B14 106           +FILTHUTH+KLUGE+..    (HEID+EFI+CERN+SACLAY)
CLINE    69 LNC 2 407            +LAUMANN+MAPP                          (WISC)
GALTIERI 69 LUND 352             BARBARO-GALTIERI,BANGERTER,MAST,TRIPP (LRL)
    ALSO 70 DUKE 95              R D TRIPP                               (LRL)

BURKHARDT71 NP  B27 64           +FILTHUTH,KLUGE,OBERLACK++ (HEID+CERN+SACL)
COLLEY   71 NP  B31 61           +COX,EASTWOOD,FRY+..  (BIRM+EDIN+GLAS+LOIC)
KIM      71 PRL 27 356           J K KIM                              (HARV)IJP
    ALSO 70 DUKE 161             J. K. KIM                            (HARV)IJP

CHAN     72 PRL 28 256           +BUT.-SHAFER,HERTZBACH,KOFLER++ (MASA,YALE)
MAST     73 PR D7 5              +ALSTON-GARNJCST,BANGERTER,+...       (LBL) IJP
MAST2    73 PRD 7 3212           +BANGERTER,ALSTON-GARNJOST,+          (LBL)IJP
BERTHON  74 NC 21A 146           BERTHON,TRISTRAM,+    (CDEF+RHEL+SACL+STRB)   U
CORDEN   75 NP B84 306           CORDEN,COX,CARTNELL,KENYON,ONEALE,+  (BIRM)

MAST     76 LBL-4294 (PRPNT)  MAST,ALSTON-GARNJOST,BANGERTER+          (LBL)
RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSCN,ROSS+    (RHEL+LOIC)IJP
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PAPERS NOT REFERRED TO IN DATA CARDS


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BERLEY   70 PR D1 1996           +YAMIN,KOFLER,MANN,MEISNER+ (BNL,MASA,YALE)IJP
GOLOWICH 74 PRD 10 3861          EUCEN GOLOWICH                         (SLAC)
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Λ(1600) 101 Y*0(1600, JP=1/2+) I=0 **P'_{01}** 1/76*

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                  101   Y*0(1600) MASS (MEV)                               1/76*

M    1      (1570.)                        KIM        71 DPWA    K-MATRIX ANAL.    1/76*
M    1  POSSIBLE EFFECT IN SIGMA PI AND KBAR N CHANNELS.
M          1620.0      10.0                LANGBEIN   72 IPWA    MULTICHANNEL      1/76*
M          1573.       25.                 RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
M            . . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)

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                  101   Y*0(160C) WIDTH (MEV)                              1/76*

W    1       (50.)                         KIM        71 DPWA    K-MATRIX ANAL.    1/76*
W             60.0      10.0               LANGBEIN   72 IPWA    MULTICHANNEL      1/76*
W            147.       50.                RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
W            . . . . . . . . . . .
W    AVG      63.3       9.8       AVERAGE (ERROR INCLUDES SCALE FACTCR OF 1.0)
W    STUDENT  62.8      10.8       AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
         SEE THE NOTES ACCOMPANYING MASSES CUCTED

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                  101   Y*0(1600) PARTIAL DECAY MODES                      1/76*

                                                          CECAY MASSES
P1      Y*0(1600) INTO KBAR N                           497+ 939
P2      Y*0(1600) INTO SIGMA PI                        1197+ 139

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                  101   Y*0(1600) BRANCHING RATIOS                         1/76*

R1      Y*0(1600) INTO (KBAR N)/TCTAL                        (P1)                  1/76*
R1            0.25      0.15               LANGBEIN   72 IPWA    MULTICHANNEL      1/76*
R1             .24       .04               RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
R1           . . . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R2      Y*0(1600) FROM KBAR N INTO SIGMA PI                  SQRT(P1*P2)           1/76*
R2            0.28      0.09               LANGBEIN   72 IPWA    MULTICHANNEL      1/76*
R2            -.16       .04               RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
R2           . . . . . . . . . . .
R2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.2)

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REFERENCES FOR Y*0(1600)


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KIM      71 PRL 27 356           J K KIM                              (HARV)IJP
    ALSO 70 DUKE 161             J. K. KIM                            (HARV)IJP

LANGBEIN 72 NP B47 477           +WAGNER                              (MPIM)IJP

RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSCN,ROSS+    (RHEL+LOIC)IJP
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Λ(1670) 40 Y*0(1670, JP=1/2-) I=0 **S''_{01}**

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        SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

         THIS RESONANCE IS WELL ESTABLISHED.
         (SEE THE NOTE FOR THE Y*0(1330)).

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                  40   Y*0(1670) MASS (MEV)

M    M      (1666.0)OR(1675.0)             BERLEY     65 HBC   0 K-P TO LAM ETA     7/66
M    M    THE FIRST VALUE ASSUMES THE BRANCHING RATIO INTO LAMBDA ETA IS
M       SMALL, THE SECOND THAT IT IS LARGE.  BECAUSE THE RESONANCE IS NEAR
M       THE LAMBDA ETA THRESHOLC, THE BRANCHING RATIO AFFECTS THE MOMENTUM
M       DEPENDENCE OF THE TOTAL WIDTH, AND THUS ALSO THE RESONANCE PARA-
M       METERS OBTAINED BY FITTING TO THE DATA.
M     N     (1663.0)     (3.0)             ARMENT-1   68 HBC   0 ELASTIC, CH EXCH 11/68
M     N     (1678.0)     (2.0)             ARMENT-2   68 HBC   0 K-P TO SIGMA PI  11/68
M     A      1674.0      (5.0)             ARMENT-3   69 HBC   0 MULTICHANNEL      9/69
M     N      1662.0      (3.0)             ARMENT-4   69 HBC   0 ELAST,CH.EXC.ED   9/69
M     N      1680.0      (1.0)             ARMENT-4   69 HBC   0 K-P TO SIG PI.ED  9/69
M            1674.0                        BERLEY     69 HBC   0 K-P TO SIGMA PI   6/70
M            1683.0      (5.0)             GALTIERI   70 HBC   0 SIG PI,EDPWA      7/70
M            1670.                         KIM        71 DPWA    K-MATRIX ANAL.    3/71
M            1640.0     (40.0)             LANGBEIN   72 IPWA    MULTICHANNEL     .12/72
M            1700.      (10.)              BAXTER     73 DPWA  0 K- P TO NEUTRALS 10/74*
M            1672.       (1.)              HART       73 DPWA    EL+CX,.7-.8GEV/C  2/74
M            1665.       (5.)              PREVOST    74 DPWA 0- K-N TO S(1385)PI 10/74*
M            1670.       (5.)              RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
M     A            THE MULTICHANNEL ANALYSIS INCLUDES ELASTIC AND SIGMA PI .   10/69
M     N   THE APPARENT DISCREPANCY BETWEEN THESE RESULTS IS PROBABLY NOT
M       SERIOUS.  THE ERRORS GIVEN ARE JUST STATISTICAL.  THE SYSTEMATIC
M       ERRORS THAT RESULT FRCM THE RESTRICTIVE PARAMETRIZATION FORCED ON
M       THE PARTIAL-WAVE AMPLITUDES ARE NOT INCLUDED, AND CAN BE LARGE.

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                  40   Y*0(1670) WIDTH (MEV)

W    M      (22.0)OR(15.0)                 BERLEY     65 HBC   0 SEE NOTE M ABCVE  7/66
W     N     (26.0)       (8.0)             ARMENT-1   68 HBC   0 SEE NOTE N ABOVE 11/68
W     N     (26.0)       (5.0)             ARMENT-2   68 HBC   0                  11/68
W     A      23.0        (3.0)             ARMENT-3   69 HBC   0                   9/69
W     N      38.0       (15.0)             ARMENT-4   69 HBC   0 ELAST,CH EXC.ED   9/69
W     N      33.0        (5.0)             ARMENT-4   69 HBC   0 K-P TO SIG PI.ED  9/69
W            31.0                          BERLEY     69 HBC   0 K-P TO SIGMA PI   6/70
W            25.0        (5.0)             GALTIERI   70 HBC   0 SIG PI,EDPWA      7/70
W            35.                           KIM        71 DPWA    K-MATRIX ANAL.    3/71
W            45.0       (20.0)             LANGBEIN   72 IPWA    MULTICHANNEL     12/72
W            65.        (20.)              BAXTER     73 DPWA  0 K- P TO NEUTRALS 10/74*
W            19.         (2.)              HART       73 DPWA    EL+CX,.7-.8GEV/C  2/74
W            19.         (5.)              PREVOST    74 DPWA 0- K-N TO S(1385)PI 10/74*
W            45.        (10.)              RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
         SEE THE NOTES ACCOMPANYING THE MASSES QUCTED


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                  40   Y*0(1670) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      Y*0(1670) INTO KBAR N                           497+ 939
P2      Y*0(1670) INTO LAMBDA ETA                      1115+ 548
P3      Y*0(1670) INTO SIGMA PI                        1189+ 139
P4      Y*0(1670) INTO SIGMA(1385) PI                   139+1384

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                  40   Y*C(1670) BRANCHING RATICS

R1      Y*0(1670) INTO (KBAR N)/TOTAL                        (P1)
R1    P     (0.14)     (0.04)              ARMENT-1   68 HBC   0 OLD DATA         11/68
R1           0.17                          ARMENT-3   69 HBC   0                   9/69
R1    P      0.14      (0.04)              ARMENT-4   69 HBC   0 NEW DATA          9/69
R1    A     (0.39)     (0.05)              CCNFORTO   71 HBC   0 K-P,ELAST,CEX     6/70
R1           0.28                          KIM        71 DPWA    K-MATRIX ANAL.    3/71
R1           0.35      (0.06)              LANGBEIN   72 IPWA    MULTICHANNEL     12/72
R1            .36       (.03)              HART       73 DPWA    EL+CX,.7-.8GEV/C  2/74
R1            .20       (.03)              RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
R1    A    EFFECT BELOW REGION ANALYZED. VALUE OF .18 DOES NOT
R1    A  AFFECT FIT OR VALUES OF CTHER PARAMETERS.
R1    P   THIS IS THE DIAMETER OF THE CIRCLE IN THE ARGAND PLOT.  IT IS
R1      SUPERIMPCSED ON A LARCE BACKGROUND.

R2      Y*0(1670) FROM KBAR N TO LAMBDA ETA                  SQRT(P1*P2)
R2    M     (0.20) OR 0.23                 BERLEY     65 HBC   0 SEE NOTE M ABOVE  7/66
R2          (0.26)                         ARMENT-3   69 HBC   0                   9/69
R2          (0.24)                         KIM        71 DPWA    K-MATRIX ANAL.    3/71
R2           +.20       (.05)              BAXTER     73 DPWA  0 K- P TO NEUTRALS 10/74*
      SEE THE NCTES ACCCMPANYING MASSES CUOTED

R3      Y*0(1670) FROM KBAR N TO SIGMA PI                    SQRT(P1*P3)
R3   1     (-0.25)     (0.06)              ARMENT-2   68 HBC   0 OLD DATA
R3   1     (-0.27)                         ARMENT-3   69 HBC   0                   9/69
R3   1     (-0.30)     (0.03)              ARMENT-4   69 HBC   0 NEW CATA          9/69
R3   1  PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CCNVENTICN (SEE TEXT) 10/74*
R3          -0.27                          BERLEY     69 HBC   0 K-P TO SIGMA PI   6/70
R3          -0.29      (C.C3)              GALTIERI   70 HBC   0 SIG PI,EDPWA      7/70
R3          -0.38                          KIM        71 DPWA    K-MATRIX ANAL.    3/71
R3           -.28       (.05)              BAXTER     73 DPWA  0 K- P TO NEUTRALS 10/74*
R3           -.23       (.03)              LONDCN     75 HLBC  0 K- P TO SIGO PIO  4/75*
R3           -.31       (.03)              RLIC       76 DPWA    KBAR N MULTICHNL  1/76*

R4      Y*0(1670) FROM KBAR N TO SIGMA(1385) PI              SQRT(P1*P4)
R4           -.18        .05               PREVOST    74 DPWA 0- K-N TO S(1385)PI 10/74*


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Baryons
Λ(1670), Λ(1690), Λ(1800)


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                              REFERENCES FOR Y*0(1670)

BERLEY    65 PRL 15 641       +CONNOLLY, HART, RAUM, STCNEHILL, +   (BNL)IJP
ARMENT-1 68 NP B8 195         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-2 68 NP B8 223         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP

ARMENT-3 69 LUND PAPER 229    ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
   VALUES ARE QUOTED IN LEVI SETTI 69.
ARMENT-4 69 NP B14 91         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BERLEY    69 PL 30B 430       + HART, RAHM, WILLIS, YAMAMOTO          (BNL)IJP
GALTIERI 70 DUKE 173          A. BARBARO GALTIERI                     (LRL)IJP
CONFORTO 71 NP  B34  41       +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+EID)IJP
KIM       71 PRL 27 356       J K KIM                                (HARV)IJP
   ALSO  70 DUKE 161          J. K. KIM                              (HARV)IJP
LANGBEIN 72 NP B47 477        +WAGNER                                (MPIM)IJP
BAXTER    73 NP B67 125       BAXTER,BUCKINGHAM,CORBETT,DUNN,+    (OXFORD)IJP
HART      73 PURDUE CONF. 311 +RICE,BACASTOW,FUNG,+  (TENN+UCR+MASA+BUFF)IJP
PREVOST  74 NP B69 246        PREVOST,BARLOUTAUD,+          (SACL+CERN+HEID)
LONDCN    75 NP B85 289       LONDON,YU,BOYD,+  (BNL,CERN,EPOL,ORSA,TORI)

RLIC      76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+     (RHEL+LOIC)IJP

                              PAPERS NOT REFERREC TC IN CATA CARDS

BIRMINGH 66 PR 152 1148          (BIRMINGHAM,GLASGOW,LOIC,OXFORC,RUTHERFD)
LEVISETT 69 LUND 339          R LEVI SETTI  (RAPPORTEUR)           (CHICAGO)
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Λ(1690) — D''_{03}

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55  Y*0(1690, JP=3/2-) I=0

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

THIS RESONANCE IS WELL ESTABLISHED.

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                    55  Y*0(1690) MASS (MEV)

M          (1696.0)    (3.0)            ARMENT-1  68 HBC   0 ELASTIC, CH EXCH 11/68
M          (1681.0)    (2.0)            ARMENT-3  68 HBC   0 K-P TO SIGMA PI  11/68
M           1681.      (8.)             BARTLEY   68 DBC   0 K-P AND K-D DATA 11/68
M           1655.0     (4.0)            BUGG      68 CNTR  0 K-P, D TOTAL      7/68
M   M      (1697.0)    (2.0)            CONFORTO  68 HBC   0 ELASTIC, CH EXCH 11/68
M   A       1691.0     (2.0)            ARMENT-4  69 HBC   0 ELAS,CH EXC.ED    9/69
M   A       1688.0     (2.0)            ARMENT-4  69 HBC   0 K-P TO SIG PI.ED  9/69
M           1689.0                      BERLEY    69 HBC   0 K-P TO SIGMA PI   6/70
M           1701.0     (4.0)            BERTANZA  69 HBC   0 ELASTIC, CH EXCH  9/69
M           1680.0     (5.0)            GALTIERI  70 HBC   0 SIG PI,EDPWA      7/70
M           1688.0     (3.0)            CONFORTO  71 HBC   0 K-P,ELAST,CEX     6/70
M           1690.                       KIM       71 DPWA    K-MATRIX ANAL.    3/71
M           1680.0    (20.0)            LANGBEIN  72 IPWA    MULTICHANNEL     12/72
M           1670.     (10.)             BAXTER    73 DPWA  0 K- P TO NEUTRALS 10/74*
M           1684.      (3.)             HART      73 DPWA    EL+CX,.7-.8GEV/C  2/74
M           1690.      (5.)             RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
M   M   THE Y*0(1690) IS AT THE EDGE OF THE ENERGY REGION ANALYZED BY
M   M  CONFORTO.  THE SAME CATA AS WELL AS OTHERS EXTENDING TO LOWER
M   M  ENERGIES ARE INCLUDED IN ARMENTEROS 1.
M   A   ANALYSIS INCLUDES OLC AND NEW DATA OF CHS COLLAB.  .43-.8 GEV/C     10/69
M   A   THE APPARENT DISCREPANCY BETWEEN THE SIGMA PI AND OTHER RESULTS IS
M   A PROBABLY NOT SERIOUS.  THE ERRORS GIVEN ARE JUST STATISTICAL.  THE
M   A SYSTEMATIC ERRORS THAT RESULT FROM THE RESTRICTIVE PARAMETRIZATION
M   A OF THE PARTIAL-WAVE AMPLITUDES ARE NOT INCLUDED, AND CAN BE LARGE.

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                    55  Y*0(1690) WIDTH (MEV)

W           (35.0)     (7.0)            ARMENT-1  68 HBC   0 OLD DATA         11/68
W           (85.0)     (7.0)            ARMENT-3  68 HBC   0 OLD DATA         11/68
W            48.      (15.)             BARTLEY   68 DBC   0 K-P AND K-D DATA 11/68
W            40.0      (7.0)            BUGG      68 CNTR  0                   7/68
W   M       (27.0)     (5.0)            CONFORTO  68 HBC   0 SEE NOTE M ABOVE 11/68
W   A        31.0      (7.0)            ARMENT-4  69 HBC   0 ELAS,CH EXC.ED    9/69
W   A        72.0      (6.0)            ARMENT-4  69 HBC   0 K-P TO SIG PI ED  9/69
W            57.0                       BERLEY    69 HBC   0 K-P TO SIGMA PI   6/70
W            28.0      (8.0)            BERTANZA  69 HBC   0                   9/69
W            85.0     (10.0)            GALTIERI  70 HBC   0 SIG PI,EDPWA      7/70
W            64.0      (5.0)            CONFORTO  71 HBC   0 K-P,ELAST,CEX     6/70
W            55.                        KIM       71 DPWA    K-MATRIX ANAL.    3/71
W            40.0     (10.0)            LANGBEIN  72 IPWA    MULTICHANNEL     12/72
W            30.      (10.)             BAXTER    73 DPWA  0 K- P TO NEUTRALS 10/74*
W            86.       (9.)             HART      73 DPWA    EL+CX,.7-.8GEV/C  2/74
W            60.       (5.)             RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
       SEE THE NOTES ACCCMPANYING THE MASSES QUOTED

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                    55  Y*0(1690) PARTIAL DECAY MCDES

                                                              DECAY MASSES
P1      Y*0(1690) INTO KBAR N                                 497+ 939
P2      Y*0(1690) INTO SIGMA PI                               1189+ 139
P3      Y*0(1690) INTO LAMBCA PI PI                           1115+ 139+ 139
P4      Y*0(1690) INTO SIGMA PI PI                            1189+ 139+ 139
P5      Y*0(1690) INTO Y*1(1385) PI S-WAVE                    139+1384
P6      Y*0(1690) INTO LAMBDA ETA                             1115+ 548

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                    55  Y*0(169C) BRANCHING RATIOS

    THE SUM OF ALL THE QUOTED BRANCHING RATIOS IS MORE THAN 1.0.  THE
  TWO-BODY RATIOS ARE FROM PARTIAL WAVE ANALYSES, AND THUS PROBABLY ARE
  MORE RELIABLE THAN THE THREE-BODY RATIOS, WHICH ARE CETERMINED FROM
  BUMPS IN CROSS SECTIONS.  OF THE LATTER, THE SIGMA PI PI BUMP LOOKS
  MORE SIGNIFICANT (THE ERROR GIVEN FOR THE LAMBDA PI PI RATIO LOCKS UN-
  REASONABLY SMALL).  HARDLY ANY OF THE SIGMA PI PI DECAY CAN BE VIA
  Y*1(1385), FOR THEN NINE TIMES AS MUCH LAMBDA PI PI DECAY WOULD BE
  REQUIRED.

R1      Y*0(1690) INTO (KBAR N)/TCTAL                       (P1)
R1           (0.18)    (0.03)           ARMENT-1  68 HBC   0                  11/68
R1           (0.23)                     BUGG      68 CNTR  0 ASSUMING J=3/2    7/68
R1   M       (0.22)    (0.03)           CONFORTO  68 HBC   0 SEE NOTE M ABOVE 11/68
R1            0.18     (0.02)           ARMENT-4  69 HBC   0 NEW DATA          9/69
R1            0.28     (0.04)           BERTANZA  69 HBC   0                   9/69
R1   N       (0.34)    (0.02)           CONFORTO  71 HBC   0 K-P,ELAST,CEX     6/70
R1            0.22                      KIM       71 DPWA    K-MATRIX ANAL.    3/71
R1            0.15     (0.05)           LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R1             .24      (.01)           HART      73 DPWA    EL+CX,.7-.8GEV/C  2/74
R1             .24      (.03)           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R1   N   EFFECT IS AT END OF REGION ANALYZED. THIS COULD AFFECT VALUE OF X1.
R1       FROM ALL ABOVE WE ESTIMATE  X=0.20                                    3/72

R2      Y*0(1690) FROM KBAR N TO SIGMA PI                       SQRT(P1*P2)
R2   1       (-0.33)    (0.02)          ARMENT-3  68 HBC   0 OLD DATA         11/68
R2   1       (-0.36)    (0.02)          ARMENT-4  69 HBC   0 NEW DATA          9/69
R2   1   PUBLISHED SIGN CHANGED TC AGREE WITH LUND 1969 CONVENTION (SEE TEXT) 10/74*
R2            -0.27                     BERLEY    69 HBC   0 K-P TO SIGMA PI   6/70
R2            -0.31     (0.03)          GALTIERI  70 HBC   0 SIG PI,EDPWA      7/70
R2            -0.40                     KIM       71 DPWA    K-MATRIX ANAL.    3/71
R2             0.26     (0.07)          LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R2             -.20      (.03)          BAXTER    73 DPWA  0 K- P TO NEUTRALS 10/74*
R2             -.28      (.03)          LONDON    75 HLBC  0 K- P TO SIGO PIO  4/75*
R2             -.25      (.03)          RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R3      Y*0(1690) FROM KBAR N TO LAMBCA PI PI                   SQRT(P1*P3)
R3   B        (0.25)    (0.02)          BARTLEY   68 HDBC  0 LAM 2PI CROS SEC 11/68
R3   B   CNLY CROSS-SECTION CATA USED. ENHANCEMENT NOT SEEN BY PREVOST 71,     3/72

R4      Y*0(1690) FROM KBAR N TO SIGMA PI PI                    SQRT(P1*P4)
R4            (0.21)                    ARMENT-2  68 HDBC  0 K-N TO SIG PI PI 11/68

R5      Y*0(1690) FROM KBAR N INTO LAMBDA ETA                   SQRT(P1*P6)
R5              .00      (.03)          BAXTER    73 DPWA  0 K- P TO NEUTRALS 10/74*

R6      Y*0(1690) FROM KBAR N TO Y*1(1385) PI S-WAVE            SQRT(P1*P5)
R6             +.27      .04            PREVCST   74 DPWA 0- K-N TO S(1385)PI 10/74*

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                              REFERENCES FOR Y*0(1690)

ARMENT-1 68 NP B8 195         ARMENTEROS, BAILLCN, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-2 68 NP B8 216         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY) I
ARMENT-3 68 NP B8 223         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BARTLEY  68 PRL 21 1111       +CHU,DOWD,GREENE,+     (TUFTS,FSU,BRANDEIS) I
BUGG     68 PR 168 1466       +GILMORE, KNIGHT, +        (BIRM,CAVE,RHEL) I
   ALSO  67 PRL 18 62         CAVIES,DOWELL,+            (BIRM,CAVE,RHEL) I
CONFORTO 68 NP B8 265         +HARMSEN, LASINSKI, +    (CHICAGO,HEIDEL)IJP

ARMENT-4 69 NP B14 91         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BERLEY   69 PL 30B 430        + HART, RAHM, WILLIS, YAMAMOTO          (BNL)IJP
BERTANZA 69 PR 177 2036       +BIGI,CARRARA,CASALI, +     (PISA,BNL,YALE)IJP

GALTIERI 70 DUKE 173          A. BARBARO GALTIERI                     (LRL)IJP
CONFORTO 71 NP  B34  41       +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM      71 PRL 27 356        J K KIM                                (HARV)IJP
   ALSO  70 DUKE 161          J. K. KIM                              (HARV)IJP
LANGBEIN 72 NP B47 477        +WAGNER                                (MPIM)IJP
BAXTER   73 NP B67 125        BAXTER,BUCKINGHAM,CORBETT,DUNN,+    (OXFORD)IJP
HART     73 PURDUE CONF. 311  +RICE,BACASTOW,FUNG,+  (TENN+UCR+MASA+BUFF)IJP
PREVOST  74 NP B69 246        PREVOST,BARLOUTAUD,+          (SACL+CERN+HEID)

LONDCN   75 NP B85 289        LCNDON,YU,BOYD,+  (BNL,CERN,EPOL,ORSA,TORI)
RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSCN,ROSS+     (RHEL+LOIC)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS

PREVOST  71   AMSTERDAM CONF   + CHS COLLABORATION          (CERN+HEID+SACL)
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Λ(1800) — P''_{01}

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77  Y*0(1800, JP=1/2+) I=0

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THE EVIDENCE FOR THIS STATE IS SOMEWHAT CONFUSED.  IT
WAS FIRST SUGGESTED IN A PARTIAL WAVE ANALYSIS OF
KBAR N CATA BY THE BEHAVIOUR OF THE P01 AMPLITUDE
WHEN IT WAS PARAMETRIZED AS A TWO-STRAIGHT-LINE
BACKGROUND (ARMENTEROS 68).
   A WIDER AND MORE ELASTIC P01 RESONANCE AT ABOUT THE SAME MASS IS
SUGGESTED BY THE ANALYSIS OF BAILEY 69.  THIS USES CONSIDERABLY LESS
DATA THAN ALL OTHER ANALYSIS, FOR THIS REASON WE DO NOT QUOTE ANY
PARAMETERS FOR THE OTHER PARTIAL WAVES OBTAINEC IN THIS ANALYSIS.
   ALMOST ALL THE RECENT ANALYSES CONTAIN A P01 STATE, AND SOMETIMES
TWO, BUT THE MASSES AND BRANCHING RATIOS OBTAINED IN THE VARIOUS
ANALYSES ARE RATHER DIFFERENT.

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                    77  Y*0(1800) MASS (MEV)

M   O      (1745.0)                     ARMENTERO 68 HBC   0 ELASTIC, CH EXCH 11/68
M          (1740.0)                     BAILEY    69 DPWA  0 ELASTIC, CH EXCH 10/70
M          (1800.0)                     ARMENTERO 70 HBC   0 ELASTIC, CH EX    6/70
M          (1750.0)                     ARMENTERO 70 HBC   0 SIGMA PI          6/70
M   N      (1690.0)   (10.0)            GALTIERI  70 HBC   0 SIG PI,EDPWA      7/70
M   N   ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED    1/71
M          (1755.)                      KIM       71 DPWA    K-MATRIX ANAL.    3/71
M           1780.0      20.0            LANGBEIN  72 IPWA    MULTICHANNEL     12/72
M           1746.       10.             PREVCST   74 DPWA 0- K-N TO S(1385)PI 10/74*
M           1853.       20.             RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
M   O   OLD ANALYSIS, USING CLD DATA.
M            . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 3.4)

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                    77  Y*0(1800) WIDTH (MEV)

W           (147.0)                     ARMENTERO 68 HBC   0
W           (300.0)                     BAILEY    69 DPWA  0 ELASTIC, CH EXCH 10/70
W            (30.0)                     ARMENTERO 70 HBC   0 ELASTIC, CH EX    6/70
W            (70.0)                     ARMENTERO 70 HBC   0 SIGMA PI          6/70
W   N        (22.0)                     GALTIERI  70 HBC   0 SIG PI,EDPWA      7/70
W            (35.)                      KIM       71 DPWA    K-MATRIX ANAL.    3/71
W            120.0      10.0            LANGBEIN  72 IPWA    MULTICHANNEL     12/72
W             46.       20.             PREVCST   74 DPWA 0- K-N TO S(1385)PI 10/74*
W            166.       20.             RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
W            . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 3.1)
        SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                    77  Y*0(1800) PARTIAL CECAY MODES

                                                              DECAY MASSES
P1      Y*0(1800) INTO KBAR N                                 497+ 939
P2      Y*0(1800) INTO SIGMA PI                               1197+ 139
P3      Y*0(1800) INTO SIGMA(1385) PI                         139+1384

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Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ(1800), Λ(1815)

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                    77  Y*0(1800) BRANCHING RATICS

R1     Y*0(1800) INTO (KBAR N)/TOTAL                   (P1)
R1           (0.4)                   ARMENTERO 68 DPWA  O ELASTIC, CH EXCH 11/68
R1           (0.55)                  BAILEY    69 DPWA  O ELASTIC, CH EXCH 10/70
R1           (0.15)                  ARMENTERO 70 DPWA  O ELASTIC, CH EXCH 10/70
R1           (0.30)                  KIM       71 DPWA    K-MATRIX ANAL.    3/71
R1            0.36      0.05         LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R1             .21       .04         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R1             . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)

R2     Y*0(1800) FROM KBAR N INTO SIGMA PI            SQRT(P1*P2)
R2  2        (+0.20)                 ARMENTERO 70 DPWA  0 K-P TO SIGMA PI   6/70
R2  2  PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CONVENTION (SEE TEXT) 10/74*
R2  N        (-0.13)    (0.03)       GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
R2           (0.17)                  KIM       71 DPWA    K-MATRIX ANAL.    3/71
R2           (0.01) OR LESS          LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R2             -.24      .04         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R3     Y*0(1800) FROM KBAR N TO SIGMA(1385) PI        SQRT(P1*P3)
R3             +.18      .10         PREVOST   74 DPWA 0- K-N TO S(1385)PI 10/74*
       SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                         REFERENCES FOR Y*0(1800)

ARMENTER 68 NP B8 195          ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BAILEY   69 THESIS UCRL-50617 DAVID SAAL BAILEY          (LRL LIVERMORE)IJP
ARMENTER 70 DUKE CONF 123      ARMENTEROS, BAILLON, +         (CERN, HEIDEL)IJP
GALTIERI 70 DUKE CONF 173      A BARBARO-GALTIERI                      (LRL)IJP
KIM      71 PRL 27 356         J K KIM                                (HARV)IJP
  ALSO   70 DUKE 161           J. K. KIM                              (HARV)IJP
LANGBEIN 72 NP B47 477         +WAGNER                                (MPIM)IJP

PREVOST  74 NP B69 246         PREVOST,BARLOUTAUD,+         (SACL+CERN+HEID)
RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+     (RHEL+LOIC)IJP

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Λ(1800) 102 Y*0(1800, JP=9/2-) I=0 **G_{09}** 1/76*

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THIS NARROW RESONANCE SEEMS NECESSARY TO FIT A PEAK
IN THE A7 COEFFICIENT OF THE K-P ANGULAR DISTRIBUTION.
IT IS NOT REQUIRED IN ANY OTHER CHANNEL.
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                    102  Y*C(1800) MASS (MEV)                            1/76*

M         1808.        5.            RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                    102  Y*0(1800) WIDTH (MEV)                           1/76*

W           27.        5.            RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                    102  Y*0(1800) PARTIAL DECAY MODES                   1/76*

                                                          DECAY MASSES
P1     Y*0(1800) INTO KBAR N                             497+ 939
P2     Y*0(1800) INTO SIGMA PI                          1197+ 139

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                    102  Y*0(1800) BRANCHING RATICS                      1/76*

R1     Y*0(1800) INTO (KEAR N)/TOTAL                   (P1)              1/76*
R1             .04       .01         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R2     Y*0(1800) FROM KBAR N INTO SIGMA PI            SQRT(P1*P2)        1/76*
R2          LESS THAN .04            RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                         REFERENCES FOR Y*0(1800)

RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSCN,ROSS+     (RHEL+LOIC)IJP

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Λ(1815) 39 Y*0(1815, JP=5/2+) I=0 **F'_{05}**

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SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THIS STATE IS WELL ESTABLISHED. MOST OF THE QUOTED ER-
RORS ARE STATISTICAL ONLY. THE SYSTEMATIC ERRORS DUE TO
THE PARTICULAR PARAMETRIZATION USED IN THE P.W.A. ARE
NOT INCLUDED. FOR THIS REASON WE DO NOT CALCULATE WEIGHTED AVERAGES FOR
MASS AND WIDTH.

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                    39  Y*0(1815) MASS (MEV)

M   N     1813.0     (2.0)           ARMENT-1  67 HBC   0 K-P TO SIGMA PI   8/67
M   N     1816.0     (4.0)           BELL      67 HDBC  0 K-N TO SIGMA PI  11/67
M   N     1817.0     (2.0)           ARMENT-3  68 HBC   0 ELASTIC, CH EXCH 11/68
M   N     1819.0     (4.0)           BUGG      68 CNTR  0 K-P, D TOTAL      6/68
M   N     1825.0     (1.0)           BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
M   N     1819.0     (1.0)           BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
M         1830.0    (10.0)           COOL      70 CNTR    K-P, D TOTAL     10/70
M         1820.0    (10.0)           GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
M   N     1818.0     (2.0)           CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
M         1810.                      KIM       71 DPWA    K-MATRIX ANAL.    3/71
M   N     1823.0     (3.0)           KANE      72 DPWA  0 K-P TO PI SIG    10/71
M   N     1818.0     (3.0)           LANGBEIN  72 IPWA    MULTICHANNEL     12/72
M   N     1822.      (2.)            RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
M   N  ERROR STATIST. CNLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED  1/71

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                    39  Y*0(1815) WIDTH (MEV)

W           87.0     (15.0)          ARMENT-1  67 HBC   0                   8/67
W           64.0     (12.0)          BELL      67 HDBC  0                  11/67
W   N       71.0      (4.0)          ARMENT-3  68 HBC   0 ELASTIC, CH EXCH 11/68
W   N       75.0      (7.0)          BUGG      68 CNTR  0 K-P, D TOTAL      6/68
W   N       80.0      (6.0)          BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
W   N       79.0      (3.0)          BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
W          100.0                     COOL      70 CNTR    K-P, D TOTAL     10/70
W          100.0     (20.0)          GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
W   N       90.0      (4.0)          CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
W           70.                      KIM       71 DPWA    K-MATRIX ANAL.    3/71
W   N      104.0     (16.0)          KANE      72 DPWA  0 K-P TO PI SIG    10/71
W   N       70.0      (5.0)          LANGBEIN  72 IPWA    MULTICHANNEL     12/72
W   N       81.       (5.)           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
       SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                    39  Y*0(1815) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     Y*0(1815) INTO KBAR N                             497+ 939
P2     Y*0(1815) INTO SIGMA PI                          1189+ 139
P3     Y*0(1815) INTO Y*1(1385) PI P-WAVE                139+1384
P4     Y*0(1815) INTO SIGMA PI PI                       1192+ 139+ 139
P5     Y*0(1815) INTO ETA LAMBDA                         548+1115

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

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        P 1          P 2          P 3          P 4         P 5
P 1  .6009+-.0214
P 2   -.5154     .1155+-.0080
P 3   -.1541      .0795     .1390+-.0261
P 4   -.4139      .0216      -.7638    .1292+-.0308
P 5   -.0642      .0331       .0C99      -.2505   .0153+-.0086

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                    39  Y*0(1815) BRANCHING RATIOS

       ERRORS QUOTED BY EXPERIMENTERS DO NOT INCLUDE UNCERTAINTY DUE
       TO PARAMETRIZATICN USED IN THE P.W.A.  THEY SHOULD BE INCREASED.

R1     Y*0(1815) INTO (KBAR N)/TOTAL                   (P1)
R1            0.62      0.02         ARMENT-3  68 HBC   0 ELASTIC, CH EXCH 11/68
R1           (0.72)                  BUGG      68 CNTR  0 K-P, D TOTAL      6/68
R1            0.65      0.02         BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
R1            0.58      0.02         BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
R1           (0.8)                   COOL      70 CNTR    K-P, D TOTAL     10/70
R1            0.63      0.01         CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
R1           (0.52)                  KIM       71 DPWA    K-MATRIX ANAL.    3/71
R1            0.47      0.02         LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R1             .57       .02         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R1             . . . . . . . . . . .
R1  AVG       0.601     0.023   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.5)
R1  STUDENT   0.614     0.010   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1  FIT       0.601     0.021  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 3.2)

R2     Y*0(1815) FROM KBAR N INTO SIGMA PI            SQRT(P1*P2)
R2  1        -0.27      0.01         ARMENT-1  67 DPWA  0 K-P TO SIGMA PI  10/74*
R2  1 PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CONVENTION (SEE TEXT) 10/74*
R2            0.23      0.025        BELL      67 DPWA  0 K-P TO SIGMA PI  11/67
R2           -0.26      0.03         GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
R2           (0.26)                  KIM       71 DPWA    K-MATRIX ANAL.    3/71
R2           -0.268     0.027        KANE      72 DPWA  0 K-P TO PI SIG    10/71
R2            0.25      0.03         LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R2            -.28       .03         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R2             . . . . . . . . . . .
R2  AVG MOD   0.2645    0.0078  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  STUDENT   0.2650    0.0087  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2  FIT       0.2635    0.0078 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3     Y*0(1815) FROM KBAR N TO Y*1(1385) PI P-WAVE   SQRT(P1*P3)
R3  A        (0.3)     (0.05)        ARMENT-2  67 HBC   0 K-P TO LAM P+ P+
R3            +.27       .03         PREVOST   74 DPWA 0- K-N TO S(1385)PI 10/74*
R3             . . . . . . . . . . .
R3  FIT       0.289     0.027  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R4     Y*0(1815) INTO (Y*1(1385) PI)/TOTAL            (P3)
R4            0.20      0.05         BIRGE     65 HBC   0 K-P TO LAM PI PI  7/66
R4             . . . . . . . . . . .
R4  FIT       0.139     0.026  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R5     Y*0(1815) INTO (SIGMA PI PI)/TOTAL             (P4)
R5   P      NO CLEAR SIGNAL          ARMENT-4  68 HDBC  0 K-N TO SIG PI PI 11/68
R5   P   THERE IS A SUGGESTICN CF A BUMP, ENOUGH TO BE CONSISTENT WITH
R5     WHAT IS EXPECTED FROM SIGMA PI DECAY OF THE Y*1(1385) -- ABOUT 0.02.
R5             . . . . . . . . . . .
R5  FIT       0.129     0.031  FROM FIT

R6     Y*0(1815) FROM KBAR N TO ETA LAMBDA                 SQRT(P1*P5)      9/73
R6           -.096      .040      .020 RADER      73 MPWA                   9/73
R6             . . . . . . . . . . .
R6  FIT       0.096     0.027  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                         REFERENCES FOR Y*0(1815)
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BIRGE    65 ATHENS CONF  296  +ELY,KALMUS,KERNAN,LOUIE,SAHOURIA, +  (LRL)IJP
ARMENT-1 67 PL 24B 198        ARMENTEROS, F LUZZI, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-2 67 ZEIT PHYS 202 486 ARMENTEROS, F LUZZI, + (CERN,HEIDEL,SACLAY)IJP
BELL     67 PRL 19 936        R B BELL                                (LRL)IJP
ARMENT-3 68 NP B8 195         ARMENTEROS, BAILLCN, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-4 68 NP B8 216         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY) I
BUGG     68 PR 168 1466       +GILMORE, KNIGHT,    +      (RHEL+BIRM+CAVE) I
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Baryons

Λ(1815), Λ(1830), Λ(1860)

Data Card Listings

For notation, see key at front of Listings.

BRICMAN 70 PL 31B 152 +FERRO LUZZI, PERREAU,+ (CERN,CAEN,SACLAY)
BRICMAN1 70 PL 33B 511 +FERRO-LUZZI,LAGNAUX (CERN)
COOL 70 PR D1 1887 +GIACOMELLI, KYCIA, LEONTIC, LI, + (BNL) I
GALTIERI 70 DUKE CONF 173 A BARBARO-GALTIERI (LRL)IJP

CONFORTO 71 NP B34 41 +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM 71 PRL 27 356 J K KIM (HARV)IJP
ALSO 70 DUKE 161 J. K. KIM (HARV)IJP

KANE 72 PR D5 1583 D F KANE (LBL)IJP
LANGBEIN 72 NP B47 477 +WAGNER (MPIM)IJP
RADER 73 NC 16A 178 +BARLOUTAUD,+ (SACL+HEID+CERN+RHEL+CDEF)
PREVOST 74 NP B69 246 PREVOST,BARLOUTAUD,+ (SACL+CERN+HEID)

RLIC 76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+ (RHEL+LOIC)IJP

PAPERS NOT REFERRED TO IN DATA CARDS

THE FOLLOWING PAPERS ARE NOW OF ONLY HISTORICAL INTEREST --

CHAMBERL 62 PR 125 1696 CHAMBERLAIN,CROWE,KEEFE,KERTH, + (LRL) I
GALTIERI 63 PL 6 296 A BARBARO-GALTIERI,A HUSSAIN,RD TRIPP (LRL)IJ
SODICKSO 64 PR 133 B757 SODICKSON,MANNELLI,FRISCH,WAHLIG (MIT(BNL)) J
HOLLEY 65 UCRL-16274 THESIS W R HOLLEY (LRL) J
BIRMINGH 66 PR 152 1148 BIRMINGHAM,GLASGOW,I.C., OXFORD,RUTHERFORD
COOL 66 PRL 16 1228 +GIACOMELLI,KYCIA,LEONTIC,LUNDBY + (BNL)I
GELFAND 66 PRL 17 1224 +HARMSEN,LEVI-SETTI,PREDAZZI+ (EFI,ANL)
ARMENTER 67 NP B3 592 ARMENTEROS,FERRO-LUZZI+ (CERN,HEID,SACLAY)IJP
CONFORTO 68 NP B8 265 +HARMSEN, LASINSKI, + (CHICAGO,HEIDEL)IJP
LASINSKI 68 PR 163 1792 LASINSKI, LEVI SETTI, PREDAZZI (CHICAGO) JP
PREVOST 71 AMSTERDAM CONF + CHS COLLABORATION (CERN+HEID+SACL)

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Λ(1830) — 56 Y*0(1830, JP=5/2-) I=0 — D05

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THE BEST EVIDENCE FOR THIS RESONANCE COMES FROM THE SIGMA PI CHANNEL. IT IS WELL ESTABLISHED.

56 Y*0(1830) MASS (MEV)

M	N	1827.0	(3.0)	ARMENTERO 67 HBC	0	K-P TO SIGMA PI	8/67
M	N	1837.0	(11.0)	BELL 67 HBC	0	K-P TO SIGMA PI	11/67
M	N	1807.0	(10.0)	ARMENTERO 68 HBC	0	ELASTIC, CH EXCH	11/68
M		1840.0	(15.0)	GALTIERI 70 DPWA	0	K-P TO SIGMA PI	7/70
M	N	1831.0	(5.0)	CONFORTO 71 DPWA	0	ELASTIC, CH EXCH	6/70
M		1830.		KIM 71 DPWA		K-MATRIX ANAL.	3/71
M	K	(1720.)		KIM 71 DPWA		K-MATRIX ANAL.	3/71
M		1832.0	(5.0)	KANE 72 DPWA	0	K-P TO PI SIG	10/71
M		1810.0	(10.0)	LANGBEIN 72 IPWA		MULTICHANNEL	12/72
M		1825.	(10.)	RLIC 76 DPWA		KBAR N MULTICHNL	1/76*

M K POSSIBLE EFFECT MAINLY IN SIGMA PI. NOT CLEAR IF UNCORRELATED
M K WITH THE 1830 EFFECT
M N ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED 1/71

56 Y*0(1830) WIDTH (MEV)

W		75.0	(9.0)	ARMENTERO 67 HBC	0	K-P TO SIGMA PI	8/67
W		74.0	(18.0)	BELL 67 HBC	0	K-P TO SIGMA PI	8/67
W		123.0	(32.0)	ARMENTERO 68 HBC	0	ELASTIC, CH EXCH	11/68
W		150.0	(30.0)	GALTIERI 70 DPWA	0	K-P TO SIGMA PI	7/70
W		104.0	(35.0)	CONFORTO 71 DPWA	0	ELASTIC, CH EXCH	6/70
W		80.		KIM 71 DPWA		K-MATRIX ANAL.	3/71
W	K	(20.)		KIM 71 DPWA		K-MATRIX ANAL.	3/71
W		88.0	(10.0)	KANE 72 DPWA	0	K-P TO PI SIG	10/71
W		60.0	(20.0)	LANGBEIN 72 IPWA		MULTICHANNEL	12/72
W		94.	(10.)	RLIC 76 DPWA		KBAR N MULTICHNL	1/76*

SEE THE NOTES ACCOMPANYING MASSES QUOTED

56 Y*0(1830) PARTIAL DECAY MODES

		DECAY MASSES
P1	Y*0(1830) INTO KBAR N	497+ 939
P2	Y*0(1830) INTO SIGMA PI	1189+ 139
P3	Y*0(1830) INTO Y*1(1385) PI D-WAVE	139+1384
P4	Y*0(1830) INTO ETA LAMBDA	548+1115

56 Y*0(1830) BRANCHING RATIOS

R1 Y*0(1830) INTO (KBAR N)/TOTAL (P1)

R1		0.09	(0.01)	ARMENTERO 68 HBC	0	ELASTIC, CH EXCH	11/68
R1		0.03	(0.02)	BRICMAN1 70 DPWA		SIGTOT,ELAS,CHEX	1/71
R1		0.05	(0.02)	CONFORTO 71 DPWA	0	ELASTIC, CH EXCH	6/70
R1		(0.24)		KIM 71 DPWA		K-MATRIX ANAL.	3/71
R1		0.10	(0.03)	LANGBEIN 72 IPWA		MULTICHANNEL	12/72
R1		.04	(.03)	RLIC 76 DPWA		KBAR N MULTICHNL	1/76*

R2 Y*0(1830) FROM KBAR N INTO SIGMA PI SQRT(P1*P2)

R2	A	(-0.15)	(0.02)	ARMENTERO 67 DPWA	0	K-P TO SIGMA PI	10/74*

R2 A PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CONVENTION (SEE TEXT) 10/74*

R2		0.19	(0.01)	BELL 67 DPWA	0	K-P TO SIGMA PI	11/67
R2		-0.16	(0.03)	GALTIERI 70 DPWA	0	K-P TO SIGMA PI	7/70
R2		0.15		KIM 71 DPWA		K-MATRIX ANAL.	3/71
R2		-0.138	(0.018)	KANE 72 DPWA	0	K-P TO PI SIG	10/71
R2		0.27	(0.07)	LANGBEIN 72 IPWA		MULTICHANNEL	12/72
R2		-.17	(.03)	RLIC 76 DPWA		KBAR N MULTICHNL	1/76*

R3 Y*0(1830) FROM KBAR N TO ETA LAMBDA SQRT(P1*P4) 9/73
R3 -.044 .020 RADER 73 MPWA 9/73

R4 Y*0(1830) FROM KBAR N TO Y*1(1385) PI D-WAVE SQRT(P1*P3)
R4 +.13 .03 PREVOST 74 DPWA 0- K-N TO S(1385)PI 10/74*

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REFERENCES FOR Y*0(1830)

ARMENTER 67 PL 24B 198 ARMENTEROS, F-LUZZI, + (CERN,HEIDEL,SACLAY)IJP
BELL 67 PRL 19 936 R B BELL (LRL)IJP
ARMENTER 68 NP B8 195 ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
CONFORTO 68 NP B8 265 +HARMSEN, LASINSKI, + (CHICAGO,HEIDEL)IJP
IS SUPERSEDED BY CONFORTO 71.
BRICMAN1 70 PL 33B 511 +FERRO-LUZZI,LAGNAUX (CERN)
GALTIERI 70 DUKE CONF 173 A BARBARO-GALTIERI (LRL)IJP

CONFORTO 71 NP B34 41 +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM 71 PRL 27 356 J K KIM (HARV)IJP
ALSO 70 DUKE 161 J. K. KIM (HARV)IJP
KANE 72 PR D5 1583 D F KANE (LBL)IJP
LANGBEIN 72 NP B47 477 +WAGNER (MPIM)IJP
RADER 73 NC 16A 178 +BARLOUTAUD,+ (SACL+HEID+CERN+RHEL+CDEF)

PREVOST 74 NP B69 246 PREVOST,BARLOUTAUD,+ (SACL+CERN+HEID)
RLIC 76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+ (RHEL+LOIC)IJP

PAPERS NOT REFERRED TO IN DATA CARDS

PREVOST 71 AMSTERDAM CONF + CHS COLLABORATION (CERN+HEID+SACL)

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Λ(1860) — 60 Y*0(1860, JP=3/2+) I=0 — P03

THE JP=3/2+ ASSIGNMENT IS CONSISTENT WITH ALL AVAILABLE DATA (INCLUDING POLARIZATION) AND RECENT PARTIAL WAVE ANALYSES. THE DOMINANT INELASTIC MODES REMAIN UNKNOWN. SEE ALSO Y*0(2010) MINI-REVIEW.

60 Y*0(1860) MASS (MEV)

M	A	F07	1864.0	2.0	ARMENTERO 68 DPWA	0	ELASTIC, CH EXCH	11/68
M	N		1870.0	5.0	BUGG 68 CNTR	0	K-P TOTAL	7/68
M	A	F07	1877.0	6.0	BRICMAN 70 CNTR	0	TOTAL AND CH EX	6/70
M			1870.0	6.0	BRICMAN1 70 DPWA	0	SIGTOT,ELAS,CHEX	1/71
M	N		1883.0	10.0	CONFORTO 71 DPWA	0	ELASTIC, CH EXCH	6/70
M	1		(1710.)		KIM 71 DPWA		K-MATRIX ANAL.	3/71
M			1850.0	20.0	LANGBEIN 72 IPWA		MULTICHANNEL	12/72
M	2		(1868.)		LEA 73 DPWA		MULTICHNL K-MTRX	9/73
M			1894.	10.	HEMINGWA 75 DPWA	0	K- P TO KBAR N	11/75*
M	3		(1900.)		NAKKASYA 75 DPWA	0	K-P TO LAM. OMG.	1/76*
M			1900.	5.	RLIC 76 DPWA		KBAR N MULTICHNL	1/76*

M A THESE TWO ANALYSES GAVE THE F07 ASSIGNMENT, THEY HAVE TO BE 1/71
M A DISCARDED IN VIEW OF CONFORTO 70 AND BRICMAN1 70
M N DUE TO PARTICULAR PARAMETERIZATION USED,ERROR CAN BE LARGE 1/71
M 1 POSSIBLE EFFECT MAINLY IN SIGMA PI. WE TENTATIVELY LIST IT HERE.
M 2 ONLY UNCONSTRAINED STATES FROM TABLE 1 OF LEA73 ARE IN LISTINGS. 9/73
M 3 FOUND IN ONE OF TWO BEST SOLUTIONS. 1/76*
M . . . .
M AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)

60 Y*0(1860) WIDTH (MEV)

W	A	F07	39.0	7.0	ARMENTERO 68 DPWA	0	ELASTIC, CH EXCH	11/68
W	N		40.0	10.0	BUGG 68 CNTR	0	K-P TOTAL	7/68
W	A	F07	24.0	15.0	BRICMAN 70 CNTR	0	TOTAL AND CH EX	6/70
W			37.0	10.0	BRICMAN1 70 DPWA	0	SIGTOT,ELAS,CHEX	1/71
W	N		80.0	20.0	CONFORTO 71 DPWA	0	ELASTIC, CH EXCH	6/70
W	1		(20.)		KIM 71 DPWA		K-MATRIX ANAL.	3/71
W			125.0	20.0	LANGBEIN 72 IPWA		MULTICHANNEL	12/72
W	2		(323.8)		LEA 73 DPWA		MULTICHNL K-MTRX	9/73
W			107.	10.	HEMINGWA 75 DPWA	0	K- P TO KBAR N	11/75*
W	3		(100.)		NAKKASYA 75 DPWA	0	K-P TO LAM. OMG.	1/76*
W			72.	10.	RLIC 76 DPWA		KBAR N MULTICHNL	1/76*

W SEE THE NOTES ACCOMPANYING MASSES QUOTED
W . . . .
W AVERAGE MEANINGLESS (SCALE FACTOR = 2.9)

60 Y*0(1860) PARTIAL DECAY MODES

		DECAY MASSES
P1	Y*0(1860) INTO KBAR N	497+ 939
P2	Y*0(1860) INTO SIGMA PI	1189+ 139
P3	Y*0(1860) INTO LAMBDA OMEGA	1115+ 783

60 Y*0(1860) BRANCHING RATIOS

R1 Y*0(1860) INTO (KBAR N)/TOTAL (P1)

R1	A	F07	0.12	0.02	ARMENTERO 68 HBC	0	ELASTIC, CH EXCH	11/68
R1			(J+1/2)P1= 0.40		BUGG 68 CNTR	0		7/68
R1	A	F07	0.07	0.02	BRICMAN 70 CNTR	0	TOTAL AND CH EX	6/70
R1			0.14	0.02	BRICMAN1 70 DPWA	0	SIGTOT,ELAS,CHEX	1/71
R1	N		0.25	0.03	CONFORTO 71 DPWA	0	ELASTIC, CH EXCH	6/70
R1			0.37	0.05	LANGBEIN 72 IPWA		MULTICHANNEL	12/72
R1	2		(.32)		LEA 73 DPWA		MULTICHNL K-MTRX	9/73
R1			.24	.04	HEMINGWA 75 DPWA	0	K- P TO KBAR N	11/75*
R1			.18	.02	RLIC 76 DPWA		KBAR N MULTICHNL	1/76*

R1 SEE THE NOTES ACCOMPANYING MASSES QUOTED
R1 . . . .
R1 AVERAGE MEANINGLESS (SCALE FACTOR = 2.5)

R2 Y*0(1860) INTO SIGMA PI (P2)
R2 P PROBABLY SEEN GALTIERI 68 DBC 0 K-N TO SIG PI PI 11/68
R2 (0.03) OR LESS LANGBEIN 72 IPWA MULTICHANNEL 12/72
R2 P POSSIBLY THIS BUMP SEEN AT 1840+-10 MEV WITH A WIDTH OF 35+-10 MEV
R2 IS THE Y*0(1830), WHICH DECAYS STRONGLY TO SIGMA PI. HOWEVER THE
R2 NARROW WIDTH HERE ARGUES FOR ITS BEING THE Y*0(1860).

R3 Y*0(1860) FROM KBAR N TO SIGMA PI SQRT(P1*P2) 9/73
R3 2 (+.15) LEA 73 DPWA MULTICHNL K-MTRX 9/73
R3 -.09 .03 RLIC 76 DPWA KBAR N MULTICHNL 1/76*

R4 Y*0(1860) FROM KBAR N INTO LAMBDA OMEGA SQRT(P1*P3) 1/76*
R4 3 (.032) NAKKASYA 75 DPWA 0 K-P TO LAM. OMG. 1/76*

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REFERENCES FOR Y*0(1860)

ARMENTERO68 NP B8 195 ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BUGG 68 PR 168 1466 +GILMORE, KNIGHT, + (RHEL,BIRM,CAVE) I
GALTIERI 68 PRL 21 573 BARBARO-GALTIERI, MATISON, + (LRL,SLAC)

BRICMAN 70 PL 31B 152 +FERRO LUZZI, PERREAU,+ (CERN,CAEN,SACLAY)
BRICMAN1 70 PL 33B 511 +FERRO-LUZZI,LAGNAUX (CERN)
CONFORTO 71 NP B34 41 +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM 71 PRL 27 356 J K KIM (HARV)IJP
ALSO 70 DUKE 161 J. K. KIM (HARV)IJP
LANGBEIN 72 NP B47 477 +WAGNER (MPIM)IJP

Data Card Listings

Baryons

For notation, see key at front of Listings. Λ(1860), Λ(1870), Λ(2010), Λ(2020), Λ(2100)

LEA 73 NP B56 77 +MARTIN,MOORHOUSE+ (RHEL+LOUC+GLAS+AARHUS)IJP
HEMINGWA 75 NP B91 12 HEMINGWAY,EADES,HARMSEN+ (CERN,HEID,MPIM)IJP
NAKKASYA 75 NP B93 85 A. NAKKASYAN (CERN)IJP

RLIC 76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSCN,ROSS+ (RHEL+LOIC)IJP

PAPERS NOT REFERRED TO IN DATA CARDS

ARMENTER 67 NP B3 592 ARMENTEROS, F-LUZZI, + (CERN,HEIDEL,SACLAY)IJP
REPLACED BY ARMENTEROS 68 AND CONFORTO 68.
CONFORTO 68 NP B8 265 +HARMSEN, LASINSKI, + (CHICAGO,HEIDEL)IJP
SUPERSEDED BY CONFORTO 71.
LEVISETT 69 LUND 339 R.LEVI SETTI (RAPPORTEUR) (EFI)
ALBROW 71 NP B29 413 +ANDERSON,BOSNJAKOVIC,DAUM,ERNZ,+ (CERN)

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Λ(1870)

36 Y*0(1870, JP=1/2-) I=0 S01

THE S01 AMPLITUDE SHOWS A SECOND RESONANCE BEHAVIOR AT ABOUT 1800 MEV IN 4 ANALYSES. THE ELASTICITY OF KIM 71 IS SURPRISINGLY LARGE.

36 Y*0(1870) MASS (MEV)

M	(1872.0)	(10.0)	BRICMAN	70 DPWA	TOT, ELAS, CHEX	1/71
M	(1780.)		KIM	71 DPWA	K-MATRIX ANAL.	3/71
M	1830.0	(20.0)	LANGBEIN	72 IPWA	MULTICHANNEL	12/72
M	1825.	(20.)	RLIC	76 DPWA	KBAR N MULTICHNL	1/76*

36 Y*0(1870) WIDTH (MEV)

W	(100.0)	(20.0)	BRICMAN	70 DPWA	TOT, ELAS, CHEX	1/71
W	(40.)		KIM	71 DPWA	K-MATRIX ANAL.	3/71
W	70.0	(15.0)	LANGBEIN	72 IPWA	MULTICHANNEL	12/72
W	230.	(20.)	RLIC	76 DPWA	KBAR N MULTICHNL	1/76*

36 Y*0(1870) PARTIAL DECAY MODES

		DECAY MASSES
P1	Y*0(1870) INTO KBAR N	497+ 939
P2	Y*0(1870) INTO SIGMA PI	1197+ 139

36 Y*0(1870) BRANCHING RATIOS

R1 Y*0(1870) INTO (KBAR N)/TOTAL (P1)

R1	(0.18)	(0.02)	BRICMAN	70 DPWA	TOT, ELAS, CHEX	1/71
R1	(0.80)		KIM	71 DPWA	K-MATRIX ANAL.	3/71
R1	0.35	(0.15)	LANGBEIN	72 IPWA	MULTICHANNEL	12/72
R1	.37	(.05)	RLIC	76 DPWA	KBAR N MULTICHNL	1/76*

R2 Y*0(1870) FROM KBAR N TO SIGMA PI SQRT(P1*P2)

R2	(0.24)		KIM	71 DPWA	K-MATRIX ANAL.	3/71
R2	-.08	(.05)	RLIC	76 DPWA	KBAR N MULTICHNL	1/76*

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REFERENCES FOR Y*0(1870)

BRICMAN 70 PL 31B 511 C BRICMAN, M FERRO-LUZZI, J P LAGNAUX(CERN)IJP
KIM 71 PRL 27 356 J K KIM (HARV)IJP
ALSO 70 DUKE 161 J. K. KIM (HARV)IJP
LANGBEIN 72 NP B47 477 +WAGNER (MPIM)IJP

RLIC 76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+ (RHEL+LOIC)IJP

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Λ(2010)

89 Y*0(2010,) I=0

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

SEVERAL AMBIGUOUS RESONANCE POSSIBILITIES ARISE FROM THE ANALYSES LISTED HERE. POSSIBLE QUANTUM NUMBERS ARE D3 (GALTIERI 70, SIGMA PI), D3+F5 OR P3+D5 OR P1+D3 (BRANDSTETTER 72, LAMBDA OMEGA). A MORE RECENT LAMBDA OMEGA ANALYSIS (NAKKASYAN 75) FINDS TWO BEST SOLUTIONS, EACH WITH THE Y*0(2100) AND ONE ADDITIONAL RESONANCE WHICH CAN BE EITHER THE Y*0(1860,JP=3/2+) OR THE Y*0(2110,JP=5/2+).

89 Y*0(2010) MASS (MEV)

M		(2010.0) (30.0)	GALTIERI	70 DPWA	0 K-P TO SIGMA PI	7/70
M	1	1935. TO 1971.	BRANDSTE	72 DPWA	0 K-P TO LAM. OMG.	1/74
M	1	1951. TO 2034.	BRANDSTE	72 DPWA	0 K-P TO LAM. OMG.	1/74
M	1	PARAMETERS QUOTED ARE RANGES FROM THREE BEST FITS, THE LOWER				11/75*
M	1	(HIGHER) MASS STATE PROBABLY HAS J.LE.3/2(5/2).				11/75*

89 Y*0(2010) WIDTH (MEV)

W		(130.0) (50.0)	GALTIERI	70 DPWA	0 K-P TO SIGMA PI	7/70
W	1	180. TO 240. (LWR. MASS)	BRANDSTE	72 DPWA	0 K-P TO LAM. OMG.	1/74
W	1	73. TO 154. (HGR. MASS)	BRANDSTE	72 DPWA	0 K-P TO LAM. OMG.	1/74

SEE THE NOTES ACCOMPANYING MASSES QUOTED

89 Y*0(2010) PARTIAL DECAY MODES

		DECAY MASSES
P1	Y*0(2010) INTO KBAR N	497+ 939
P2	Y*0(2010) INTO SIGMA PI	1197+ 139
P3	Y*0(2010) INTO LAMBDA OMEGA	1115+ 783

89 Y*0(2010) BRANCHING RATIOS

R1 Y*0(2010) FROM KBAR N TO SIGMA PI SQRT(P1*P2)

R1	(-0.20)	(0.04)	GALTIERI	70 DPWA	0 K-P TO SIGMA PI	7/70

R2 Y*0(2010) FROM KBAR N INTO LAMBDA OMEGA SQRT(P1*P3)

R2	1	(.17) TO .25 (LWR.)	BRANDSTE	72 DPWA	0 K-P TO LAM. OMG.	1/74
R2	1	(.04) TO .15 (HGR.)	BRANDSTE	72 DPWA	0 K-P TO LAM. OMG.	1/74

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REFERENCES FOR Y*0(2010)

GALTIERI 70 DUKE CONF 173 A BARBARO-GALTIERI (LRL)IJP
BRANDSTE 72 NP B39 13 BRANDSTETTER,BUTTERWORTH,+ (RHEL+CDEF+SACL)

PAPERS NOT REFERRED TO IN DATA CARDS.

NAKKASYA 75 NP B93 85 A. NAKKASYAN (CERN)IJP

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Λ(2020)

27 Y*0(2020, JP=7/2+) I=0 F07

EFFECTS IN THIS PARTIAL WAVE HAVE OBSERVED AT SOMEWHAT DIFFERENT ENERGIES IN TWO CHANNELS. HOWEVER, LITCHFIELD 71 NOTE THAT THE NEED FOR THIS STATE IN THEIR ANALYSIS RESTS SOLELY ON A POSSIBLY INCONSISTENT POLARIZATION MEASUREMENT AT 1.784 GEV/C. THE STATE WAS NOT REQUIRED IN THE KBAR N TO KBAR N ANALYSIS OF HEMINGWAY 75, BUT COULD NOT BE CONCLUSIVELY RULED OUT.

27 Y*0(2020) MASS (MEV)

M	(2020.0)	(20.0)	GALTIERI	70 DPWA	0 K-P TO SIGMA PI	7/70
M	(2100.)	(30.)	LITCHFIE	71 DPWA	K-P TO KBAR N	10/71

27 Y*0(2020) WIDTH (MEV)

W	(160.0)	(30.0)	GALTIERI	70 DPWA	0 K-P TO SIGMA PI	7/70
W	(120.)	(30.)	LITCHFIE	71 DPWA	K-P TO KBAR N	10/71

27 Y*0(2020) PARTIAL DECAY MODES

		DECAY MASSES
P1	Y*0(2020) INTO KBAR N	497+ 939
P2	Y*0(2020) INTO SIGMA PI	1197+ 139

27 Y*0(2020) BRANCHING RATIOS

R1 Y*0(2020) INTO (KBAR N)/TOTAL (P1)

R1	(0.05)	(0.02)	LITCHFIE	71 DPWA	K-P TO KBAR N	10/71

R2 Y*0(2020) FROM KBAR N TO SIGMA PI SQRT(P1*P2)

R2	(-0.15)	(0.02)	GALTIERI	70 DPWA	0 K-P TO SIGMA PI	7/70

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REFERENCES FOR Y*0(2020)

GALTIERI 70 DUKE CONF 173 A BARBARO-GALTIERI (LRL)IJP
LITCHFIE 71 NP B30 125 LITCHFIELD,...+LESQUOY,+.. (RHEL+CDEF+SACL)IJP

PAPERS NOT REFERRED TO IN DATA CARDS.

HEMINGWA 75 NP B91 12 HEMINGWAY,EADES,HARMSEN+ (CERN,HEID,MPIM)IJP

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Λ(2100)

41 Y*0(2100, JP=7/2-) I=0 G07

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THIS ENTRY ONLY INCLUDES RESULTS FROM PARTIAL-WAVE ANALYSES. PARAMETERS OF PEAKS SEEN IN CROSS-SECTIONS AND INVARIANT-MASS DISTRIBUTIONS AROUND 2100 MEV ARE GIVEN IN THE NEXT ENTRY. EVENTUALLY THE PARTIAL-WAVE ANALYSES SHOULD GIVE THE BEST RESULTS, AS THEY ISOLATE THE G07 WAVE. THIS SUPERIORITY IS, HOWEVER, PROBABLY NOT YET ATTAINED, AND WE RELY ON BOTH ENTRIES FOR PARAMETERS GIVEN IN THE MAIN BARYON TABLE.

41 Y*0(2100) MASS (MEV)

M		(2120.0)		WOHL	66 HBC	K-P CH EX	7/66
M	A	(2080.0)	(10.0)	BURGUN	68 DPWA	0 K-P TO XI K	10/69
M	L	(2130.0)	(20.0)	BERTHON1	70 DPWA	0 K-P TO SIGMA PI	10/70
M		2110.0	(20.0)	GALTIERI	70 DPWA	0 K-P TO SIGMA PI	7/70
M		2100.	(15.)	LITCHFIE	71 DPWA	K-P TO KBAR N	10/71
M	L	2110.0	(30.0)	LITCHFIE	71 DPWA	K-P TO SIG PI	10/71
M	1	2113. TO 2154.		BRANDSTE	72 DPWA	0 K-P TO LAM. OMG.	1/74
M		2092.0	(12.0)	KANE	72 DPWA	0 K-P TO PI SIG	10/71
M		2105.	(10.)	HEMINGWA	75 DPWA	0 K- P TO KBAR N	11/75*
M	2	2110. OR 2089.		NAKKASYA	75 DPWA	0 K-P TO LAM. OMG.	11/75*
M		2110.	(10.)	RLIC	76 DPWA	KBAR N MULTICHNL	1/76*
M	2	QUOTED PARAMETERS CORRESPOND TO THE TWO BEST SOLUTIONS FOUND.					11/75*
M	2	EACH HAS THE Y*0(2100) AND ONE ADDITIONAL RESONANCE (P3 OR F5).					11/75*
M	A	BURGUN 68 SEE A RESONANCE-LIKE EFFECT IN THIS REGION IN THE					
M		REACTION K-P TO XI K. HOWEVER, AS THEY POINT OUT, IT IS NOT CLEAR					
M		WHETHER IT IS MAINLY THE G07 Y*0(2100) OR INSTEAD A SO FAR OTHERWISE					
M		UNOBSERVED RESONANCE WITH A SPIN LESS THAN 7/2.					
M	L	LITCHFIELD 71 IS AN UPDATE OF BERTHON1 70					3/72
M	1	PARAMETERS QUOTED ARE RANGES FROM THREE BEST FITS.					1/74

Baryons

Λ(2100), Λ(2110)

Data Card Listings

For notation, see key at front of Listings.

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                    41  Y*C(2100) WIDTH (MEV)

W          (145.0)                     WOHL      66 HBC                      7/66
W   A       (80.0)   (10.0)            BURGUN    68 DPWA  0 K-P TO XI K     10/69
W           140.0    (15.0)            BERTHON1  70 DPWA  0 K-P TO SIGMA PI 10/70
W            60.0    (25.0)            GALTIERI  70 DPWA  0 K-P TO SIGMA PI  7/70
W   B      (170.) TO 300.  .           LITCHFIE  71 DPWA    K-P TO KBAR N   10/71
W   B  LARGER VALUE CORRESPCNDS TC PURE B.W. LOWER VALUE , TO B.W. + BCKGRD
W    L      140.0    (50.0)   (30.0)   LITCHFIE  71 CPWA    K-P TO SIG PI   10/71
W    1      208. TO  229.              BRANDSTE  72 DPWA  0 K-P TO LAM. OMG.  1/74
W           144.0    (26.0)            KANE      72 DPWA  0 K-P TO PI SIG   10/71
W           241.     (30.)             HEMINGWA  75 DPWA  0 K- P TO KBAR N  11/75*
W    2      244. OR  302.              NAKKASYA  75 DPWA  0 K-P TO LAM. JMG. 11/75*
W           250.     (30.)             RLIC      76 CPWA    KBAR N MULTICHNL  1/76*
      SEE THE NOTES ACCCMPANYING MASSES CUOTED

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                    41  Y*0(2100) PARTIAL CECAY MODES

                                                                DECAY MASSES
P1      Y*0(2100) INTO KBAR N                                  497+ 939
P2      Y*0(2100) INTO SIGMA PI                               1197+ 139
P3      Y*0(2100) INTO XI K                                   1321+ 497
P4      Y*0(2100) INTO LAMBCA OMEGA                           1115+ 783
P5      Y*0(21C0) INTO ETA LAMBDA                              548+1115

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                    41  Y*0(2100) BRANCHING RATIOS

R1      Y*0(2100) INTO (KBAR N)/TCTAL                          (P1)
R1            (0.25)                   WOHL      66 HBC                      7/66
R1  D         (0.33)                   DAUM      68 CNTR    K-P ELA,POL,SIGT  7/70
R1             0.30      (.03)         LITCHFIE  71 DPWA    K-P TO KBAR N   .10/71
R1              .31      (.03)         HEMINGWA  75 DPWA  0 K- P TO KBAR N  11/75*
R1              .30      (.03)         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R1  D   DAUM 68 ASSUMES (J+1/2)*X VALUE SEEN IN TOTAL CRCSS SECTION.

R2      Y*0(2100) FROM KBAR N INTO SIGMA PI                    SQRT(P1*P2)
R2  L       (+0.16)     (0.02)         BERTHON1  70 DPWA  0 K-P TO SIGMA PI 10/70
R2           +0.06      (0.03)         GALTIERI  70 DPWA  0 K-P TO SIGMA PI  7/70
R2   L        0.16      (0.05)         LITCHFIE  71 DPWA    K-P TO SIG PI   10/71
R2           +0.096     (0.037)        KANE      72 DPWA  0 K-P TO PI SIG   10/71
R2            +.12      (.04)          RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R3      Y*0(2100) FROM KBAR N TO XI K                          SQRT(P1*P3)
R3            (0.05)                   TRIPP     67 RVUE  0 K-P TO XI K      8/67
R3  B         (0.09)    (0.01)         BURGUN    68 DPWA  0 K-P TO XI K     10/69
R3            (0.003)                  MULLER    69 DPWA  0                  7/70
R3             0.035     0.018         LITCHFIE  71 DPWA    K-P TO XI K      3/72
R3  B   BURGUN 68 UPDATED BY LITCHFIELD 71, WHO TAKES SOLUTION C OF BURGUN   3/72

R4      Y*0(2100) FROM KBAR N INTO LAMBDA OMEGA                SQRT(P1*P4)
R4   1        (.05) TO   .11           BRANDSTE  72 DPWA  0 K-P TO LAM. OMG.  1/74
R4   2        (.122)OR  .154           NAKKASYA  75 DPWA  0 K-P TO LAM. OMG. 11/75*

R5      Y*0(2100) FROM KBAR N TO ETA LAMBDA                    SQRT(P1*P5)   9/73
R5             -.050     .020          RADER     73 MPWA                     9/73
         SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                              REFERENCES FOR Y*0(2100)

WOHL      66 PRL 17 107         C G WOHL, F T SOLMITZ, M L STEVENSON  (LRL)IJP
TRIPP     67 NP B3 10           + LEITH, +    (LRL,SLAC,CERN,HEIDEL,SACLAY)
BURGUN    68 NP B8 447          +MEYER,PAULI, +     (SACLAY,COLFRANCE,RHEL)
DAUM      68 NP B7 19           +ERNE, LAGNAUX, SENS, STEUER, UDO    (CERN)JP
   CCNFIRMS THE SPIN-PARITY ASSIGNMENT.
MULLER    69 THESIS,UCRL 19372 R A MULLER                            (LRL)

BERTHON1 70 NP B24 417          +VRANA, BUTTERWCRTH, + (CCEF, RHEL, SACLAY)IJP
GALTIERI 70 DUKE CONF 173       A BARBARO-GALTIERI                   (LRL)IJP
LITCHFIE 71 NP  B30 125         LITCHFIELD,...+LESQUOY,+.. (RHEL+CDEF+SACL)IJP

BRANDSTE 72 NP B39 13           BRANCSTETTER+...+TALLINI   (RHEL,CDEF,SACL) IJP
KANE      72 PR D5 1583         D F KANE                             (LBL)IJP
RADER     73 NC 16A 178         +BARLOUTAUD,+     (SACL+HEID+CERN+RHEL+CDEF)

HEMINGWA 75 NP B91 12           HEMINGWAY,EADES,HARMSEN+   (CERN,HEID,MPIM)IJP
NAKKASYA 75 NP B93 85           A. NAKKASYAN                        (CERN)IJP

RLIC      76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSCN,ROSS+    (RHEL+LOIC)IJP
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Λ(2110)

F″05

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                    35  Y*0(2110, JP=5/2+) I=0

                       BERTHON1 70 FIND EITHER F05 OR D05 POSSIBLE IN
                    THE SIC PI CHANNEL, WITH F05 SLIGHTLY PREFERRED.
                    IN THE KBAR N CHANNEL, LITCHFIELD 71 (SAME GROUP)
                    FIND ONLY D05. AS USUAL, THE STATISTICS ARE MUCH
                    BETTER IN THE ELASTIC CHANNEL.
               ALTHOUGH KANE 72 FINDS AN F05 EFFECT, THE UNUSUALLY BROAD
     WIDTH MAY INVALIDATE A RESONANT INTERPRETATION.  HOWEVER RLIC 76 AND
     BELLEFCN 76 ALSO FIND AN F05.  THE WEIGHT OF THE EVIDENCE IS THUS IN
     FAVOR OF F05.  SEE ALSO THE Y*0(2010) MINI-REVIEW.

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                    35  Y*0(2110) MASS (MEV)

M          (2110.)     (10.)           BERTHON1  70 DPWA -  K- P TO SIG PI    1/71
M       D05 2140.       40.            LITCHFIE  71 DPWA    K-P TO KBAR N   10/71
M   A     (2141.0)     (6.0)           KANE      72 DPWA  0 K-P TO PI SIG   10/71
M   1     (2103.)                      NAKKASYA  75 DPWA  0 K-P TO LAM. OMG.  1/76*
M   .     (2140.)      (20.)           BELLEFON  76 DPWA  0 K- P TO SIG PI    1/76*
M         (2100.)      (50.)           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
M   A  RESCNANCE OUTSIDE RANGE OF DATA.
M   1  FCUND IN CNE OF TWO BEST SOLUTICNS.                                    1/76*

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                    35  Y*0(2110) WIDTH (MEV)

W           (185.)     (30.)           BERTHCN1  70 DPWA -  K- P TO SIG PI    1/71
W       D05  120.       40.            LITCHFIE  71 DPWA    K-P TO KBAR N   10/71
W   A       (504.0)    (10.0)          KANE      72 DPWA  0 K-P TO PI SIG   10/71
W   1       (391.)                     NAKKASYA  75 DPWA  0 K-P TO LAM. OMG.  1/76*
W           (140.)     (20.)           BELLEFON  76 DPWA  0 K- P TO SIG PI    1/76*
W           (200.)     (50.)           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                    35  Y*0(2110) PARTIAL CECAY MODES

                                                                DECAY MASSES
P1      Y*0(2110) INTO KBAR N                                  497+ 939
P2      Y*0(2110) INTO SIGMA PI                               1197+ 139
P3      Y*0(2110) INTO LAMBCA OMEGA                           1115+ 783

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                    35  Y*0(2110) BRANCHING RATIOS

R1      Y*0(2110) FROM KBAR N TO SIGMA PI                      SQRT(P1*P2)
R1            (+.17)     (.03)         BERTHON1  70 DPWA -  K- P TO SIG PI    1/71
R1   A      (+0.156)   (0.013)         KANE      72 DPWA  0 K-P TO PI SIG   10/71
R1            (+.14)     (.01)         BELLEFCN  76 DPWA  0 K- P TO SIG PI    1/76*
R1            (+.10)     (.03)         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R2      Y*0(2110) INTO (KBAR N)/TCTAL                          (P1)
R2      D05     0.14      0.04         LITCHFIE  71 DPWA    K-P TO KBAR N   10/71
R2              (.07)    (.03)         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R3      Y*0(2110) FROM KBAR N INTC LAMBDA OMEGA                SQRT(P1*P3)    1/76*
R3   1          (.112)                 NAKKASYA  75 DPWA  0 K-P TO LAM. OMG.  1/76*

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                              REFERENCES FOR Y*0(2110)

BERTHON1 70 NP B24 417          +VRANA,BUTTERWORTH,+      (CDEF,RHEL,SACLAY)IJP
LITCHFIE 71 NP  B30 125         LITCHFIELD,...+LESQUOY,+.. (RHEL+CDEF+SACL)IJP
KANE      72 PR D5 1583         D F KANE                             (LBL)IJP

NAKKASYA 75 NP B93 85           A. NAKKASYAN                        (CERN)IJP
BELLEFON 76 SBMTD. TO NP        DE BELLEFCN,BILLCIR,BERTHCN+   (CDEF+SACL)IJP
RLIC      76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+    (RHEL+LOIC)IJP
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2100 MEV REGION – PRODUCTION AND σ_{TOTAL} EXP'TS

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                    25  Y*0(2100, JP=    ) I=0        PRODUCTICN EXPERIMENTS

                    SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                    SEE THE NOTE TO THE G07 Y*0(2100), WHICH PRECEDES THIS
                    ENTRY.  HERE WE LIST ONLY PARAMETERS OF PEAKS IN CROSS
                    SECTIONS ANC INVARIANT-MASS DISTRIBUTIONS.  THE CROSS-
     SECTION PEAKS ARE AT LEAST DCMINANTLY ASSOCIATED WITH THE Y*0(2100),
     BUT MAY CONTAIN A SMALL CONTRIBUTION FRCM THE SUGGESTED BUT NOT ESTAB-
     LISHED OTHER RESCNANCES IN THIS REGION.

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                    25  Y*0(2100) MASS (MEV) (PROC. EXP.)

M         (2097.0)     (6.0)           BOCK      65 HBC     PBAR P 5.7 BEV/C  7/66
M          2100.0      (7.0)           BUGG      68 CNTR    K-P, D TCTAL      6/68
M          2121.0      (5.0)           BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
M          2107.0     (10.0)           COOL      70 CNTR    K-P, D TOTAL     10/70
M         (2135.0)    (20.0)           LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71

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                    25  Y*0(2100) WIDTH (MEV) (PROD. EXP.)

W           (24.0)    (14.0)   (24.0)  BOCK      65 HBC     INTO KBAR N (PI)  7/66
W           140.0     (15.0)           BUGG      68 CNTR                      6/68
W           147.0     (15.0)           BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
W           185.0                      COOL      70 CNTR    K-P, D TOTAL     10/70
W           (40.0)                     LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71

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                    25  Y*0(2100) PARTIAL CECAY MODES (PROD. EXP.)

                                                                DECAY MASSES
P1      Y*0(2100) INTO KBAR N                                  497+ 939
P2      Y*C(2100) INTO KBAR N PI                               497+ 939+ 139
P3      Y*0(2100) INTO LAMBDA ETA                             1115+ 548
P4      Y*0(2100) INTO LAMBCA CMEGA                           1115+ 783

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                    25  Y*0(2100) BRANCHING RATIOS (PROD. EXP.)

R1      Y*0(2100) INTO (KBAR N)/TCTAL                          (P1)
R1         THESE VALUES OF ELASTICITIES ASSUME J=7/2 --
R1             0.305                   BUGG      68 CNTR                      6/68
R1             0.24     (0.02)         BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
R1             0.4                     COOL      70 CNTR    K-P, D TCTAL     10/70

R2      Y*0(2100) INTO KBAR N PI                               (P2)
R2                SEEN                 BOCK      65 HBC

R3      Y*0(2100) FROM KBAR N INTO LAMBDA ETA                  SQRT(P1*P3)
R3            (0.09) OR LESS           FLATTE 2  67 HBC   0 K-P TO LAM ETA    6/68

R4      Y*0(2100) INTO (LAMBCA CMEGA)/TOTAL                    (P4)
R4            (0.1)  OR LESS           FLATTE 1  67 HBC   0 K-P TO LAM OMEGA  8/67

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                              REFERENCES FOR Y*0(2100) (PROD. EXP.)

BOCK      65 PL 17 166          +COOPER,FRENCH,KINSON, +       (CERN,SACLAY)
FLATTE 1 67 PR 155 1517         S M FLATTE                             (LRL)
FLATTE 2 67 PR 163 1441         S M FLATTE, C G WOHL                   (LRL)
BUGG      68 PR 168 1466        +GILMORE,KNIGHT, +         (RHEL,BIRM,CAVE) I

BRICMAN   70 PL 31B 152         +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL      70 PR D1 1887         +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
LU        70 PR D2 1846         +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)

                              PAPERS NOT REFERRED TO IN CATA CARDS

COOL      66 PRL 16 1228        +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
    SUPERSEDED BY COOL 70.
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Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ(2350), Λ(2585), Σ^+, Σ^-, Σ^0, Σ(1385)

Λ(2350) BUMPS

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42  Y*0(2350, JP=     ) I=0        PRODUCTICN EXPERIMENTS

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

DAUM 68 FAVORS JP=7/2- OR 9/2+. BRICMAN 70 FAVORS 9/2+.
LASINSKI 71 SUGGESTS THREE STATES IN THIS REGICN
USING A POMERON + RESCNANCES MODEL.  THERE IS NOW ALSO
ONE FORMATION EXPERIMENT WHICH WE INCLUDE HERE, DE BELLEFCN 76, WHICH
FINDS 9/2+ FROM A DPWA OF KBAR N TO SIGMA PI.

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                 42  Y*0(2350) MASS (MEV) (PRCC. EXP.)

M        2340.0     (7.0)            BUGG      68 CNTR    K-P, D TOTAL      6/68
M        2358.0     (6.0)            BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
M        2344.0    (15.0)            COOL      70 CNTR    K-P, D TOTAL     10/70
M       (2360.0)   (20.0)            LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71
M        2360.     10.               BELLEFCN  76 DPWA  0 K- P TO SIG PI    1/76*

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                 42  Y*0(2350) WIDTH (MEV) (PROD. EXP.)

W         140.0    (20.0)            BUGG      68 CNTR    K-P, D TOTAL      6/68
W         324.0    (30.0)            BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
W        (190.0)                     COOL      70 CNTR    K-P, D TOTAL     10/70
W         (55.0)                     LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71
W         120.       15.             BELLEFON  76 DPWA  0 K- P TO SIG PI    1/76*

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                 42  Y*0(2350) PARTIAL DECAY MCDES (PROD. EXP.)

                                                          DECAY MASSES
P1     Y*0(2350) INTO KBAR N                           497+ 939
P2     Y*0(2350) INTO SIGMA PI                        1197+ 139

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                 42  Y*0(2350) BRANCHING RATIOS (PROC. EXP.)

R1     Y*0(2350) INTO (KBAR N)/TOTAL                      (P1)
R1        J IS NOT DETERMINEC.  THE FCLLOWING IS (J+1/2)*P1.
R1          (0.57)                   BUGG      68 CNTR    K-P, D TOTAL      6/68
R1           1.1       0.25          BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
R1          (1.0)                    COOL      70 CNTR    K-P, D TOTAL     10/70

R2     Y*0(2350) FROM KBAR N INTO SIGMA PI                SQRT(P1*P2)       1/76*
R2           -.10      .02           BELLEFON  76 DPWA  0 K- P TO SIG PI    1/76*

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                         REFERENCES FOR Y*0(2350) (PROD. EXP.)

BUGG      68 PR 168 1466        +GILMORE,KNIGHT, +           (RHEL,BIRM,CAVE) I
DAUM      68 NP B7 19           +ERNE, LAGNAUX, SENS, STEUER, UDO    (CERN)JP
BRICMAN   70 PL 31B 152         +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL      70 PR D1 1887         +GIACOMELLI, KYCIA, LEONTIC, LI, +     (BNL) I
LU        70 PR D2 1846         +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)

BELLEFCN 76 SBMTD. TO NP        DE BELLEFON,BILLOIR,BERTHON+     (CDEF+SACL)IJP

                                PAPERS NOT REFERRED IN DATA CARDS
COOL      66 PRL 16 1228        +GIACOMELLI,KYCIA,LECNTIC,LI,LUNDBY,+ (BNL) I
    SUPERSEDED BY COOL 70.
LASINSKI 71 NP  B29  125        T A LASINSKI                           (EFI)IJP
BELLEF02 75 NC 28A 289          DE BELLEFON,BERTHON,BILLOIR+     (CDEF+SACL)
    PRESENTLY LISTED UNDER Y*1(2250), BUT ISOSPIN UNDETERMINED.
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Λ(2585) BUMPS

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7  Y*0(2585, JP=     ) I=0        PRODUCTICN EXPERIMENTS

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

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                 7  Y*0(2585) MASS (MEV) (PRCD. EXP.)

M        2585.0     45.0             ABRAMS    70 CNTR    K-P, D TOTAL     10/70
M       (2530.0)   (25.0)            LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71

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                 7  Y*0(2585) WIDTH (MEV) (PROD. EXP.)

W        (300.0)                     ABRAMS    70 CNTR    K-P, D TCTAL     10/70
W        (150.0)                     LU        70 CNTR  0 GAMMA P TC K+ Y*  1/71

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                 7  Y*0(2585) PARTIAL CECAY MCDES (PROD. EXP.)

                                                          DECAY MASSES
P1     Y*0(2585) INTO KBAR N                           497+ 939

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                 7  Y*0(2585) BRANCHING RATIOS (PROD. EXP.)

R1     Y*0(2585) INTO (KBAR N)/TCTAL                      (P1)
R1        J IS NOT KNOWN.  THE FCLLCWING IS (J+1/2)*P1.
R1          (1.0)                    ABRAMS    70 CNTR    K-P, D TOTAL     10/70
R1  C       (0.12)    (0.12)         BRICMAN   70 CNTR    TOTAL AND CH EX  10/70
R1  C    RESONANCE AT END OF REGION ANALYZED -- NO CLEAR SIGNAL.

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                         REFERENCES FOR Y*0(2585) (PROD. EXP.)

ABRAMS    70 PR 1D 1917         +COCL, GIACCMELLI, KYCIA, LEONTIC, +  (BNL) I
BRICMAN   70 PL 31B 152         +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
LU        70 PR D2 1846         +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)

                                PAPERS NOT REFERRED TO IN DATA CARDS

COOL      66 PRL 16 1228        +GIACOMELLI,KYCIA,LECNTIC,LUNDBY +     (BNL)I
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S=-1 I=1 HYPERON STATES (Σ)

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Σ^+

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19  SIGMA+(1189, JP=1/2+) I=1

SEE STABLE PARTICLE DATA CARD LISTINGS

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Σ^-

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20  SIGMA-(1198, JP=1/2+) I=1

SEE STABLE PARTICLE DATA CARD LISTINGS

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Σ^0

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21  SIGMA0(1193, JP=1/2+) I=1

SEE STABLE PARTICLE CATA CARD LISTINGS

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Σ(1385) P'_{13}

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43  Y*1(1385, JP=3/2+) I=1

FOR DISCUSSION OF INCCNSISTENCY OF ERRORS AND OUR
MODIFICATIONS, SEE NOTE CN K*(892)

FOR THE TABLES WE USE CNLY THE UNSTARREC DATA, WHICH
ATTEMPTS TO OBTAIN THE SEPARATE CHARGE-STATE MASSES AN
WICTHS.  SEE HOWEVER THE IDEOGRAMS INSERTED IN LISTING
THESE INDICATE SERICUS SYSTEMATICS, PERHAPS ARISING FROM INTERFERENCE E
FECTS THAT CHANGE WITH PRODUCTION MECHANISM AND BEAM MOMENTUM.

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                 43  Y*1(1385) MASS (MEV)

M       141(1384.0)                 ALSTCN    60 HBC  +- K-P 1.15 BEV/C
M          (1385.0)                 BERGE     61 HBC  +- K-P .4-.85 BEV/C
M        38(1384.0)                 MARTIN    61 HBC  +0 K20 P .98 BEV/C
M          (1392.0)    (7.0)        COLLEY    62 HLBC -0 PI- PRP 2. BEV/C
M          (1389.0)    (3.0)        BALTAY    65 HBC  +- PBAR P 3.7 BEV/C  7/66
M          (1392.0)   '(10.0)       MUSGRAVE  65 HBC  +-OPBAR P 3-4 BEV/C  7/66
M           1380.      5.           AMMANN    73 CBC     K-N 4.5GEV/C      9/73
M          (1386.)                  ATHERTCN  75 HBC     PBAR P 5.7 GEV/C  1/76*

MO      106(1381.0)    (4.0)        CURTIS    63 CSPK  0 PI-P 1.5 BEV/C
MO      330 1385.1      2.0         THCMAS    73 HBC     PI-P TO PIOKOLM   9/73
MO 2   3100 1380.       1.3         BORENSTE  74 HBC  +-OK-P TO(1385)+PIS 10/74*
MO 2     FROM FIT TO LAM PIO MASS SPECTRUM (IN LAM PI+ PI- PIO EVENTS) WITH
MO 2     WO FIXED AT 34 MEV.
MO          . . . . . . . . . . .
MO  AVG     1381.5      2.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.1)
MO  STUDENT1381.3       1.4     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M+   E 154 1376.0       3.9         ELY       61 HLBC +  K-P 1.11 BEV/C
M+   E            ERROR OF 3.0 ENLARGED TO 3.9 BY US,BECAUSE LT STATIST.ERR. 10/69
M+     170 1375.0       3.9         CCOPER    64 HBC  +  K-P 1.45 BEV/C
M+     859 1381.0       1.6         HUWE      64 HBC  +  K-P 1.22 BEV/C
M+     750 1382.0       1.0         ARMENTERO 65 HBC  +  K-P .9-1.2 BEV/C
M+   S 250 1382.6       2.1         SMITH     65 HBC  +  K-P 1.95 BEV/C    9/66
M+   S 250 1384.3       1.9         SMITH     65 HBC  +  K-P 1.8 BEV/C     9/66
M+   S            ERROR OF 1.4 ENLARGEC TO 2.1 BY US,BECAUSE <  STATIST.ER. 10/69
M+   S            ERROR OF 1.1 ENLARGED TO 1.9 BY US,BECALSE <  STATIST.ER. 10/69
M+   B  40 1383.0       4.0         BIRMINGHA 66 HBC  +  K-P 3.5           9/67
M+   B            ERROR OF 2.0 ENLARGED TO 4.0 BY US,BECAUSE <  STATIST.ERR. 10/69
M+         1378.0       5.0         LCNDCN    66 HBC  +  K-P 2.24 BEV/C    7/66
M+    1260 1384.4       1.0         SIEGEL    67 HBC  +  K-P AT 2.1 GEV/C 10/69
M+         1390.0       6.0         AGUILAR   70 HBC  +  K-P 4 GEV/SIG.PI  5/70
M+         1384.8       2.0         ATHERTON  71 HBC       LAM PI+ + C.C. 10/71
M+     470 1382.0       2.0         AGUILAR   72 HBC   + K-P TO LAM+PIS   10/74*
M+    2300 1383.5        .85        HABIBI    73 HBC     K-P TO 2PI LAM    9/73
M+    3740(1382.)      (1.)         BERTHCN   74 HBC   0 QUASI 2 BODY CS  10/74*
M+    6846 1381.        1.          BORENSTE  74 HBC  +-OK-P TO(1385)+PIS 10/74*
M+         1380.        2.          BARDADIN  75 HBC  +  K- P 14.3 GEV/C   1/76*
M+          . . . . . . . . . . .
M+  AVG     1382.53     0.50    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
M+  STUDENT1382.51      0.50    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                        (SEE IDEOGRAM BELOW )
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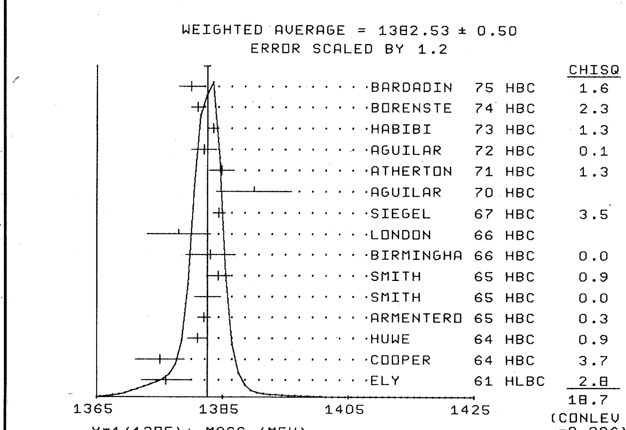

Baryons
Σ(1385)


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M-       93 1382.0       3.0                DAHL       61 CBC  -  K-C 0.45 BEV/C
M-     E 224 1376.0       4.4                ELY        61 HLBC -
M-     E                ERROR OF 3.0 ENLARGED TO 4.4 BY US,BECAUSE <  STATIST.ERR. 10/69
M-      200 1392.0       6.2                COOPER     64 HBC  -
M-     1086 1385.3       1.5                HUWE       64 HBC  -
M-     1380 1384.0       1.0                ARMENTERO  65 HBC  -
M-     S 120 1391.5       2.6                SMITH      65 HBC  -  K-P 1.8 BEV/C       9/66
M-     S  58 1399.8       4.0                SMITH      65 HBC  -  K-P 1.95 BEV/C      9/66
M-     S                ERROR OF 1.8 ENLARGED TO 2.6 BY US,BECALSE <  STATIST.ER.  10/69
M-     S                ERROR OF 1.4 ENLARGED TO 4.0 BY US,BECAUSE <  STATIST.ER.  10/69
M-          1389.0       9.0                LCNDCN     66 HBC  -                     7/66
M-      370 1390.7       2.0                SIEGEL     67 HBC  -  K-P AT 2.1 GEV/C 10/69
M-     1900 1390.7       1.2                HABIBI     73 HBC     K-P TO 2PI LAM     9/73
M-      722 1387.1       1.3                THOMAS     73 HBC     PI-P TG PI-K+LM    9/73
M-     3060(1389.)      (1.)                BERTHON    74 HBC   0 QUASI 2 BODY CS  10/74*
M-     2303 1383.        2.                 BORENSTE   74 HBC  +-OK-P TO(1385)+PIS 10/74*
M-          1383.        2.                 BARDADIN   75 HBC  -  K- P 14.3 GEV/C   1/76*
M-          • • • • • • • • •
M-   AVG    1386.6       1.2       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.3)
M-   STUDENT1386.15      0.80      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                         (SEE IDEOGRAM BELOW )
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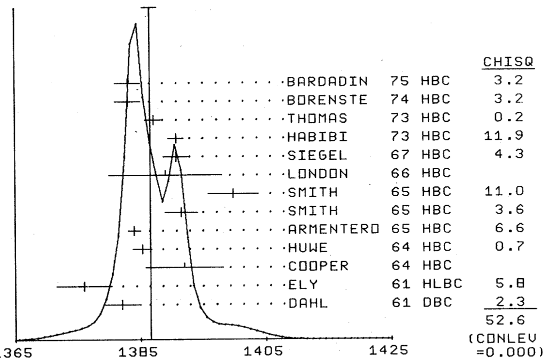
WEIGHTED AVERAGE = 1386.6 ± 1.2
ERROR SCALED BY 2.3

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                  43  (Y*-) - (Y*+) MASS DIFFERENCE (MEV)

D    R       (0.0)      (4.2)           ELY        61 HLBC +- K-P 1.11 BEV/C     8/66
D    R      (17.)       (7.)            COOPER     64 HBC                       10/69
D    R       (4.3)      (2.2)           HUWE       64 HBC  +- K-P 1.22 BEV/C     8/66
D    R       (2.0)      (1.5)           ARMENTERO  65 HBC  +- K-P .9-1.2 BEV/C   8/66
D    R       (7.2)      (2.1)           SMITH      65 HBC  +- K-P 1.8 BEV/C      9/66
D    R      (17.2)      (2.0)           SMITH      65 HBC  +- K-P 1.95 BEV/C     9/66
D    R      (11.0)      (9.0)           LONDON     66 HBC  +- K-P 2.24 BEV/C     8/66
D             9.0        6.0            LCNDCN     66 HBC  +- LAMBDA 3 PI EVTS   7/66
D    R       (6.3)      (2.0)           SIEGEL     67 HBC     K-P AT 2.1 GEV/C  10/69
D    R       (7.2)      (1.4)           HABIBI     73 HBC     K-P TO 2PI LAM     9/73
D    R     REDUNDANT WITH CATA IN MASS LISTING.

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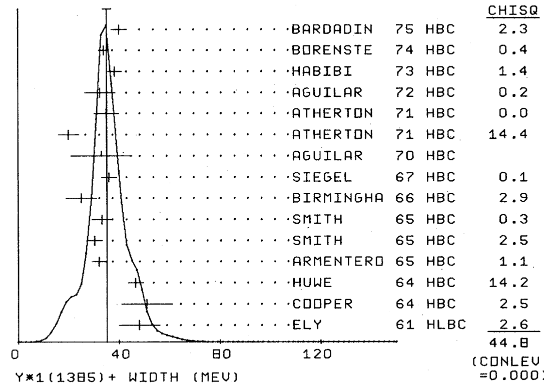
                  43  Y*1(1385) WIDTH (MEV)

W            (64.0)                     ALSTCN     60 HBC  +-
W            (40.0)                     BERGE      61 HBC  +-
W            (20.0)  OR LESS ,          MARTIN     61 HBC  +0
W            (80.0)   (10.0)            COLLEY     62 HLBC -0
W            (30.0)    (9.0)            CURTIS     63 OSPK  0
W            (26.0)    (5.0)            BALTAY     65 HBC  +-                    7/66
W            (38.0)    (9.0)            MUSGRAVE   65 HBC  +-0                   7/66
W             61.      10.              AMMANN     73 DBC     K-N 4.5GEV/C       9/73
W             89.      23.              ATHERTON   75 HBC     PBAR P 5.7 GEV/C   1/76*
W            • • • • • • • • •
W    AVG      65.5     10.2      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
W    STUDENT  65.2     10.2      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

WO     330    39.3      6.1             THCMAS     73 HBC     PI-P TO PIOKOLM    9/73
WO     3100 CONSISTENT WITH WO=W+=W-    BORENSTE   74 HBC  +-OK-P TO(1385)+PIS 10/74*

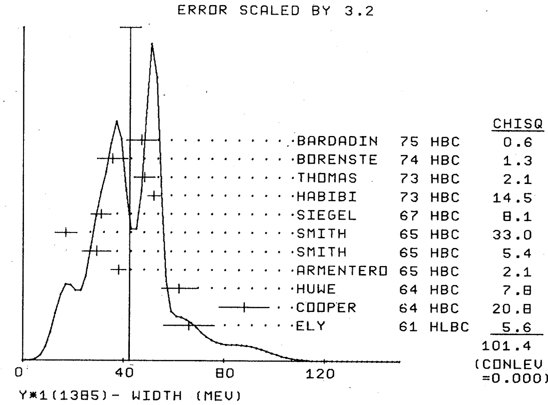
W+            48.0      8.0             ELY        61 HLBC +
W+            51.0     10.0             COOPER     64 HBC  +
W+            46.5      3.0             HUWE       64 HBC  +
W+            32.0      3.0             ARMENTERO  65 HBC  +
W+            30.3      3.1             SMITH      65 HBC  +  K-P 1.8 BEV/C      9/66
W+            33.1      3.8             SMITH      65 HBC  +  K-P 1.95 BEV/C     9/66
W+      40    25.0      6.0             BIRMINGHA  66 HBC  +  K-P 3.5            9/67
W+    1260    36.0      3.0             SIEGEL     67 HBC     K-P AT 2.1 GEV/C  10/69
W+            33.      12.0             AGUILAR    70 HBC  +  K-P 4 GEV/SIG.PI   5/70
W+ T    40    20.       4.              ATHERTON   71 HBC     LAM PI+ + C.C.    10/71
W+ T    FIT B.W. + PHASE SPACE BCKGRD
W+ R    40    35.       5.              ATHERTON   71 HBC     LAM PI+ + C.C.    10/71
W+            32.5      6.0             AGUILAR    72 HBC   + K-P TO LAM+PIS    10/74*
W+    2300    38.3      2.6             HABIBI     73 HBC     K-P TO 2PI LAM     9/73
W+ 1  6846    34.       2.              BORENSTE   74 HBC  +-OK-P TO(1385)+PIS 10/74*
W+            40.       3.2             BARCADIN   75 HBC  +  K- P 14.3 GEV/C   1/76*
W+ 1  RESULTS FROM LAM PI+ PI- AND LAM PI+ PI- PIO COMBINED BY US.
W+ R    FIT B.W. AND NO BCKGRD
W+            • • • • • • • • •
W+  AVG       35.2      1.7      AVERAGE (ERROR INCLUDES SCALE FACTCR OF 1.9)
W+  STUDENT   35.0      1.2      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                        (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 35.2 ± 1.7
ERROR SCALED BY 1.9




```
W-             (40.0)                    DAHL       61 CBC  -
W-              66.0      10.0           ELY        61 HLBC -
W-              88.0      10.0           COOPER     64 HBC  -
W-              62.0       7.0           HUWE       64 HBC  -
W-              38.0       3.0           ARMENTERO  65 HBC  -
W-              29.2       5.7           SMITH      65 HBC  -  K-P 1.80 BEV/C     9/66
W-              17.1       4.4           SMITH      65 HBC  -  K-P 1.95 BEV/C     9/66
W-       370    31.0       4.0           SIEGEL     67 HBC     K-P AT 2.1 GEV/C 10/69
W-      1900    51.9       2.5           HABIBI     73 HBC     K-P TO 2PI LAM     9/73
W-       722    48.2       4.0           THCMAS     73 HBC     PI-P TO PI-KOLM    9/73
W- 1    2303    35.5       6.            BORENSTE   74 HBC  +-OK-P TO(1385)+PIS 10/74*
W-              47.        6.            BARCADIN   75 HBC  -  K- P 14.3 GEV/C   1/76*
W-             • • • • • • • • •
W-   AVG        42.4       4.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.2)
W-   STUDENT    42.7       2.7     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                           (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 42.4 ± 4.2
ERROR SCALED BY 3.2

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               43  Y*1(1385) REAL PART OF POLE POSITION                  4/75*

RE+        1379.0      1.0               LICHTENB  74      +  EXTRAP HABIBI73   4/75*
RE-        1383.0      1.0               LICHTENB  74      -  EXTRAP HABIBI73   4/75*

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               43  Y*1(1385) IMAGINARY PART OF POLE POSITION             4/75*

IM+          17.5      1.5               LICHTENB  74      +  EXTRAP HABIBI73   4/75*
IM-          22.5      1.5               LICHTENB  74      -  EXTRAP HABIBI73   4/75*

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               43  Y*1(1385) PARTIAL CECAY MODES

                                                       DECAY MASSES
P1      Y*1(1385) INTO LAMBDA PI                       1115+ 139
P2      Y*1(1385) INTO SIGMA PI                        1197+ 139
P3      Y*1(1385) INTO LAMBCA GAMMA                    1115+   0
P4      Y*1(1385) INTO KBAR N                           493+ 938
P5      Y*1(1385) INTO SIGMA GAMMA                     1197+   0

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Data Card Listings

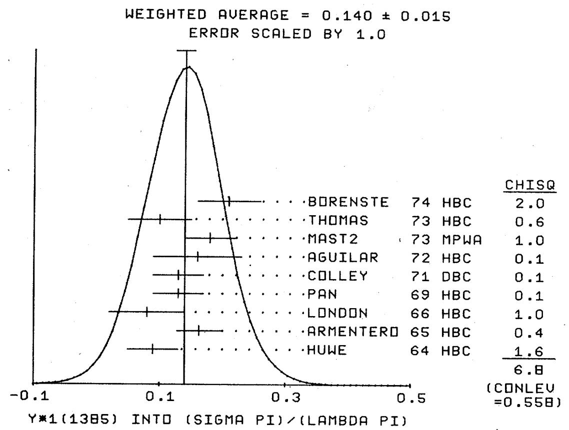
For notation, see key at front of Listings.

Baryons

Σ(1385), Σ(1440), Σ(1480), Σ(1580)

```
                 43  Y*1(1385) BRANCHING RATIOS

R1      Y*1(1385) INTO (SIGMA PI)/(LAMBDA PI)               (P2)/(P1)
R1           (0.04)    (C.04)            BASTIEN   61 HBC  +-
R1           (0.04) OR LESS              ALSTON    62 HBC  +-0
R1            0.09      0.04             HUWE      64 HBC  +-
R1            0.163     0.035            ARMENTERO 65 HBC  +-                    7/66
R1            0.08      0.06             LONDCN    66 HBC  +                     7/66
R1            0.13      0.04             PAN       69 HBC     PI+ P - K Y PI    12/72
R1            0.13      0.04             COLLEY    71 DBC     K-N 1.5 GEV PROD  10/71
R1             .16       .07             AGUILAR   72 HBC   + K-P TO LAM+PIS    10/74*
R1             .18       .04             MAST2     73 MPWA    K-P TO 2PI SIG     9/73
R1             .10       .05             THOMAS    73 HBC     PI-P TO PI K Y     9/73
R1         .16+/-.03 OR .11+/-.02        BERTHCN   74 HBC   0 QUASI 2 BODY CS   10/74*
R1             .21       .05             BORENSTE  74 HBC  +-OK-P TO(1385)+PIS  10/74*
R1         . . . . . . . . .
R1  AVG       0.140     0.015    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  STUDENT   0.140     0.017    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                       (SEE IDEOGRAM BELOW )
```




```
R2      Y*1(1385) INTO LAMBDA GAMMA                         (P3)
R2        1    (0.17)    (0.17)         MEISNER   72 HBC      1 EVENT ONLY        1/73

R3      Y*1(1385) FROM KBAR N TO LAMBDA PI                  SQRT(P1*P4)         4/75*
R3 C          +.586      .319           DEVENISH  74        0 FIXED T DISP REL  4/75*
R3 C     EXTRAPOLATICN OF PARAMETRIZED AMPLITUDE BELOW THRESHOLD                4/75*

R4      Y*1(1385) INTO (LAMBCA GAMMA)/(LAMBDA PI)           (P3)/(P1)           1/76*
R4            LESS THAN .06             COLAS     75 HLBC  0 90 PCT CONF LVL    1/76*

R5      Y*1(1385) INTO (SIGMA GAMMA)/(LAMBCA PI)            (P5)/(P1)           1/76*
R5            LESS THAN .05             COLAS     75 HLBC  0 90 PCT CONF LVL    1/76*

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REFERENCES FOR Y*1(1385)


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ALSTON   60 PRL 5 520           +ALVAREZ,EBERHARD,GOCC,GRAZIANO, +      (LRL) I
BASTIEN  61 PRL 6 702           P BASTIEN,M FERRO-LUZZI,A H ROSENFELD (LRL)
BERGE    61 PRL 6 557           +BASTIEN,DAHL,FERRO-LUZZI,KIRZ, +       (LRL)
DAHL     61 PRL 6 142           +HORWITZ,MILLER,MURRAY,WHITE            (LRL)
ELY      61 PRL 7 461           +FUNG,GIDAL,PAN,POWELL,WHITE            (LRL) J
MARTIN   61 PRL 6 283           +LEIPUNER,CHINOWSKY,SHIVELY, +     (BNL,YALE)

ALSTON   62 CERN CCNF 311       +ALVAREZ,FERRO-LUZZI,ROSENFELD, +       (LFL)
COLLEY   62 PR 128 1930         +GELFAND,NAUENBERG, +     (COLUMBIA,RUTGERS) JP
CURTIS   63 PR 132 1771         +COFFIN,MEYER,TERWILLIGER              (MICH) J
COOPER   64 PL 8 365            +FILTHUTH,FRIDMAN,MALAMUD, +      (CERN,AMST)
HUWE     64 UCRL-11291 THESIS D C HUWE                                  (LRL) JP
    ALSO 69 PR 180 1824         D O HUWE                                (LRL)

ARMENTER 65 PL 19 75            ARMENTEROS, +             (CERN,HEIDEL,SACLAY)
BALTAY   65 PR 140 B1027        +SANDWEISS,TAFT,CULWICK,KOPP, +  (YALE,BNL)
MUSGRAVE 65 NC 35 735           +PETMEZAS,+     (BIRM,CERN,EPOL,LOIC,SACLAY)
SMITH    65 THESIS (UCLA)       L T SMITH                              (UCLA)

BIRMINGH 66 PR  152  1148       BIRMINGHAM,GLASGOW,I.C., CXFORDYRUTHERFORD
LONDCN   66 PR 143 1034         +RAU,SAMIOS,YAMAMOTO,GOLDBERG,+  (BNL,SYRA) J
SIEGEL   67 UCRL 18041 THESIS D M SIEGEL                             (LRL)
PAN      69 PRL 23 808          +FCRMAN                               (PENN) I
AGUILAR  70 PRL 25 58           +BARNES, BASSANC, CHUNG, EISNER,+(BNL,SYRA)
ATHERTCN 71 NP B29 477          +CELNIKIER,CLAYTCN,FRENCH,FRISK,+     (CERN)
COLLEY   71 NP  B31 61          +COX,EASTWOOD,FRY+..  (BIRM+EDIN+GLAS+LOIC)

AGUILAR  72 PR D6 29            AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS   (BNL)
MEISNER  72 NC 12A 62           G MEISNER              (U NC GREENSBORO+LBL)
AMMANN   73 PRD 7 1345          +CARMONY,GARFINKEL,GUTAY,+        (PURD+IUPU)
MAST2    73 PRD 7 3212          +BANGERTER,ALSTCN-GARNJCST,+           (LBL)IJP
    ALSO 73 PRD 7 5             MAST,BANGERTER,ALSTON-GARNJOST,+       (LBL)IJP
HABIBI   73 NEVIS 199(THESIS) M.HABIBI                           (COLUMBIA)
    ALSO 73 PURD73, PG. 387     BALTAY,BRIDGEWATER,CGOPER,+ (CCLUMBIA+BING)
THOMAS   73 NP B56 15           THOMAS,ENGLER,FISK,KRAEMER            (CARN)IJ

BERTHON  74 NC 21A 146          BERTHCN,TRISTRAM,+     (CDEF+RHEL+SACL+STRB)   U
BORENSTE 74 PR D9 3006          BORENSTEIN,KALBFLEISCH,STRAND,+  (BNL+MICH)
DEVENISH 74 NP B81 330          DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
LICHTENB 74 PRD 10 3865         D B LICHTENBERG         (INCIANA UNIVERSITY)
    ALSC 74 PRIV. COMM.         D B LICHTENBERG         (INDIANA UNIVERSITY)

ATHERTCN 75 NC 25A 1            ATHERTCN,BAR-NIR,FRENCH                (CERN)
BARDADIN 75 NP B98 418          BARDADIN-OTWINCWSKA+        (SACL+EPOL+RHEL)
COLAS    75 NP B91 253          COLAS,FARWELL,FERRER,SIX               (ORSA)

                                PAPERS NOT REFERRED TO IN CATA CARDS.

MALAMUD  64 PL 10 145           E MALAMUD, P E SCHLEIN          (CERN,UCLA) JP
SHAFER   64 PR 134 B1372        J B SHAFER, D O HUWE                    (LRL) JP
HUNGERBU 74 PRD 10 2051         HUNGERBUHLER,MAJKA,+    (YALE,FNAL,BNL,PITT)
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Σ(1440) BUMPS

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80  Y*1(1440, JP=     ) I=1        PROCUCTION EXPERIMENTS

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

CLINE 68 FINC A NARROW PEAK AT 1440 MEV (JUST ABOVE
THE KBAR N THRESHOLD) IN THE LAMBCA PI INVARIANT MASS
FOR K- C TO LAMBDA PI- P EVENTS.  THEY DISCUSS ALTER-
NATE INTERPRETATICNS -- THAT IT IS A RESONANCE OR A KINEMATIC EFFECT.
IN CLINE 68 THE K- BEAM MOMENTUM IS 0.4 GEV/C.  IN A STUDY OF THE SAME
REACTION WITH A MOMENTUM OF 1.1 GEV/C, ALEXANDER 69 FIND NO PEAK.  IN
ADDITION, THEY ARE ABLE TC EXPLAIN THE RESULTS OF BOTH EXPERIMENTS
WITHOUT INVOKING A NEW RESONANCE. A REANALYSIS OF THE CLINE 68
CATA MADE BY BUNNEL 70 SHOW AGREEMENT OF THE DATA WITH THE
ALEXANDER 69 INTERPERTATICN.

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REFERENCES FOR Y*1(1440) (PROD. EXP.)


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CLINE    68 PRL 21 1372        D CLINE, R LAUMANN, J MAPP        (WISCONSIN) I
ALEXANDE 69 PRL 22 483         ALEXANDER, HALL, JEW, +       (LRL,RIVERSIDE)
BUNNELL  70 LNC 3 224          +CLINE,LAUMANN,MAPP  +        (NWES+WISC+ANL)
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Σ(1480) BUMPS

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23  Y*1(1480, JP=     ) I=1        PROCUCTION EXPERIMENTS

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

PEAKS ARE SEEN IN LAMBCA PI ANC SIGMA PI SPECTRA IN
THE REACTION PI+P TO K+ PI Y AT 1.7 GEV/C.  ALSO THE
Y POLARIZATION OSCILLATES IN THE SAME REGION.

   SEE MILLER 70 FOR A CISCUSSION OF THIS STATE.  HE SUGGESTS A POS-
SIBLE ALTERNATE EXPLANATION IN TERMS OF A REFLECTION OF N*1/2(1670)
DECAY TO LAMBDA K. HOWEVER, SUCH AN EXPLANATION FOR THE K+ SIGMA+ PIO
CHANNEL SEEMS UNLIKELY (SEE PAN 70) IN TERMS OF KNOWN N*3/2(1690)
DECAY INTO SIGMA K. IN ACDITICN SUCH REFLECTIONS WOULD ALSO HAVE
TO ACCOUNT FOR THE OSCILLATICN OF THE Y PCLARIZATION IN THE 1480
MASS REGION.
 HANSON 71, WITH FEWER CATA THAN PAN 70, CAN NEITHER CONFIRM NOR
DENY THE EXISTENCE OF THIS STATE.  MAST 75 SEES NO STRUCTURE IN THIS
MASS REGICN IN K- P TC LAMBCA PIO.

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                 23  Y*1(1480) MASS (MEV) (PRCD. EXP.)

M          1479.      10.            PAN       70 HBC  +  PI+P TO K PI LAM  3/71
M          1465.      15.            PAN       70 HBC  +  PI+P TO K PI SIG  3/71
M          1485.      10.            CLINE     73 MPWA    K- D TO LM PI- P  9/73
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                 23  Y*1(1480) WIDTH (MEV) (PROD. EXP.)

W            31.      15.            PAN       70 HBC  +  PI+P TO K PI LAM  3/71
W            30.      20.            PAN       70 HBC  +  PI+P TO K PI SIG  3/71
W            40.      20.            CLINE     73 MPWA    K- D TO LM PI- P  9/73
W          . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                 23  Y*1(148C) PARTIAL DECAY MODES (PROD. EXP.)

                                                        DECAY MASSES
P1      Y*1(1480) INTO KEAR N                            497+ 939
P2      Y*1(1480) INTO LAMBCA PI                        1115+ 139
P3      Y*1(1480) INTO SIGMA PI                         1189+ 139

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                 23  Y*1(1480) BRANCHING RATIOS (PROD. EXP.)

R1      Y*1(1480) INTO (SIGMA PI)/(LAMBDA PI)              (P3)/(P2)
R1            0.82      0.51         PAN       70 HBC  +                    3/71

R2      Y*1(1480) INTO (PROTON KCBAR)/(LAMBDA PI)          (P1)/(P2)
R2            0.36      0.25         PAN       70 HBC  +                    3/71

R3      Y*1(1480) INTO KBAR N                              (P1)             9/73
R3            SMALL                  CLINE     73 MPWA    K- D TO LM PI- P  9/73

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REFERENCES FOR Y*1(1480) (PROD. EXP.)


```
PAN      70 PR D2, 49          +FORMAN,KO,HAGOPIAN,SELOVE              (PENN)
CLINE    73 LNC 6 205          CLINE,LAUMANN,MAPP                (WISCONSIN)IJP

                               PAPERS NOT REFERRED TO IN DATA CARDS

YU-LI PA 69 PRL 23 806         YU-LI PAN, F L FORMAN                   (PENN) I
YU-LI PA 69 PRL 23 808         YU-LI PAN, F L FORMAN                   (PENN) I
MILLER   70 DUKE 229           D H MILLER       (REVIEW TALK)       (PURDUE)
HANSON   71 PR D4 1296         ,KALMUS,LOUIE                            (LBL) I
MAST     75 PRD 11 3078        +ALSTON-GARNJOST,BANGERTER+              (LBL)
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Σ(1580) D'_{13}

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00  Y*1(1580,JP=3/2-)  I=1                                              4/75*

OBSERVEC IN K- N I=1 TOTAL CS AT BNL(LI 73,CARROLL 73),
AND IN PWA OF K- P --> LAMBDA PI FOR CM ENERGIES=1560-
1600 MEV BY LITCHFIELD 74. LITCHFIELD 74 FINDS JP=3/2-.

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                 00  Y*1(1580) MASS (MEV)                               4/75*

M  L       1582.      4.                LITCHFIEL 74 CPWA  0 K- P TO LAM PI  4/75*

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                 00  Y*1(1580) WIDTH (MEV)                              4/75*

W  L         11.      4.                LITCHFIEL 74 CPWA  0 K- P TO LAM PI  4/75*

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Baryons

Σ(1580), Σ(1620)

Data Card Listings

For notation, see key at front of Listings.

```
                    00  Y*1(1580) PARTIAL DECAY MODES                    4/75*

                                                       DECAY MASSES
P1     Y*1(1580) INTO KBAR N                          497+ 939
P2     Y*1(1580) INTO LAMBDA PI                      1115+ 139
P3     Y*1(1580) INTO SIGMA PI                       1197+ 139

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                    00  Y*1(1580) BRANCHING RATIOS                       4/75*

R1     Y*1(1580) INTO KBAR N/TOTAL                     (P1)              4/75*
R1 L         +.03      .01        LITCHFIEL 74 DPWA   KBAR N MULTICHNL  4/75*
R1 L    MAIN EFFECT OBSERVED BY LITCHFIELD 74 IS IN PI LAMBDA FINAL STATE, 4/75*
R1 L    KBAR N AND SIGMA PI COUPLINGS ALSO ESTIMATED FROM MULTICHANNEL FIT 4/75*
R1 L    INCLUDING TOTAL CROSS SECTION DATA (LI 73).                      4/75*

R2     Y*1(1580) FROM KBAR N TO LAMBDA PI              SQRT(P1*P2)       4/75*
R2 L         +.10      .02        LITCHFIEL 74 DPWA  0 K- P TO LAM PI   4/75*

R3     Y*1(1580) FROM KBAR N TO SIGMA PI               SQRT(P1*P3)       4/75*
R3 L         +.03      .04        LITCHFIEL 74 DPWA   KBAR N MULTICHNL  4/75*

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                              REFERENCES FOR Y*1(1580)

LITCHFIE 74 PL 51B 509        LITCHFIELD                         (CERN)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS.

CARROLL  73 APS BRKLY MTG 208 CARROLL,CHIANG,KYCIA,LI,MAZUR,MICHAEL+(BNL)I
LI       73 PURDUE CONF. 283  LI                                    (BNL)I

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<u>Note on Σ(1620)</u>

This state was first suggested by the BNL-CCNY collaboration (CRENNELL 68) who presented evidence for it in the reaction $K^-n \rightarrow \Sigma(1620)^{\pm}\pi^{\mp}\pi^-$ with $\Sigma(1620)^{\pm}$ decaying into $\Lambda\pi^{\pm}$. Since then there have been conflicting reports about this state.

<u>Total Cross-Section Experiment</u>

A measurement of the K^-p and K^-d total cross sections in the 0.4 to 1.1 GeV/c range has been reported by the BNL group (CARROLL 73, LI 73). A clear bump about 40 MeV wide and 3-4 mb high [corresponding to $(J+1/2)x \sim 0.1$] is seen at a c.m. energy of 1590 MeV in the $I=1$ K^-N cross section.

<u>Formation Experiments</u>

There is evidence from several partial-wave analyses for one or two fairly narrow states within ~ 50 MeV of the effect seen in production; see the entries for $\Sigma(1580,3/2^-)$, $\Sigma(1620,1/2^-)$, and $\Sigma(1660,1/2^+)$. Note however that the various analyses do not agree on the widths and branching ratios of these states.

<u>Production Experiments</u>

A good review of the production experiments has been given by MILLER 70. Here the evidence is only in the $\Lambda\pi$ channel. The BNL-CCNY collaboration, with increased data, CRENNELL 69, still claim the effect in the $\Lambda\pi$ channel (no evidence seen in $\bar{K}N$ or $\bar{K}N\pi$). SABRE 70 studied the same reaction at 3.0 GeV/c with comparable statistics and do not see any evidence for it in the $\Lambda\pi$ channel; on the contrary, they believe it to be a spurious peak resulting from misidentified Σ^0 from the production of Σ(1670) decaying into $\Sigma^0\pi^+$. CRENNELL 69 give counter arguments to show that this is not the case in their data and the controversy goes on. AMMANN 70 studied the same reaction at 4.5 GeV/c and report a state at 1640 MeV, again decaying only into $\Lambda\pi$ (no evidence seen in $\Sigma\pi$ or $\bar{K}N$ channels). Upper limits on production cross sections for a 25 GeV/c Σ^- beam are reported by HUNGERBUHLER 74.

In conclusion, for understanding of the Σ(1620) we probably have to wait for more data and for a more complete understanding of the entire mass region from 1600 to 1700 MeV. The closeness of the Σ(1620) mass to 1670 MeV is suggestive that this effect may be related to what goes on in that region (see discussion below).

Σ(1620) → **S'_{11}**

```
32  Y*1(1620, JP=1/2-) I=1
THE S11 STATE AT 1697 MEV REPORTED BY VANHORN 75 IS
INTERMEDIATE IN MASS BETWEEN THE SIGMA(1620) AND
SIGMA(1750).  WE TENTATIVELY LIST IT UNDER SIGMA(1750).

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                    32  Y*1(1620) MASS (MEV)

M          (1620.)                    KIM       71 DPWA   K-MATRIX ANAL.   3/71
M           1630.0    (10.0)          LANGBEIN  72 IPWA   MULTICHANNEL    12/72

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                    32  Y*1(1620) WIDTH (MEV)

W            (40.)                    KIM       71 DPWA   K-MATRIX ANAL.   3/71
W             65.0    (20.0)          LANGBEIN  72 IPWA   MULTICHANNEL    12/72

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                    32  Y*1(1620) PARTIAL DECAY MODES

                                                       DECAY MASSES
P1     Y*1(1620) INTO KBAR N                          497+ 939
P2     Y*1(1620) INTO SIGMA PI                       1197+ 139
P3     Y*1(1620) INTO LAMBDA PI                      1115+ 134

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                    32  Y*1(1620) BRANCHING RATIOS

R1     Y*1(1620) INTO KBAR N                           (P1)
R1          (0.05)                    KIM       71 DPWA   K-MATRIX ANAL.   3/71
R1 A          0.05  OR LESS           WONG      71 DPWA   K-+P--LAM+PI    10/71
R1            0.22     (0.02)         LANGBEIN  72 IPWA   MULTICHANNEL    12/72
R1 A    K-MATRIX FIT(NEGLECTS 3-BODY CHANNELS) REQUIRES NO RESONANCE      10/71

R2     Y*1(1620) FROM KBAR N TO SIGMA PI               SQRT(P1*P2)
R2          (0.08)                    KIM       71 DPWA   K-MATRIX ANAL.   3/71
R2            0.40     (0.06)         LANGBEIN  72 IPWA   MULTICHANNEL    12/72

R3     Y*1(1620) FROM KBAR N TO LAMBDA PI              SQRT(P1*P3)
R3          (0.15)                    KIM       71 DPWA   K-MATRIX ANAL.   3/71
R3          NOT SEEN                  BAILLON   75 IPWA   KBAR N TO LAM PI 11/75*

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                              REFERENCES FOR Y*1(1620)

KIM      71 PRL 27 356        J K KIM                              (HARV)IJP
   ALSO  70 DUKE 161          J. K. KIM                            (HARV)IJP
WONG     71 NC 2A 353         N S WONG                             (YALE)IJP
LANGBEIN 72 NP B47 477        +WAGNER                              (MPIM)IJP
BAILLON  75 NP B94 39         P. BAILLON,P. J. LITCHFIELD     (CERN,RHEL)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS

VANHORN  75 NP B87 145        A. J. VAN HORN                        (LBL)IJP
   ALSO  75 NP B87 157        A. J. VAN HORN                        (LBL)IJP

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Data Card Listings

For notation, see key at front of Listings.

Baryons

Σ(1620), Σ(1660), Σ(1670)

1620 MEV REGION – PRODUCTION EXPERIMENTS

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                78  Y*1(1620, JP=    ) I=1        PRODUCTION EXPERIMENTS

                SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

                THIS RESONANCE NEEDS CONFIRMATION. THE RESULTS OF
                CRENNELL 69 AT 3.9 GEV/C ARE NOT CONFIRMED BY THE SABRE
     COLLABORATION AT 3.0 GEV/C (SABRE 70).  HOWEVER IN AN EXPERIMENT AT
     4.5 GEV/C, AMMANN 70 SEE A PEAK AT 1642 MEV WHICH ON THE BASIS OF
     BRANCHING RATIOS THEY DO NOT ASSOCIATE WITH THE Y*1(1670). SEE MILLER
     70 FOR A REVIEW OF THESE CONFLICTS.

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                78  Y*1(1620) MASS (MEV) (PROD. EXP.)

M   N     (1616.0)     (8.0)            CRENNELL  68 DBC  +- K-D 3.9 BEV/C     11/68
M   N     EVENTS OF CRENNELL 68 ARE IN THE LARGER SAMPLE OF CRENNELL 69.
M      20 1618.0        3.0             BLUMENFEL 69 HBC  +  KO LONG + PROTON   9/69
M         1619.0        8.0             CRENNELL  69 DBC  +- K-N TO LAM 3 PI    9/69
M         1642.0       12.0             AMMANN    70 DBC     K-N 4.5 GEV/C      9/73
M         . . . . . . . . . . .
M   AVG    1619.4       3.8        AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
M   STUDENT1619.1       3.0        AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                78  Y*1(1620) WIDTH (MEV) (PROD. EXP.)

W   N        (66.0)    (16.0)           CRENNELL  68 DBC  +- SEE NOTE N ABOVE 11/68
W      20     30.0      10.0            BLUMENFEL 69 HBC  +                    9/69
W             72.0      22.0     15.0   CRENNELL  69 DBC  +-                   9/69
W             55.0      24.0            AMMANN    70 DBC     K-N 4.5 GEV/C     9/73
W         . . . . . . . . . . .
W   AVG       41.3      12.2       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
W   STUDENT   40.7      10.4       AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
            SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

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                78  Y*1(1620) PARTIAL DECAY MODES (PROD. EXP.)

                                                             DECAY MASSES
P1     Y*1(1620) INTO KBAR N                                  497+ 939
P2     Y*1(1620) INTO LAMBDA PI                              1115+ 139
P3     Y*1(1620) INTO Y*1(1385) PI                           1384+ 139
P4     Y*1(1620) INTO LAMBDA PI PI                           1115+ 139+ 139
P5     Y*1(1620) INTO SIGMA PI                               1197+ 139
P6     Y*1(1620) INTO Y*0(1405) PI                           1405+ 139

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                78  Y*1(1620) BRANCHING RATIOS (PROD. EXP.)

R1     Y*1(1620) INTO (LAMBDA PI PI)/(LAMBDA PI)          (P4)/(P3)
R1      14    (2.5)  APPROX            BLUMENFEL 69 HBC  +

R2     Y*1(1620) INTO (KBAR N)/(LAMBDA PI)                (P1)/(P2)
R2          (0.0)     (0.1)            CRENNELL  68 DBC  +
R2           0.4       0.4             AMMANN    70 DBC     K-P 4.5 GEV/C      6/70

R3     Y*1(1620) INTO LAMBDA PI                           (P2)
R3           LARGE                     CRENNELL  68 DBC  +-                   11/68

R4     Y*1(1620) INTO (Y*1(1385) PI)/(LAMBDA PI)          (P3)/(P2)
R4          (0.2)     (0.1)            CRENNELL  68 DBC  +-                   11/68
R4          (0.3)  OR LESS  CL=.95     AMMANN    70 DBC     K-P 4.5 GEV/C      6/70

R5     Y*1(1620) INTO (SIGMA PI)/(LAMBDA PI)              (P5)/(P2)
R5          (1.1)(95 PC UPPER LIMIT) AMMANN      70 DBC     K-N 4.5 GEV/C      9/73

R6     Y*1(1620) INTO (Y*0(1405) PI)/(LAMBDA PI)          (P6)/(P2)
R6           0.7       0.4             AMMANN    70 DBC     K-P 4.5 GEV/C      6/70

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                         REFERENCES FOR Y*1(1620) (PROD. EXP.)

CRENNELL 68 PRL 21 648          +DELANEY, FLAMINIO, KARSHON, +   (BNL,CUNY) I
BLUMENFE 69 PL 29B 58           BLUMENFELD, KALBFLEISCH               (BNL) I
CRENNELL 69 LUND PAPER 183      +KARSHON, LAI, ONEIL, SCARR, +   (BNL,CUNY) I
    RESULTS ARE QUOTED IN LEVI SETTI 69.

AMMANN   70 PRL 24 327          + GARFINKEL, CARMONY, GUTAY,+  (PURDUE,IND)
    ALSO 73 PRD 7 1345          AMMANN,CARMONY,GARFINKEL,        (PURD+IUPU)

                                PAPERS NOT REFERRED TO IN DATA CARDS

ARMENTER 68 NP B8 183           ARMENTEROS,BAILLON +         (CERN+HEID+SACL)
LEVISETT 69 LUND CONF           R LEVI SETTI    (RAPPORTEUR)          EFINS
TRIPP    69 UCRL 19361          R D TRIPP                              (LRL)
ARMENTER 70 DUKE 123            ARMENTEROS,BAILLON +         (CERN+HEID+SACL)
MILLER   70 DUKE 229            D H MILLER   (REVIEW TALK)          (PURDUE)
SABRE    70 NP B16 201          SABRE COLLAB.    (SACL,AMST,BGNA,REHO,EPOL)
HUNGERBU 74 PRD 10 2051         HUNGERBUHLER,MAJKA,+    (YALE,FNAL,BNL,PITT)
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Σ(1660) **P'_{11}**

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               79  Y*1(1660, JP=1/2+) I=1

               SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

               THE PARTIAL-WAVE ANALYSIS OF K- N TO SIGMA PI BY
               ARMENTOROS 70 SUGGEST SUCH A RESONANCE. NOW
               FOUND ALSO IN SOME, BUT NOT ALL, MORE RECENT
               ANALYSES.

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               79  Y*1(1660) MASS (MEV)

M          1500. -- 1600.              ARMENTERO 70 HDBC -0 K-N TO SIGMA PI    6/70
M         (1670.)                      KIM       71 DPWA    K-MATRIX ANAL.     3/71
M    2    (1621.)                      LEA       73 DPWA    MULTICHNL K-MTRX   9/73
M    2  ONLY UNCONSTRAINED STATES FROM TABLE 1 OF LEA73 ARE IN LISTINGS.       9/73
M          1658.      (4.)             HART      73 DPWA    EL+CX,.7-.8GEV/C   2/74
M    1    (1660.)    (30.)             BAILLON   75 IPWA    KBAR N TO LAM PI  11/75*
M    1  FROM SOLUTION 1 OF BAILLON 75, NOT PRESENT IN SOLUTION 2              11/75*
M    3    (1671.)     (2.)             PONTE     75 DPWA  0 K- P TO LAM PI     1/76*
M    3  FROM SOLUTION 2 OF PONTE 75, NOT PRESENT IN SOLUTION 1.                1/76*
M          1668.     (25.)             VANHORN   75 DPWA  0 K- P TO LAM PIO   11/75*
M          1676.     (15.)             RLIC      76 DPWA    KBAR N MULTICHNL   1/76*

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               79  Y*1(1660) WIDTH (MEV)

W          (50.0)                      ARMENTERO 70 HDBC -0 K-N TO SIGMA PI    6/70
W          (50.)                       KIM       71 DPWA    K-MATRIX ANAL.     3/71
W    2     (51.8)                      LEA       73 DPWA    MULTICHNL K-MTRX   9/73
W           40.      (10.)             HART      73 DPWA    EL+CX,.7-.8GEV/C   2/74
W    1     (80.)     (40.)             BAILLON   75 IPWA    KBAR N TO LAM PI  11/75*
W    3     (81.)     (10.)             PONTE     75 DPWA  0 K- P TO LAM PI     1/76*
W          230.     (165.)    (60.)    VANHORN   75 DPWA  0 K- P TO LAM PIO   11/75*
W          120.      (20.)             RLIC      76 DPWA    KBAR N MULTICHNL   1/76*

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               79  Y*1(1660) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1     Y*1(1660) INTO KBAR N                                  497+ 939
P2     Y*1(1660) INTO SIGMA PI                               1197+ 139
P3     Y*1(1660) INTO LAMBDA PI                              1115+ 139

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               79  Y*1(1660) BRANCHING RATIOS

R1     Y*1(1660) FROM KBAR N TO SIGMA PI                  SQRT(P1*P2)
R1          (+0.2)                     ARMENTERO 70 HDBC -0 K-N TO SIGMA PI    6/70
R1          (0.24)                     KIM       71 DPWA    K-MATRIX ANAL.     3/71
R1   2      (-.21)                     LEA       73 DPWA    MULTICHNL K-MTRX   9/73
R1           -.16     (.03)            RLIC      76 DPWA    KBAR N MULTICHNL   1/76*

R2     Y*1(1660) INTO KBAR N                              (P1)
R2          (0.14)                     KIM       71 DPWA    K-MATRIX ANAL.     3/71
R2   2       (.10)                     LEA       73 DPWA    MULTICHNL K-MTRX   9/73
R2            .11     (.02)            HART      73 DPWA    EL+CX,.7-.8GEV/C   2/74
R2           LESS THAN .04             RLIC      76 DPWA    KBAR N MULTICHNL   1/76*

R3     Y*1(1660) FROM KBAR N TO LAMBDA PI                 SQRT(P1*P3)
R3          (0.0)                      KIM       71 DPWA    K-MATRIX ANAL.     2/73
R3   2      (+.07)                     LEA       73 DPWA    MULTICHNL K-MTRX   9/73
R3   1      (-.04)    (.02)            BAILLON   75 IPWA    KBAR N TO LAM PI  11/75*
R3   3      (+.16)    (.01)            PONTE     75 DPWA  0 K- P TO LAM PI     1/76*
R3            .12     (.12)    (.04)   VANHORN   75 DPWA  0 K- P TO LAM PIO   11/75*
R3           LESS THAN .04             RLIC      76 DPWA    KBAR N MULTICHNL   1/76*

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                         REFERENCES FOR Y*1(1660)

ARMENTER 70 DUKE 123            ARMENTEROS, BAILLON, +          (CERN,HEIDEL)IJP
KIM      71 PRL 27 356          J K KIM                                (HARV)IJP
    ALSO 70 DUKE 161            J. K. KIM                              (HARV)IJP
HART     73 PURDUE CONF. 311    +RICE,BACASTOW,FUNG,+  (TENN+UCR+MASA+BUFF)IJP
LEA      73 NP B56 77           +MARTIN,MOORHOUSE+  (RHEL+LOUC+GLAS+AARHUS)IJP

BAILLON  75 NP B94 39           P. BAILLON,P. J. LITCHFIELD        (CERN,RHEL)IJP
PONTE    75 PRD 12 2597         +HERTZBACH,BUTTON-SHAFER+   (MASA+TENN+UCR)IJP
VANHORN  75 NP B87 145          A. J. VAN HORN                          (LBL)IJP
    ALSO 75 NP B87 157          A. J. VAN HORN                          (LBL)IJP

RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+     (RHEL+LOIC)IJP
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Note on Σ(1670)

Production Experiments

The measured Σπ/Σππ branching ratio for produced Σ(1670)'s is strongly dependent on momentum transfer. This was first discovered by EBERHARD 69 who suggested the existence of two Y_1^*'s with the same mass and quantum numbers; one object with a large Σππ [mainly Λ(1405)π] decay mode produced peripherally, and another one with a large Σπ decay mode produced at larger angles. This observation has been confirmed by AGUILAR-BENITEZ 70, APSELL 74, ESTES 74, and BLOKZIJL 75. When determined, the most likely quantum numbers are $3/2^-$ [for both Σπ and Λ(1405)π]. There is also the possibility of a third Y_1^* state, referred to as Σ(1690) in the Data Card Listings, with a large Λπ/Σπ branching ratio and somewhat larger mass. The large branching ratio is the main justification for this hypothesis and needs confirmation. These problems have been reviewed by EBERHARD 73 and MILLER 70.

Baryons
Σ(1670)

Data Card Listings
For notation, see key at front of Listings.

Formation Experiments

Two states are also observed near this mass in formation. One of these, the $\Sigma(1670, 3/2^-)$, has the same quantum numbers as those observed in production and a large $\Sigma\pi/\Sigma\pi\pi$ branching ratio. It may well correspond to the produced $\Sigma(1670)$ seen at larger angles. The other, the $\Sigma(1660, 1/2^+)$ has different quantum numbers from those seen in production, and its $\Sigma\pi/\Sigma\pi\pi$ branching ratio is unknown. Thus its relation to the produced $\Sigma(1670)$ remains obscure. [See also the mini-review on $\Sigma(1620)$].

Σ(1670) **D''_{13}**

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44  Y*1(1670, JP=3/2-) I=1
SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

SEE NOTE ABOVE

WELL ESTABLISHED RESONANCE. IT HAS BEEN SEEN IN BOTH
FORMATION AND PRODUCTION EXPERIMENTS. HOWEVER THE
BRANCHING RATIOS OBTAINED BY THESE TWO METHODS SHOW
LARGE INCONSISTENCIES.

SEE LISTING OF PRODUCTION EXPERIMENTS BELOW

AS FOR THE QUANTUM NUMBERS, THE ANALYSES OF LAMBDA PI CHANNEL (IN
FORMATION EXP.) AS WELL AS THE SIGMA PI CHANNEL AGREE ON JP=3/2-.
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                   44  Y*1(1670) MASS (MEV)

M          1660.0                    BERLEY     64 HBC   0 K-P TO LAM PIO     7/66
M          1668.      (5.)           ARMENTER   68 HBC   0 K-P ELAS.+CH.EX   11/68
M         (1661.0)    (2.0)          ARMENTE2   68 HBC   0 K-P TO SIGMA PI   11/68
M          1680.                     ARMENTE4   69 DBC     K-N TO SIG- PIO   12/68
M          1663.0     (2.0)          ARMENT-5   69 HBC   0 K-P TO SIGMPI ED   9/69
M          1672.0                    BERLEY     69 HBC     K-P TO SIG PI      5/70
M          1660.                     ARMENTER   70 HBC   0 K-P TO LAM.PI EI   5/70
M          1681.0     (3.0)          BRUCKER    70 DBC  -  K-N TO SIG 2PI    10/71
M          1662.0     (5.0)          GALTIERI   70 HBC   0 SIG PI,EDPWA       7/70
M          1665.      (10.)          GALTIERI   70 HBC   0 LAM. PI, EDPWA     7/70
M          1676.      (2.)           BUDGEN     71 DPWA    LAM PIO,CHS DATA  10/71
M          1670.                     KIM        71 DPWA    K-MATRIX ANAL.     3/71
M          1675.0     (15.0)         LANGBEIN   72 IPWA    MULTICHANNEL      12/72
M          1685.      (20.)          BAILLON    75 IPWA    KBAR N TO LAM PI  11/75*
M   C     (1671.)     (3.)           PONTE      75 DPWA  0 K- P TO LAM PI     1/76*
M   C   FROM SOLUTION 1 OF PONTE 75.                                          1/76*
M   D     (1655.)     (2.)           PONTE      75 DPWA  0 K- P TO LAM PI     1/76*
M   D   FROM SOLUTION 2 OF PONTE 75.                                          1/76*
M          1659.      (12.)   (5.)   VANHORN    75 DPWA  0 K- P TO LAM PIO   11/75*
M          1670.      (5.)           RLIC       76 DPWA    KBAR N MULTICHNL   1/76*
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                   44  Y*1(1670) WIDTH (MEV)

W          60.0                      BERLEY     64 HBC   0                    7/66
W          56.        (18.)          ARMENTER   68 HBC   0 K-P ELAS.+CH.EX   11/68
W         (44.0)      (4.0)          ARMENTE2   68 HBC   0 K-P TO SIGMA PI   11/68
W          47.0                      ARMENTE4   69 DBC     K-N TO SIG- PIO   12/68
W          49.0       (4.0)          ARMENT-5   69 HBC   0 K-P TO SIGMPI ED   9/69
W          34.0                      BERLEY     69 HBC                        5/70
W          50.                       ARMENTER   70 HBC   0 K-P TO LAMB.PI     5/70
W          30.0       (10.0)         BRUCKER    70 DBC  -  K-N TO SIG 2PI    10/71
W          48.0       (5.0)          GALTIERI   70 HBC   0 SIG PI,EDPWA       7/70
W          50.        (10.)          GALTIERI   70 HBC   0 LAM. PI, EDPWA     7/70
W          59.        (4.5)          BUDGEN     71 DPWA    LAM PIO           10/71
W          40.                       KIM        71 DPWA    K-MATRIX ANAL.     3/71
W          65.0       (20.0)         LANGBEIN   72 IPWA    MULTICHANNEL      12/72
W          70.        (20.)          BAXTER     73 DPWA  0 K- P TO NEUTRALS  10/74*
W          85.        (25.)          BAILLON    75 IPWA    KBAR N TO LAM PI  11/75*
W   C     (44.)       (11.)          PONTE      75 DPWA  0 K- P TO LAM PI     1/76*
W   D     (76.)       (5.)           PONTE      75 DPWA  0 K- P TO LAM PI     1/76*
W          32.        (11.)          VANHORN    75 DPWA  0 K- P TO LAM PIO   11/75*
W          50.        (5.)           RLIC       76 DPWA    KBAR N MULTICHNL   1/76*
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                   44  Y*1(1670) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      Y*1(1670) INTO KBAR N                                  497+ 939
P2      Y*1(1670) INTO LAMBDA PI                              1115+ 139
P3      Y*1(1670) INTO SIGMA PI                               1197+ 139
P4      Y*1(1670) INTO LAMBDA PI PI                           1115+ 139+ 139
P5      Y*1(1670) INTO SIGMA PI PI                            1197+ 139+ 139
P6      Y*1(1670) INTO Y*1(1385) PI S-WAVE                     139+1384
P7      Y*1(1670) INTO Y*0(1405) PI                           1405+ 139
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                   44  Y*1(1670) BRANCHING RATIOS

R1      Y*1(1670) INTO (KBAR N)/TOTAL                      (P1)
R1          (0.09)    (0.02)         ARMENTER   68 HBC                        9/69
R1           0.08     (0.02)         ARMENT-5   69 HBC   0 ELAS. +CH.EX. ED   9/69
R1           0.07                    KIM        71 DPWA    K-MATRIX ANAL.     3/71
R1           0.10     (0.03)         LANGBEIN   72 IPWA    MULTICHANNEL      12/72
R1          NOT SEEN                 HART       73 DPWA    EL+CX,.7-.8GEV/C   2/74
R1            .24     (.03)          RLIC       76 DPWA    KBAR N MULTICHNL   1/76*

R2      Y*1(1670) INTO (LAMBDA PI PI)/TOTAL                (P4)
R2          (0.11) OR LESS           ARMENTE3   68 HBC     K-P (PI=.09)       9/69

R3      Y*1(1670) INTO (SIGMA PI PI)/TOTAL                 (P5)
R3  A        (0.14) OR LESS          ARMENTE3   68 HBC     K-P AND D-PI=.09  11/68
R3  A   RATIO ONLY FOR (SIG2PI) SYSTEM IN I=1, WHICH CANNOT BE Y*1(1385)     11/68

R4      Y*1(1670) INTO (Y*0(1405) PI)/TOTAL                (P7)
R4           (0.06) OR LESS          ARMENTE3   68 HBC     K-P AND D-PI=.09  11/68

R5      Y*1(1670) FROM KBAR N TO LAMBDA PI                 SQRT(P1*P2)
R5  2        (+0.1)                  ARMENTER   70HBC      K-P TO LAMB PI     5/70
R5  2   PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CONVENTION (SEE TEXT) 10/74*
R5          +0.09     (0.02)         GALTIERI   70 HBC   0 LAM. PI, EDPWA     7/70
R5           .165     (.01)          BUDGEN     71 DPWA    LAM PIO           10/71
R5           0.08                    KIM        71 DPWA    K-MATRIX ANAL.     3/71
R5           0.13     (0.03)         LANGBEIN   72 IPWA    MULTICHANNEL      12/72
R5           +.10     (.02)          BAXTER     73 DPWA  0 K- P TO NEUTRALS  10/74*
R5           +.018     .060          DEVENISH   74       0 FIXED T DISP REL   4/75*
R5           +.06     (.32)          BAILLON    75 IPWA    KBAR N TO LAM PI  11/75*
R5  C        (.08)    (.01)          PONTE      75 DPWA  0 K- P TO LAM PI     1/76*
R5  D        (.17)    (.01)          PONTE      75 DPWA  0 K- P TO LAM PI     1/76*
R5           +.09     (.02)          VANHORN    75 DPWA  0 K- P TO LAM PIO   11/75*
R5           +.10     (.02)          RLIC       76 DPWA    KBAR N MULTICHNL   1/76*

R6      Y*1(1670) FROM KBAR N TO SIGMA PI                  SQRT(P1*P3)
R6          (+0.21)   (0.01)         ARMENTE2   68 HBC   0 OLD DATA          11/68
R6          +0.19                    ARMENTE4   69 DBC                        9/69
R6          +0.20     (0.01)         ARMENT-5   69 HBC   0 NEW DATA           9/69
R6          +0.18                    BERLEY     69 HBC                        5/70
R6          +0.18     (0.06)         GALTIERI   70 HBC   0 SIG PI,EDPWA       7/70
R6           0.15                    KIM        71 DPWA    K-MATRIX ANAL.     3/71
R6           0.23     (0.05)         LANGBEIN   72 IPWA    MULTICHANNEL      12/72
R6           +.21     (.02)          RLIC       76 DPWA    KBAR N MULTICHNL   1/76*

R7      Y*1(1670) FROM KBAR N TO Y*1(1385) PI S-WAVE       SQRT(P1*P6)
R7  S        (0.17)   (0.02)         SIMS       68 DBC  -  LAM 2PI CROS.SEC  10/71
R7  S   SIMS 68 USES ONLY CROSS-SECT. DATA. RESULT USED AS UPPER LIMIT ONLY   3/72
R7           +.11      .03           PREVOST    74 DPWA 0- K-N TO S(1385)PI  10/74*

R8      Y*1(1670) INTO (Y*0(1405)PI)*(KBAR N)/TOTAL**2     (P7*P1)
R8           (0.03) OR LESS          BERLEY     69 HBC   0 K-P .6-.82 BEV/C   5/70
R8  B        0.007    (0.002)        BRUCKER    70 DBC  -  K-N TO SIG 2PI    10/71
R8  B   ASSUMING Y*0(1405) PI CROSS SECTION BUMP DUE SOLEY TO 3/2- RESON.    10/71

R9      Y*1(1670) INTO (Y*0(1405) PI)/(Y*1(1385) PI)       (P7)/(P6)
R9           0.23     (0.08)         BRUCKER    70 DBC  -  K-N TO SIG 2PI    10/71

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                         REFERENCES FOR Y*1(1670)

BERLEY    64 DUBNA CONF I 565   +CONNOLLY,HART,RAHM,STONEHILL, +       (BNL)IJP

ARMENTER  68 NP B8 195          ARMENTEROS,BAILLON +        (CERN+HEID+SACLAY)IJP
ARMENTE1  68 NP B8 183          ARMENTEROS,BAILLON +        (CERN+HEID+SACLAY)IJP
ARMENTE2  68 NP B8 223          ARMENTEROS+BAILLON +        (CERN+HEID+SACLAY)IJP
ARMENTE3  68 PL 28B 521         ARMENTEROS,BAILLON +        (CERN+HEID+SACLAY)I
SIMS      68 PRL 21 1413        SIMS,ALBRIGHT,BARTLEY,MEER+ (FSU,TUFT,BRAN)

ARMENTE4  69 NP B10 459         ARMENTEROS,BAILLON,MINTEN +    (CERN+SACLAY) J
ARMENT-5  69 NP B14 91          ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BERLEY    69 PL 30B 430         BERLEY,HART,RAHM,WILLIS,YAMAMOTO         (BNL)

ARMENTER  70 DUKE 123           ARMENTEROS, BAILLON, +              (CERN,HEID)
BRUCKER   70 DUKE 155           +HARRISON,SIMS,ALBRIGHT,CHANDLER++       (FSU)I
GALTIERI  70 DUKE 173           A. BARBARO GALTIERI                    (LRL)IJP
BUDGEN    71 LNC 2  85          D BUDGEN                              (DURH)IJP
KIM       71 PRL 27 356         J K KIM                               (HARV)IJP
   ALSO   70 DUKE 161           J. K. KIM                             (HARV)IJP

LANGBEIN  72 NP B47 477         +WAGNER                               (MPIM)IJP
BAXTER    73 NP B67 125         BAXTER,BUCKINGHAM,CORBETT,DUNN,+    (OXFORD)IJP
HART      73 PURDUE CONF. 311   +RICE,BACASTOW,FUNG,+   (TENN+UCR+MASA+BUFF)IJP
DEVENISH  74 NP B81 330         DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
PREVOST   74 NP B69 246         PREVOST,BARLOUTAUD,+           (SACL+CERN+EID)

BAILLON   75 NP B94 39          P. BAILLON,P. J. LITCHFIELD         (CERN,RHEL)IJP
PONTE     75 PRD 12 2597        +HERTZBACH,BUTTON-SHAFER+    (MASA+TENN+UCR)IJP
VANHORN   75 NP B87 145         A. J. VAN HORN                         (LBL)IJP
   ALSO   75 NP B87 157         A. J. VAN HORN                         (LBL)IJP

RLIC      76 RL-75-182 (PRPNT)  GOPAL,KALMUS,MCPHERSON,ROSS+      (RHEL+LOIC)IJP

                       PAPERS NOT REFERRED TO IN DATA CARDS

BASTIEN1  63 PRL 10 188         P L BASTIEN, J P BERGE                   (LRL) IJ
   REPLACED BY BASTIEN 2, BUT SIMILAR AND MORE READILY AVAILABLE.
BASTIEN2  63 UCRL-10779 THESIS P L BASTIEN                               (LRL) IJ
T-ZADEH   63 PRL 11 470         TAHER-ZADEH,PROWSE,SCHLEIN,SLATER,+     (UCLA) JP
   SEE NOTE FOLLOWING SCHLEIN 66.
SCHLEIN   66 UCLA-1016          P.E. SCHLEIN, T.G. TRIPPE               (UCLA) JP
   REANALYSES DATA OF TAHER-ZADEH 63 ,   BASTIEN 63 AND ALL PUBLISHED
   LAMBDA PI CROSS SECTION DATA IN THE LIGHT OF THE NOW KNOWN
   Y*1(1765) .   REVERSES THE MODEL-DEPENDENT CONCLUSION OF TAHER-
   ZADEH ON THE PREFERRED JP ASSIGNMENT (FROM 3 2+ TO 3          (2-).)
SMART     66 PRL 17 556         W M SMART,A KERNAN,G E KALMUS,R P ELY (LRL)IJP
ARMENTER  67 NP B3 592          ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)
PREVOST   71 AMSTERDAM CONF     + CHS COLLABORATION          (CERN+HEID+SACL)

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Σ(1670) BUMPS →

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51  Y*1(1670, JP=    ) I=1          PRODUCTION EXPERIMENTS

SEE NOTE PRECEDING Y*1(1670)
PROBABLY THERE ARE TWO STATES AT SAME MASS WITH SAME
QUANTUM NUMBERS, ONE DECAYING INTO SIGMA PI AND LAMBDA
PI, THE OTHER INTO Y*0(1405) PI.  BRANCHING RATIOS NOT
DISENTANGLED YET, WE LIST THEM TOGETHER FOR NOW.
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             51  Y*1(1670) MASS (MEV) (PROD. EXP.)

M          (1685.0)                  ALEXANDER 62 HBC  -0 PI-P 2-2.2 BEV/C
M           1660.0     10.0          ALVAREZ   63 HBC  +  K-P 1.51 BEV/C
M          (1665.0)    (5.0)         BUGG      68 CNTR    K-P, D TOTAL C.S
M   P     70(1661.)    (9.)          PRIMER    68 HBC  +  K-P 4.6-5. GEV/C  7/68
M   P     SEE BARNES 69 FOR NEW ANALYSIS OF DATA (3 TIMES MORE DATA)       10/69
M           1670.0      6.0          AGUILAR   70 HBC     SIG.PI K-P 4 GEV  5/70
M           1668.0     10.0          AGUILAR   70 HBC     SIG.2PI K-P 4GEV  5/70
M   B       1665.       1.0          APSELL    74 HBC     K- P 2.87 GEV/C   4/75*
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Data Card Listings

For notation, see key at front of Listings.

Baryons

Σ(1670), Σ(1690)

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M     1200 1688+/-2. OR 1683+/-5.     BERTHON   74 HBC   0 QUASI 2 BODY CS   4/75*
M   3    1665.         3.             BLOKZIJL  75 HBC     K- P AT 4.2 GEV   1/76*
M   3  PARAMETERS DETERMINED FRCM (SIGMAO PI+) PRODUCTICN.                   1/76*
M   4    1657.         3.             BLOKZIJL  75 HBC     K- P AT 4.2 GEV   1/76*
M   4  PARAMETERS DETERMINED FRCM (Y*0(1405) PI+) PRODUCTION.                1/76*
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.6)

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                   51  Y*1(1670) MASS (MEV) (PROD. EXP.)

W           (45.0)                    ALEXANDER 62 HBC  -0
W            40.0      10.0           ALVAREZ   63 HBC  +
W           (30.0)    (15.0)          BUGG      68 CNTR                      11/66
W    P   70 (60.)     (20.)           PRIMER    68 HBC  +  K-P 4.6-5. GEV/C  7/68
W           110.0      12.0           AGUILAR   70 HBC     SIG.PI K-P 4 GEV  5/70
W           135.0      40.0    30.0   AGUILAR   70 HBC     SIG.2PI K-P 4GEV  5/70
W  B         67.        2.4           APSELL    74 HBC     K- P 2.87 GEV/C   4/75*
W   3        64.        9.            BLOKZIJL  75 HBC     K- P AT 4.2 GEV   1/76*
W   4        53.        5.            BLOKZIJL  75 HBC     K- P AT 4.2 GEV   1/76*
W              SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 2.6)

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                   51  Y*1(1670) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1      Y*1(1670) INTO KBAR N                            497+ 939
P2      Y*1(1670) INTO LAMBDA PI                        1115+ 139
P3      Y*1(1670) INTO SIGMA PI                         1197+ 139
P4      Y*1(1670) INTO LAMBCA PI PI                     1115+ 139+ 139
P5      Y*1(1670) INTO SIGMA PI PI                      1197+ 139+ 139
P6      Y*1(1670) INTO Y*1(1385) PI                     1384+ 139
P7      Y*1(1670) INTO Y*0(1405) PI                     1405+ 139

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                   51  Y*1(1670) BRANCHING RATIOS (PROC. EXP.)

R1      Y*1(1670) INTO (KBAR N)/(SIGMA PI)              (P1)/(P3)
R1        0    (0.19) OR LESS         ALVAREZ   63 HBC  +  K-P 1.15 BEV/C
R1             (0.5)+- .25 OR MORE    SMITH     63 HBC  -0
R1             (0.6)  OR LESS         LONDON    66 HBC  +  K-P 2.25 BEV/C    7/66
R1             (0.025)                BUGG      68 CNTR  0 ASSUMING J=3/2   11/66
R1        0    (0.24) OR LESS         PRIMER    68 HBC  +  K-P 4.6-5. GEV/C  7/68
R1             (0.26) OR LESS         BARNES    69 HBC  +  K-P 3.9-5 GEV/C  10/69
R1             (0.2)  OR LESS         AGUILAR   70 HBC                       5/70
R1             (0.10) OR LESS         BERTHON   74 HBC   0 QUASI 2 BODY CS   4/75*
R1              (.03) OR LESS         BLOKZIJL  75 HBC     K- P AT 4.2 GEV   1/76*

R2      Y*1(1670) INTO (LAMB.PI)/(SIG PI)               (P2)/(P3)
R2      130    (1.20)                 ALVAREZ   63 HBC  +  K-P 1.15 BEV/C
R2             (1.2)                  SMITH     63 HBC  -0
R2              0.15      0.07        HUWE      64 HBC  +
R2              0.6    OR LESS        LONDON    66 HBC  +  K-P 2.25 BEV/C    7/66
R2       33     0.11      0.06        BUTTON-S  68 HBC  +  K-P AT 1.7 GEV/C 10/69
R2  P     0    (0.)                   PRIMER    68 HBC  +  K-P 3.9-5 GEV/C  10/69
R2  P   PRIMER 68 ASSUMED THIS CECAY TO BE ALL Y*(1690)- SEE BARNES 69 FOR
R2  P   NEW INTERPRATATION OF CATA.(3 TIMES MORE DATA) -
R2              0.45      0.15        BARNES    69 HBC  +  K-P 3.9-5 GEV/C  10/69
R2             (.55)     (.11)        BERTHCN   74 HBC   0 QUASI 2 BODY CS   4/75*
R2   1          .76       .09         ESTES     74 HBC   0 K-P,2.1+2.6GEV/C 11/75*
R2   1         (.46)+/-.07) OR LESS   BLOKZIJL  75 HBC     K- P AT 4.2 GEV   1/76*
R2   1  THIS EXPT. TENDS TO CONFIRM THE INTERPRETATION CF EBERHARD 69.      11/75*
R2             . . . . . . . . . .
R2  AVERAGE MEANINGLESS (SCALE FACTOR = 3.7)

R3      Y*1(1670) INTO (LAMB. PI PI)/(SIG PI)           (P4)/(P3)
R3       90    (0.56)                 ALVAREZ   63 HBC  +  K-P 1.15 BEV/C
R3             (0.17)                 SMITH     63 HBC  -0
R3             (0.6)  OR LESS         LONDON    66 HBC  + K-P AT 2.25 BEV/C  7/66

R4      Y*1(1670) INTO (SIGMA PI PI)/(SIG PI)           (P5)/(P3)
R4      180    (0.56)                 ALVAREZ   63 HBC  +  K-P 1.15 BEV/C
R4          LARGEST AT SMALL ANGLES   ESTES     74 HBC   0 K-P,2.1+2.6GEV/C 11/75*

R5      Y*1(1670) INTO (Y*0(1405) PI)/(SIG PI)          (P7)/(P3)
R5       50     3.        1.6         LONDCN    66 HBC  +  K-P 2.25 BEV/C    7/66
R5  P    17    (0.58)    (0.20)       PRIMER    68 HBC  +  K-P 4.6-5. GEV/C  7/68
R5              .88       .13         BLOKZIJL  75 HBC     K- P AT 4.2 GEV   1/76*
R5             . . . . . . . . . .
R5  AVG         0.89      0.13    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  STUDENT     0.89      0.14    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R6      Y*1(1670) INTO (SIGMA PI)/(SIGMA PI PI)         (P3)/(P5)
R6              .4    OR LESS         BIRMINGHA 66 HBC  +  K-P AT 3.5 GEV/C 11/67
R6              0.30      0.15        LONDCN    66 HBC  +  K-P 2.25 GEV/C    7/66
R6  A      BETWEEN 2.5 AND 0.24       EBERHARD  69 HBC     K-P AT 2.6 GEV/C  9/69
R6             (1.39)    (.16)        BERTHCN   74 HBC   0 QUASI 2 BODY CS   4/75*
    A      DEPENDING ON THE PRODUCTION ANGLE

R7      Y*1(1670) INTO (Y*0(1405) PI)/(SIGMA PI PI)     (P7)/(P5)
R7              0.90      0.10     0.16 EBERHARD 65 HBC +  K-P 2.45 BEV/C    7/66
R7 B            1.00      .02         APSELL    74 HBC     K- P 2.87 GEV/C   4/75*
R7 B    APSELL 74 FINDS STRCNG BRANCHING RATIC DEPENDENCE ON PRODUCTION      4/75*
R7 B    ANGLE, AS IN OTHER PRODUCTION EXPERIMENTS. BR RECORDED HERE (AND     4/75*
R7 B    ALSO MASS AND WIDTH ABOVE) ARE FROM EVENTS WITH COS(PRD. ANG.)       4/75*
R7 B    BETWEEN 1.0 AND 0.7.                                                 4/75*
R7          LARGEST AT SMALL ANGLES   ESTES     74 HBC   0 K-P,2.1+2.6GEV/C 11/75*
R7             . . . . . . . . . .
R7  AVG         0.998     0.020   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R7  STUDENT     0.998     0.021   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R8      Y*1(1670) INTO (Y*0(1405) PI)/(Y*1(1385) PI)    (P7)/(P6)
R8             (0.8)  OR LESS         EBERHARD  65 HBC  +  K-P 2.45 BEV/C    7/66

R9      Y*1(1670) INTO (LAMBCA PI PI)/(SIGMA PI PI)     (P4)/(P5)
R9              0.35      0.2         BIRMINGHA 66 HBC  +  K-P AT 3.5 GEV/C 11/67

R10     Y*1(1670) INTO (LAMBCA PI)/(SIGMA PI PI)        (P2)/(P5)
R10             (.2)  OR LESS         BIRMINGHA 66 HBC  +  K-P AT 3.5 GEV/C 11/67

R11     Y*1(1670) INTO (LAMBDA PI)/(LAMBDA PI + SIG PI) (P2)/(P2+P3)
R11            (0.6)  OR LESS         AGUILAR   70 HBC                       5/70

R12     Y*1(1670) INTO (Y*1(1385) PI)/(SIGMA PI)        (P6)/(P3)            1/76*
R12            (.25)+/-.05) OR LESS   BLCKZIJL  75 HBC     K- P AT 4.2 GEV   1/76*

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             51  Y*1(1670) QUANTUM NUMBER DETERMINATICN (PROD. EXP.)

Q1                  JP=3/2+          LEVEQUE    65 HBC      INTO Y*(1405)+PI 11/68
Q3                  JP=3/2-          EBERHARD   67 HBC  +   INTO Y*(1405) PI 11/68
Q4       400        JP=3/2-          BUTTCN-SH  68 HBC  +-  INTO SIGZERO+PI  11/68

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                             REFERENCES FOR Y*1(1670) (PROD. EXP.)

ALEXANDE 62 CERN CONF 320      ALEXANDER,JACOBS,KALBFLEISCH,MILLER,+ (LRL) I
ALVAREZ  63 PRL 10 184         +ALSTON,FERRO-LUZZI,HUWE, +           (LRL) I
SMITH    63 ATHENS CONF 67     G A SMITH                             (LRL)
HUWE     64 PR 180 1824(1969)  D O HUWE                              (LRL)
EBERHARD 65 PRL 14 466         +SHIVELY,ROSS,SIEGAL,FICENEC, +   (LRL,ILL) I

BIRMINGH 66 PR  152  1148      BIRMINGHAM,GLASGOW,I.C.Y OXFORD,RUTHERFCRD
LONDON   66 PR 143 1034        +RAU,SAMIOS,YAMAMOTO,GOLDBERG,+  (BNL,SYRA) IJ
BUGG     68 PR 168 1466        +GILMORE,KNIGHT,DAVIES+    (BIRM,CAVE,RHEL)I
BUTTCN-S 68 PRL 21 1123        J BUTTON SHAFER                  (MASA+LRL) JP
PRIMER   68 PRL 20 610         +GCLCBERG,JAEGER,BARNES,DORNAN + (SYRA,BNL)

BARNES   69 BNL 13823          +CHUNG,EISNER,FLAMINIO+          (BNL,SYRA)
EBERHARD 69 PRL 22 200         +FRIEDMAN,PRIPSTEIN,ROSS               (LRL)
AGUILAR  70 PRL 25 58          +BARNES, BASSANC, CHUNG, EISNER,+(BNL,SYRA)

APSELL   74 PRD 10 1419        APSELL,FCRD,GCUREVITCH+(BRAN,UMC,SYRA,TUFT)I
BERTHON  74 NC 21A 146         BERTHON,TRISTRAM,+    (CDEF+RHEL+SACL+STRB)   U
ESTES    74 LBL-3827 (THESIS)  R. D. ESTES                            (LBL)

BLCKZIJL 75 ANL-HEP-CP-75-58   +DEGROOT,HOOGLAND+     (AMST+CERN+NIJM+OXF)
    ALSO 75 PALERMO CONF.      +DEGROOT,HOOGLAND+     (AMST+CERN+NIJM+OXF)

                               PAPERS NOT REFERRED TO IN CATA CARDS

LEVEQUE  65 PL 18 69           +        (SACLAY,EPOL,GLASGCW,LCIC,CXF,RHEL) JP
LEE      66 PRL 17 45          Y Y LEE, D D REEDER, R W HARTUNG       (WISC) JP
EBERHARD 67 PR 163 1446        +PRIPSTEIN,SHIVELY,KRUSE,SWANSCN  (LRL,ILL)IJP
MILLER   70 DUKE 229           D H MILLER    (REVIEW TALK)           (PURDUE)
EBERHARD 73 PURDUE CONF. 247   EBERHARD                              (LBL)IJP
HUNGERBU 74 PRD 10 2051        HUNGERBUHLER,MAJKA,+    (YALE,FNAL,BNL,PITT)

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Σ(1690) BUMPS →

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58  Y*1(1690, JP=    ) I=1        PRODUCTICN EXPERIMENTS

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

SEE NOTE PRECEDING Y*1(1670) LISTINGS, SEEN IN PRC.
EXPERIMENTS CNLY, MAIN DECAY MODE IS LAMBDA PI.

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                   58  Y*1(1690) MASS (MEV) (PRCD. EXP.)

M      30(1715.0)   (12.0)        COLLEY    67 HBC  +  K-P 6 GEV/C          8/67
M   P  60(1694.0)   (24.0)        PRIMER    68 HBC  +  K-P 4.6-5 GEV/C      7/68
M    N   (1700.0)    (6.0)        SIMS      68 HBC  -  K-N TO LAM PI PI    11/68
M      46(1682.0)    (2.0)        BLUMENFEL 69 HBC  +  KO LONG + PROTCN     9/69
M        (1700.0)   (20.0)        MOTT      69 HBC  +  K-P 5.5 GEV/C        9/69
M   P    SEE Y*1(1670) LISTING-AGUILAR 70 WITH THREE TIMES THE DATA OF
M   P    PRIMER 68  SHOW THAT THEY HAVE NO EVIDENCE FOR Y*(1690)
M    N   THIS ANALYSIS, WHICH IS DIFFICULT AND REQUIRES SEVERAL ASSUMPTIONS
M      AND SHOWS NO UNAMBIGUOUS Y*1(1690) SIGNAL, SUGGESTS JP=5/2+.  SUCH A
M      Y* WOULD LEAD ALL PREVIOUSLY KNOWN Y* TRAJECTORIES.

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                   58  Y*1(1690) WIDTH (MEV) (PROD. EXP.)

W      30 (100.0)   (35.0)        COLLEY    67 HBC  +                       8/67
W      60 (105.0)   (35.0)        PRIMER    68 HBC  +                       7/68
W    N     (62.0)   (14.0)        SIMS      68 HBC  -  SEE NOTE N ABCVE    11/68
W      46  (25.0)   (10.0)        BLUMENFEL 69 HBC  +                       9/69
W         (130.0)   (25.0)        MOTT      69 HBC  +                       9/69
              SEE THE NOTES ACCOMPANYING THE MASSES QUCTED

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                   58  Y*1(1690) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1      Y*1(1690) INTO KBAR N                            497+ 939
P2      Y*1(1690) INTO LAMBDA PI                        1115+ 139
P3      Y*1(1690) INTO SIGMA PI                         1197+ 139
P4      Y*1(1690) INTO Y*1(1385) PI                     1384+ 139
P5      Y*1(1690) INTO LAMBDA PI PI (INCLUDING P4)      1115+ 139+ 139

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                   58  Y*1(1690) BRANCHING RATIOS (PROD. EXP.)

R1      Y*1(1690) INTO (KBAR N)/(LAMBDA PI)             (P1)/(P2)
R1      18      0.4       0.25        COLLEY    67 HBC  +  6/30 EVENTS      8/67
R1             (0.2)  OR LESS         MOTT      69 HBC  +                   9/69

R2      Y*1(1690) INTO (SIGMA PI)/(LAMBDA PI)           (P3)/(P2)
R2              0.3       0.3         COLLEY    67 HBC  +  4/30 EVENTS      8/67
R2             (0.4)  OR LESS  CL=.90 MOTT      69 HBC  +                   9/69

R3      Y*1(1690) INTO (Y*1(1385) PI)/(LAMBCA PI)       (P4)/(P2)
R3             (0.5)  OR LESS         MOTT      69 HBC  +                   9/69

R4      Y*1(1690) INTO (LAMBCA PI PI)/(LAMBDA PI)       (P5)/(P2)
R4              0.5       0.25        COLLEY    67 HBC  +  15/30 EVENTS     8/67
R4              2.0       0.6         BLUMENFEL 69 HBC  +  31/15 EVENTS     9/69
R4           . . . . . . . . . .
R4  AVG         0.72      0.53    AVERAGE (ERROR INCLUDES SCALE FACTOR CF 2.3)
R4  STUDENT     0.67      0.28    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R5      Y*1(1690) INTO (Y*1(1385) PI)/(LAMBDA PI PI)    (P4)/(P5)
R5            SMALL                   COLLEY    67 HBC  +                   8/67
R5            LARGE                   SIMS      68 HBC  -  K-N TO L2PI     11/68

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Baryons

Σ(1690), Σ(1750), Σ(1765)

Data Card Listings

For notation, see key at front of Listings.

REFERENCES FOR Y*1(1690) (PROD. EXP.)

COLLEY 67 PL 24B 489 (BIRM,GLAS,LOIC,MUNICH,OXFORD,RHEL) I
DERRICK 67 PRL 18 266 +FIELDS, LCKEN, AMMAR, (ARGONNE,NORTHWEST) I
REPLACED BY MOTT 69.
PRIMER 68 PRL 20 610 +GOLDBERG, JAEGER, BARNES, + (SYRACUSE,BNL) I
SIMS 68 PRL 21 1413 +ALBRIGHT, + (FSU,TUFTS,BRANDEIS) I

BLUMENFE 69 PL 29B 58 B J BLUMENFELD, G R KALBFLEISCH (BNL) I
MOTT 69 PR 177 1966 +AMMAR, DAVIS, KROPAC, +(NORTHWEST,ARGONNE) I

PAPERS NOT REFERRED TO IN DATA CARDS

AGUILAR 70 PRL 25 58 AGUILAR-BENITEZ,BARNES,BASSANO+ (BNL+SYRA)

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Σ(1750)

57 Y*1(1750, JP=1/2-) I=1 S''_{11}

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THIS STATE CORRESPONDS TO THE SIGMA ETA THRESHOLD BUMP BUT ITS INTERPRETATION IN TERMS OF A RESONANCE IS NOT CONCLUSIVE (JONES 74) -- MORE DATA ARE NEEDED. BY ANALOGY WITH THE SIMILAR N ETA AND LAMBDA ETA THRESHOLD EFFECTS, WHICH ARE ALMOST CERTAINLY RESONANCES, IT SEEMS VERY LIKELY THAT THIS TOO IS A RESONANCE.

THERE IS ALSO EVIDENCE FOR THIS STATE IN MANY PARTIAL-WAVE ANALYSES, MOSTLY IN THE LAMBDA PI CHANNEL. THIS EVIDENCE SHOULD BE CONSIDERED WITH CAUTION AS THE MASSES AND/OR BRANCHING RATIOS OF THE REPORTED STATES ARE OFTEN INCONSISTENT.

57 Y*1(1750) MASS (MEV)

M		NEAR SIGMA ETA THRESHOLD			CLINE	67	DBC	-	K-N TO SIGMA ETA	9/66
M		ABOUT 1750.0			MEYER	67	RVUE			9/69
M		ABOUT 1730.0			ARMENTERO	70	HDBC	-0	K-N TO LAMBDA PI	6/70
M		(1757.0)	(10.0)		CONFORTO	71	DPWA	0	ELASTIC, CH EXCH	6/70
M		(1790.)			KIM	71	DPWA		K-MATRIX ANAL.	3/71
M		(1790.0)	(15.0)		LANGBEIN	72	IPWA		MULTICHANNEL	12/72
M		(1716.)	(10.)		BAXTER	73	DPWA	0	K- P TO NEUTRALS	10/74*
M		(1785.)	(12.)		CHU	74	DBC	-	FIT SIG- ETA CS	10/74*
M	1	(1760.)	(5.)		JONES	74	HBC	0	FIT SIG0 ETA CS	1/74
M		(1739.)	(10.)		PREVOST	74	DPWA	0-	K-N TO S(1385)PI	10/74*
M	1	S-WAVE BW FIT TO THRSHLD C.S., NO BKGND. ERRORS STATISTICAL ONLY								1/74
M	A	(1780.)	(30.)		BAILLON	75	IPWA		KBAR N TO LAM PI	11/75*
M	A	FROM SOLUTION 1 OF BAILLON 75.								11/75*
M	B	(1700.)	(30.)		BAILLON	75	IPWA		KBAR N TO LAM PI	1/76*
M	B	FROM SOLUTION 2 OF BAILLON 75.								1/76*
M		(1697.)	(20.)	(10.)	VANHORN	75	DPWA	0	K- P TO LAM PI0	11/75*
M		(1770.)	(15.)		RLIC	76	DPWA		KBAR N MULTICHNL	1/76*

57 Y*1(1750) WIDTH (MEV)

W		ABOUT 50.0			MEYER	67	RVUE			9/69
W		ABOUT 80.0			ARMENTERO	70	HDBC	-0	K-N TO LAMBDA PI	6/70
W		(55.0)	(10.0)		CONFORTO	71	DPWA	0	ELASTIC, CH EXCH	6/70
W		(50.)			KIM	71	DPWA		K-MATRIX ANAL.	3/71
W		(100.0)	(20.0)		LANGBEIN	72	IPWA		MULTICHANNEL	12/72
W		(60.)	(20.)		BAXTER	73	DPWA	0	K- P TO NEUTRALS	10/74*
W		(89.)	(33.)		CHU	74	DBC	-	FIT SIG- ETA CS	10/74*
W	1	(92.)	(7.)		JONES	74	HBC	0	FIT SIG+ETA CS	1/74
W		(108.)	(20.)		PREVOST	74	DPWA	0-	K-N TO S(1385)PI	10/74*
W	A	(140.)	(30.)		BAILLON	75	IPWA		KBAR N TO LAM PI	11/75*
W	B	(160.)	(50.)		BAILLON	75	IPWA		KBAR N TO LAM PI	1/76*
W		(66.)	(14.)	(12.)	VANHORN	75	DPWA	0	K- P TO LAM PI0	11/75*
W		(60.)	(10.)		RLIC	76	DPWA		KBAR N MULTICHNL	1/76*

57 Y*1(1750) PARTIAL DECAY MODES

		DECAY MASSES
P1	Y*1(1750) INTO KBAR N	497+ 939
P2	Y*1(1750) INTO SIGMA ETA	1197+ 548
P3	Y*1(1750) INTO LAMBDA PI	1115+ 134
P4	Y*1(1750) INTO SIGMA PI	1197+ 139
P5	Y*1(1750) INTO SIGMA(1385) PI	139+1384

57 Y*1(1750) BRANCHING RATIOS

R1		Y*1(1750) INTO (KBAR N)/TOTAL						(P1)	
R1		(0.12)	(0.05)	CONFORTO	71	DPWA	0	ELASTIC, CH EXCH	6/70
R1		(0.8)		KIM	71	DPWA		K-MATRIX ANAL.	3/71
R1		(0.45)	(0.05)	LANGBEIN	72	IPWA		MULTICHANNEL	12/72
R1		(.15)	(.03)	RLIC	76	DPWA		KBAR N MULTICHNL	1/76*
R2		Y*1(1750) FROM KBAR N INTO SIGMA ETA						SQRT(P1*P2)	
R2		SEEN		CLINE	69	DBC	-	THRESHOLD BUMP	9/69
R2	1	(.23)	(.01)	JONES	74	HBC	0	FIT SIG+ETA CS	1/74
R3		Y*1(1750) FROM KBAR N INTO LAMBDA PI						SQRT(P1*P3)	
R3	2	(-0.25)		ARMENTERO	70	IPWA	-0	K-N TO LAMBDA PI	6/70
R3	2	PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CONVENTION (SEE TEXT)							10/74*
R3		(0.09)		KIM	71	DPWA		K-MATRIX ANAL.	3/71
R3		(0.30)	(0.05)	LANGBEIN	72	IPWA		MULTICHANNEL	12/72
R3		(-.28)	(.05)	BAXTER	73	DPWA	0	K- P TO NEUTRALS	10/74*
R3		(-.120)	(.077)	DEVENISH	74		0	FIXED T DISP REL	4/75*
R3	A	(-.12)	(.02)	BAILLON	75	IPWA		KBAR N TO LAM PI	11/75*
R3	B	(-.13)	(.03)	BAILLON	75	IPWA		KBAR N TO LAM PI	1/76*
R3		(-.13)	(.04)	VANHORN	75	DPWA	0	K- P TO LAM PI0	11/75*
R3		(-.09)	(.05)	RLIC	76	DPWA		KBAR N MULTICHNL	1/76*
R4		Y*1(1750) FROM KBAR N TO SIGMA PI						SQRT(P1*P4)	
R4		(0.16)		KIM	71	DPWA		K-MATRIX ANAL.	3/71
R4		(0.13)	(0.02)	LANGBEIN	72	IPWA		MULTICHANNEL	12/72
R4		(+.04)	(.03)	RLIC	76	DPWA		KBAR N MULTICHNL	1/76*
R5		Y*1(1750) FROM KBAR N TO SIGMA(1385) PI						SQRT(P1*P4)	
R5		+.18	.15	PREVOST	74	DPWA	0-	K-N TO S(1385)PI	10/74*

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REFERENCES FOR Y*1(1750)

CLINE 67 PL 25B 41 CLINE, OLSSON (WISCONSIN)IJP
MEYER 67 HEIDELBERG C 117 J MEYER (RAPPORTEUR) (SACLAY)IJP
ARMENTER 70 DUKE 123 ARMENTEROS, BAILLON, + (CERN,HEIDEL)IJP
CONFORTO 71 NP B34 41 +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM 71 PRL 27 356 J K KIM (HARV)IJP
ALSO 70 DUKE 161 J. K. KIM (HARV)IJP
LANGBEIN 72 NP B47 477 +WAGNER (MPIM)IJP

BAXTER 73 NP B67 125 BAXTER,BUCKINGHAM,CORBETT,DUNN,+ (OXFORD)IJP
CHU 74 NC 20A 35 CHU,BARTLEY,+ (SUNY PLATTSBURGH+TUFTS+BRAN)IJP
JONES 74 NP B73 141 JONES (U. CHICAGO)IJP
DEVENISH 74 NP B81 330 DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
PREVOST 74 NP B69 246 PREVOST,BARLOUTAUD,+ (SACL+CERN+HEID)

BAILLON 75 NP B94 39 P. BAILLON,P. J. LITCHFIELD (CERN,RHEL)IJP
VANHORN 75 NP B87 145 A. J. VAN HORN (LBL)IJP
ALSO 75 NP B87 157 A. J. VAN HORN (LBL)IJP

RLIC 76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+ (RHEL+LOIC)IJP

PAPERS NOT REFERRED TO IN DATA CARDS

FERRO-LU 66 BERKELEY CONF 183 M FERRO LUZZI (RAPPORTEUR) (CERN)
ARMENTER 68 NP B8 183 ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
ARMENTER 69 LUND CONF PAPER ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
HARRISON 70 FSU-HEP 70 3 1 W.C. HARRISON (THESIS) (FSU)

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Σ(1765)

45 Y*1(1765, JP=5/2-) I=1 D_{15}

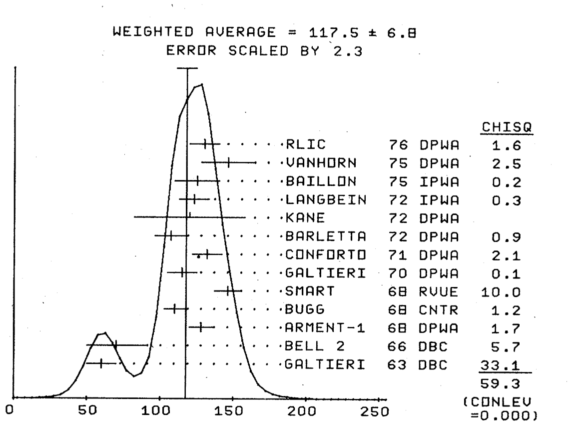
SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

45 Y*1(1765) MASS (MEV)

M		1765.0	10.0	GALTIERI	63	DBC	0	K-D 1.51 BEV/C	
M		1755.0	10.0	ARMENTER	65	HBC	0	K-P TO Y*1520 PI	7/66
M		1760.0	10.0	BELL 1	66	DBC	-	K-N TO Y*1520 PI	7/66
M	N	1768.0	2.0	ARMENT-1	68	DPWA	0	ELASTIC, CH EXCH	11/68
M	N	1768.0	4.0	BUGG	68	CNTR		K-P, D TOTAL	11/66
M		1775.0	7.0	SMART	68	RVUE	-0	K-N TO LAMBDA PI	7/68
M		1770.0	10.0	COOL	70	CNTR		K-P, D TOTAL	10/70
M		1765.0	10.0	GALTIERI	70	DPWA	0	K-P TO LAMBDA PI	7/70
M	N	1770.0	3.0	CONFORTO	71	DPWA	0	ELASTIC, CH EXCH	6/70
M		(1765.)		KIM	71	DPWA		K-MATRIX ANAL.	3/71
M		1758.7	3.9	BARLETTA	72	DPWA	0	KPPI 0.8-1.2GEV	12/72
M		1765.0	9.0	KANE	72	DPWA	0	K-P TO PI SIG	10/71
M	N	1770.0	5.0	LANGBEIN	72	IPWA		MULTICHANNEL	12/72
M		1775.	10.	BAILLON	75	IPWA		KBAR N TO LAM PI	11/75*
M		1774.	10.	VANHORN	75	DPWA	0	K- P TO LAM PI0	11/75*
M		1774.	5.	RLIC	76	DPWA		KBAR N MULTICHNL	1/76*
M	N	ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED							1/71
M		. . . .							
M		AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)							

45 Y*1(1765) WIDTH (MEV)

W		60.0	10.0	GALTIERI	63	DBC	0		
W		70.0	20.0	BELL 2	66	DBC	-		7/66
W		128.0	8.0	ARMENT-1	68	DPWA	0	ELASTIC, CH EXCH	11/68
W		110.0	7.0	BUGG	68	CNTR		K-P,D TOTAL	7/68
W		146.0	9.0	SMART	68	RVUE	-0		7/68
W		(100.0)		COOL	70	CNTR		K-P, D TOTAL	10/70
W		115.0	10.0	GALTIERI	70	DPWA	0	K-P TO LAMBDA PI	7/70
W		132.0	10.0	CONFORTO	71	DPWA	0	ELASTIC, CH EXCH	6/70
W		(100.)		KIM	71	DPWA		K-MATRIX ANAL.	3/71
W		107.2	10.9	BARLETTA	72	DPWA	0	LAM(1520)PI CH.	12/72
W		120.0	38.0	KANE	72	DPWA	0	K-P TO PI SIG	10/71
W		123.0	10.0	LANGBEIN	72	IPWA		MULTICHANNEL	12/72
W		125.	15.	BAILLON	75	IPWA		KBAR N TO LAM PI	11/75*
W		146.	18.	VANHORN	75	DPWA	0	K- P TO LAM PI0	11/75*
W		130.	10.	RLIC	76	DPWA		KBAR N MULTICHNL	1/76*
W		. . . .							
W	AVG	117.5	6.8	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.3)					
W	STUDENT	121.0	3.9	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT					
				(SEE IDEOGRAM BELOW)					



Data Card Listings

For notation, see key at front of Listings.

Baryons

Σ(1765), Σ(1770)

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                    45  Y*1(1765) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      Y*1(1765) INTO KBAR N                                  497+ 939
P2      Y*1(1765) INTO LAMBDA PI                              1115+ 134
P3      Y*1(1765) INTO Y*0(1520) PI                           1518+ 139
P4      Y*1(1765) INTO Y*1(1385) PI D-WAVE                     139+1384
P5      Y*1(1765) INTO SIGMA PI                               1197+ 139
P6      Y*1(1765) INTO SIGMA ETA                              1197+ 548
P7      Y*1(1765) INTO SIGMA PI PI                            1197+ 139+ 139
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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

	P 1	P 2	P 3	P 4	P 5	P 6
P 1	.4117+-.0145					
P 2	-.0870	.1402+-.0130				
P 3	.0877	-.0230	.1567+-.0327			
P 4	-.1192	.0104	-.0104	.0984+-.0173		
P 5	-.1172	.0102	-.0103	.0140	.0145+-.0043	
P 6	-.3298	-.2708	-.8077	-.3718	-.0641	.1784+-.0414

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                    45  Y*1(1765) BRANCHING RATIOS

        ERRORS QUOTED BY EXPERIMENTERS DO NOT INCLUDE UNCERTAINTY CUE
        TO PARAMETRIZATION USED IN THE P.W.A.  THEY SHOULD BE INCREASED.

R1      Y*1(1765) INTO (KBAR N)/TOTAL                    (P1)
R1           (0.6)                     GALTIERI  63 HBC   0 K-P RVUE
R1            0.53      0.09           UHLIG     67 HBC   0                     9/66
R1            0.45      0.01           ARMENT-1  68 DPWA  0 ELASTIC, CH EXCH 11/68
R1           (0.37)                    BUGG      68 CNTR                     11/66
R1            0.36      0.02           BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
R1           (0.4)                     COOL      70 CNTR    K-P, D TOTAL     10/70
R1            0.36      0.02           CCNFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
R1           (0.42)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
R1            0.39      0.01           LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R1             .41       .03           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R1          . . . . . . . . . .
R1  AVG       0.409     0.018   AVERAGE (ERROR INCLUDES SCALE FACTOR CF 2.8)
R1  STUDENT   0.3950    0.0099  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1  FIT       0.412     0.014  FROM FIT (ERROR INCLUDES SCALE FACTCR OF 2.4)
                        (SEE IDEOGRAM BELOW )
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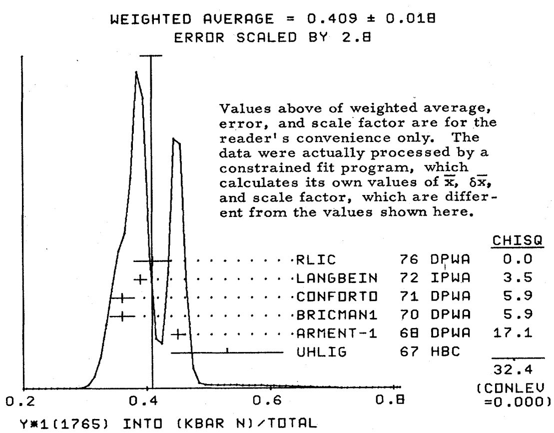


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R2      Y*1(1765) FROM KBAR N INTO LAMBDA PI            SQRT(P1*P2)
R2           -0.266     0.017          SMART     68 DPWA -0 K-N TO LAMBDA PI  7/68
R2           -0.22      0.03           GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
R2           (0.30)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
R2            0.15      0.04           LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R2            -.259      .048          DEVENISH  74       0 FIXED T DISP REL  4/75*
R2            -.25       .02           BAILLON   75 IPWA    KBAR N TO LAM PI 11/75*
R2            -.28       .04     .05   VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
R2            -.28       .03           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R2          . . . . . . . . . .
R2  AVG MOD   0.251     0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R2  STUDENT   0.253     0.012   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2  FIT       0.240     0.012  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R3      Y*1(1765) FROM KBAR N INTO Y*0(1520) PI          SQRT(P1*P3)
R3            0.27      0.03           ARMENTERO 65 HBC   0 K-P TO Y*1520 PI  9/66
R3            0.31      0.02           BARLETTA  72 DPWA  0 K-P TO Y*1520 PI 12/72
R3          . . . . . . . . . .
R3  AVG       0.298     0.018   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R3  STUDENT   0.298     0.019   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R3  FIT       0.254     0.027  FRCM FIT (ERROR INCLUDES SCALE FACTOR OF 2.1)

R4      Y*1(1765) FROM KBAR N TO Y*1(1385) PI D-WAVE     SQRT(P1*P4)
R4  A        (0.24)    (0.03)          ARMENT-2  67 HBC   0 K-P TO LAM PI PI  8/67
R4  S        (0.32)    (0.06)          SIMS      68 CBC   -  K-N TO LAM PI PI 11/68
R4  S   SIMS 68 USES ONLY CROSS-SECT. DATA. RESULT USED AS UPPER LIMIT ONLY   3/72
R4            +.20       .02           PREVOST   74 DPWA 0- K-N TO S(1385)PI 10/74*
R4          . . . . . . . . . .
R4  FIT       0.201     0.018  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5      Y*1(1765) FROM KBAR N INTO SIGMA PI              SQRT(P1*P5)
R5           +0.07      0.02           ARMENTERO 67 DPWA  0 K-P TO SIGMA PI  10/74*
R5           +0.06      0.03           GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
R5           (0.09)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
R5           +0.074     0.017          KANE      72 DPWA  0 K-P TO PI SIG    10/71
R5            0.09  OR LESS            LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R5            +.13       .02           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R5          . . . . . . . . . .
R5  AVG       0.086     0.015   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
R5  STUDENT   0.082     0.013   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R5  FIT       0.077     0.011  FROM FIT (ERROR INCLUDES SCALE FACTCR OF 1.1)

R6      Y*1(1765) INTO (LAMECA PI)/(KBAR N)              (P2)/(P1)
R6            0.33      0.05           UHLIG     67 HBC   0 K-P,.9 GEV/C      9/66
R6          . . . . . . . . . .
R6  FIT       0.341     0.035  FRCM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R7      Y*1(1765) INTO (Y*0(1520)PI)/(KBAR N)            (P3)/(P1)
R7            0.28      0.05           UHLIG     67 HBC   0 K-P,.9 GEV/C      9/66
R7          . . . . . . . . . .
R7  FIT       0.381     0.079  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.1)

R8      Y*1(1765) INTO (Y*1(1385)PI)/(KBAR N)            (P4)/(P1)
R8            0.25      0.09           UHLIG     67 HBC   0 K-P,.9 GEV/C      9/66
R8          . . . . . . . . . .
R8  FIT       0.239     0.044  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R9      Y*1(1765) INTO (SIGMA PI PI)/TOTAL               (P7)
R9  P        (0.12)                    ARMENT-2  68 HDBC -0 K-N TO SIG PI PI 11/68
R9  P   FOR ABOUT 3/4 OF THIS, THE SIGMA PI SYSTEM HAS I=0 AND IS ALMOST
R9  P ENTIRELY Y*0(1520).  FOR THE OTHER 1/4, THE SIGMA PI HAS I=1.  THIS
R9  P IS ABOUT WHAT IS EXPECTED FROM THE KNOWN RATE Y*1(1765) TO Y*1(1385)
R9  P PI, AS SEEN IN LAMBDA PI PI.

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                         REFERENCES FOR Y*1(1765)

GALTIERI 63 PL 6 296            A BARBARO-GALTIERI,A HUSSAIN,RD TRIPP (LRL)IJ
ARMENTER 65 PL 19 338           ARMENTEROS, +        (CERN,HEIDELBERG,SACLAY)IJP
BELL 1   66 PRL 16 203          R B BELL, R W BIRGE, Y-L PAN, R T PU  (LRL)IJP
BELL 2   66 UCRL-16936 THESIS R B BELL                                (LRL)IJP
ARMENTER 67 PL 24B 198          ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)IP
ARMENT-2 67 ZEIT.PHYS.202 486 ARMENTEROS,FERRO-LUZZI+    (CERN,HEID,SACLAY)
UHLIG    67 PR 155 1448         +CHARLTCN,CONDON,GLASSER,YCDH,+    (UMD,NRL)

ARMENT-1 68 NP B8 195           ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-2 68 NP B8 216           ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY) I
BUGG     68 PR 168 1466         +GILMORE,KNIGHT,DAVIES+     (BIRM,CAVE,RHEL)I
SIMS     68 PRL 21 1413         SIMS,ALBRIGHT,BARTLEY,MEER+ (FSU,TUFT,BRAN)
SMART    68 PR 169 1330         W M SMART                             (LRL)IJP

BRICMAN1 70 PL 33B 511          +FERRO-LUZZI,LAGNAUX                  (CERN)
COOL     70 PR D1 1887          +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
GALTIERI 70 DUKE CONF 173       A BARBARO-GALTIERI                    (LRL)IJP

CONFORTO 71 NP  B34  41         +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM      71 PRL 27 356          J K KIM                              (HARV)IJP
    ALSO 70 DUKE 161            J. K. KIM                            (HARV)IJP

BARLETTA 72 NP B40 45           W.A. BARLETTA                         (EFI) IJP
KANE     72 PR D5 1583          D F KANE                              (LBL)IJP
LANGBEIN 72 NP B47 477          +WAGNER                              (MPIM)IJP
DEVENISH 74 NP B81 330          DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
PREVOST  74 NP B69 246          PREVOST,BARLOUTAUD,+         (SACL+CERN+HEID)

BAILLCN  75 NP B94 39           P. BAILLON,P. J. LITCHFIELD     (CERN,RHEL)IJP
VANHORN  75 NP B87 145          A. J. VAN HCRN                        (LBL)IJP
    ALSO 75 NP B87 157          A. J. VAN HORN                        (LBL)IJP

RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSCN,ROSS+     (RHEL+LOIC)IJP

                        PAPERS NOT REFERRED TO IN CATA CARDS

FENSTER  66 PRL 17 841          +GELFAND,HARMSEN,L-SETTI,+ (CHIC,ANL(CERN))IJP
     -- FENSTER 66 IS SUPERSEDED BY BARLETTA 72
CONFORTO 68 NP B8 265           +HARMSEN, LASINSKI, +      (CHICAGO,HEIDEL)IJP
    SUPERSEDED BY CONFORTO 71.
HARRISON 70 FSU-HEP 70 3 1     W.C. HARRISCN (THESIS)                 (FSU)
PREVOST  71  AMSTERDAM CONF    + CHS COLLABORATION          (CERN+HEID+SACL)
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Σ(1770) 100 Y*1(1770, JP=1/2+) I=1 **P''_{11}**

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                    100  Y*1(1770) MASS  (MEV)

M    1      1770.       20.            BAILLCN   75 IPWA    KBAR N TO PI LAM 11/75*
M    1  FROM SOLUTION 1 OF BAILLON 75, NOT PRESENT IN SCLUTION 2.             1/76*
M           1738.       10.            RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

                    100  Y*1(1770) WIDTH (MEV)

W    1       80.        30.            BAILLCN   75 IPWA    KBAR N TO PI LAM 11/75*
W            72.        10.            RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

                    100  Y*1(1770) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      Y*1(1770) INTO KBAR N                                  497+ 939
P2      Y*1(1770) INTO LAMBDA PI                              1115+ 139
P3      Y*1(1770) INTO SIGMA PI                               1197+ 139

                    100  Y*1(1770) BRANCHING RATICS

R1      Y*1(1770) FROM KBAR N INTC LAMBDA PI             SQRT(P1*P2)
R1   1        -.08       .02           BAILLCN   75 IPWA    KBAR N TO PI LAM 11/75*
R1           LESS THAN .04             RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
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Baryons

Σ(1770), Σ(1840), Σ(1880), Σ(1915)

Data Card Listings

For notation, see key at front of Listings.

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R2      Y*1(1770) INTO (KBAR N)/TCTAL                         (P1)               1/76*
R2               .14       .04              RLIC       76 DPWA    KBAR N MULTICHNL  1/76*

R3      Y*1(1770) FROM KBAR N INTC SIGMA PI                    SQRT(P1*P3)        1/76*
R3               LESS THAN .04              RLIC       76 DPWA    KBAR N MULTICHNL  1/76*

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                              REFERENCES FOR Y*1(1770)

BAILLCN   75 NP B94 39           P. BAILLCN,P. J. LITCHFIELC        (CERN,RHEL)IJP

RLIC      76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSCN,ROSS+        (RHEL+LCIC)IJP

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Σ(1840) → P''_{13}

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01   Y*1(1840, JP=3/2+) I=1

SEE THE MINI-REVIEWS PRECEDING THE Y*0'S.

FOR THE TIME BEING, WE LIST ALL RESONANCE CLAIMS IN THE
P13 WAVE IN THE 1700-1900 MEV MASS REGION TOGETHER UNDER THIS HEADING.

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                      01   Y*1(1840) MASS (MEV)

M          1840.0     (10.0)            LANGBEIN  72 IPWA    MULTICHANNEL      12/72
M   1     (1720.)     (30.)             BAILLON   75 IPWA    KBAR N TO LAM PI 11/75*
M   1   FROM SOLUTION 1 OF BAILLCN 75, NOT PRESENT IN SOLUTION 2.               1/76*
M          1925.     (200.)             VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*

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                      01   Y*1(1840) WIDTH (MEV)

W           120.0     (10.0)            LANGBEIN  72 IPWA    MULTICHANNEL      12/72
W   1      (120.)     (30.)             BAILLON   75 IPWA    KBAR N TO LAM PI 11/75*
W            65.      (50.)     (20.)   VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*

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                      01   Y*1(184C) PARTIAL DECAY MODES

                                                              CECAY MASSES
P1      Y*1(1840) INTO KBAR N                               497+ 939
P2      Y*1(1840) INTO SIGMA PI                            1197+ 139
P3      Y*1(1840) INTO LAMBDA PI                           1115+ 134

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                      01   Y*1(184C) BRANCHING RATIOS

R1      Y*1(1840) INTO (KBAR N)/TCTAL                         (P1)
R1             0.37      (0.13)             LANGBEIN  72 IPWA    MULTICHANNEL      12/72

R2      Y*1(1840) FRCM KBAR N INTO SIGMA PI                   SQRT(P1*P2)
R2             0.15      (0.04)             LANGBEIN  72 IPWA    MULTICHANNEL      12/72

R3      Y*1(1840) FROM KBAR N INTO LAMBDA PI                  SQRT(P1*P3)
R3             0.20      (0.04)             LANGBEIN  72 IPWA    MULTICHANNEL      12/72
R3             +.122      .078              DEVENISH  74       0 FIXED T DISP REL  4/75*
R3   1        (+.11)     (.02)              BAILLCN   75 IPWA    KBAR N TO LAM PI 11/75*
R3             +.06      (.04)              VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*

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                              REFERENCES FOR Y*1(1840)

LANGBEIN 72 NP B47 477          +WAGNER                                (MPIM)IJP
DEVENISH 74 NP B81 330          DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
BAILLCN  75 NP B94 39           P. BAILLON,P. J. LITCHFIELD      (CERN,RHEL)IJP
VANHORN  75 NP B87 145          A. J. VAN HORN                          (LBL)IJP
   ALSO  75 NP B87 157          A. J. VAN HORN                          (LBL)IJP

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Σ(1880) → P'''_{11}

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67   Y*1(1880, JP=1/2+) I=1

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

SUCH A RESONANCE IS SUGGESTED BY SOME BUT NOT ALL
PARTIAL-WAVE ANALYSES ACROSS THIS REGION.  UNTIL THERE
IS MORE EVIDENCE, WE OMIT THIS STATE FROM THE MAIN
BARYCN TABLE.

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                      67   Y*1(1880) MASS (MEV)

M          1882.0      40.0             SMART     68 DPWA -0 K- N TO LAM PI    7/68
M         (1850.0)                      BAILEY    69 DPWA  0 ELASTIC, CH EXCH 10/70
M          ABOUT 1850.0                 ARMENTERO 70 IPWA -0 ELASTIC, CH EXCH  6/70
M          1950.0      50.0             GALTIERI  70 DPWA -0 K- N TO LAM PI    7/70
M          1920.0      30.0             LITCHFIEL 70 DPWA -0 K- N TO LAM PI    6/70
M         (1772.0)                      KANE      72 DPWA    K-P TO SIGMA PI   1/73
M   2     (1898.)                       LEA       73 DPWA    MULTICHNL K-MTRX  9/73
M   2   ONLY UNCONSTRAINED STATES FROM TABLE 1 OF LEA73 ARE IN LISTINGS.        9/73
M   1     (1960.)     (30.)             BAILLCN   75 IPWA    KBAR N TO LAM PI 11/75*
M   1   FROM SOLUTION 1 OF BAILLON 75, NOT PRESENT IN SOLUTION 2.               1/76*
M          1985.       50.              VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                      67   Y*1(1880) WIDTH (MEV)

W           222.0     150.0             SMART     68 DPWA -0 K- N TO LAM PI    7/68
W          (200.0)                      BAILEY    69 DPWA  0 ELASTIC, CH EXCH 10/70
W          ABOUT 30.0                   ARMENTERO 70 IPWA -0 ELASTIC, CH EXCH  6/70
W           200.0      50.0             GALTIERI  70 DPWA -0 K- N TO LAM PI    7/70
W           170.0      40.0             LITCHFIEL 70 DPWA -0 K- N TO LAM PI    6/70
W           (80.0)                      KANE      72 DPWA    K-P TO SIGMA PI   1/73
W   2      (222.2)                      LEA       73 DPWA    MULTICHNL K-MTRX  9/73
W   1      (260.)     (40.)             BAILLCN   75 IPWA    KBAR N TO LAM PI 11/75*
W           220.      140.              VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                      67   Y*1(1880) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      Y*1(1880) INTO KBAR N                               497+ 939
P2      Y*1(1880) INTO LAMBDA PI                           1115+ 134
P3      Y*1(1880) INTO SIGMA PI                            1197+ 139

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                      67   Y*1(1880) BRANCHING RATIOS

R1      Y*1(1880) INTO (KBAR N)/TOTAL                          (P1)
R1            (0.22)                       BAILEY    69 DPWA  0 ELASTIC, CH EXCH 10/70
R1            (0.20)                       ARMENTERO 70 IPWA -0 ELASTIC, CH EXCH  6/70
R1   2         (.31)                       LEA       73 DPWA    MULTICHNL K-MTRX  9/73

R2      Y*1(1880) FROM KBAR N INTO LAMBDA PI                   SQRT(P1*P2)
R2            -0.11       0.03             SMART     68 DPWA -0 K- N TO LAM PI    7/68
R2            -0.09       0.04             GALTIERI  70 DPWA -0 K- N TO LAM PI    7/70
R2            -0.14       0.03             LITCHFIEL 70 DPWA -0 K- N TO LAM PI    6/70
R2   2        (-.30)                       LEA       73 DPWA    MULTICHNL K-MTRX  9/73
R2             -.169       .119            DEVENISH  74       0 FIXED T DISP REL  4/75*
R2   1        (-.12)      (.02)            BAILLON   75 IPWA    KBAR N TO LAM PI 11/75*
R2             +.05        .07      .02    VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
R2          . . . . . . . . . .
R2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R3      Y*1(1880) FROM KBAR N TO SIGMA PI                      SQRT(P1*P3)        9/73
R3            (-.108)                      KANE      72 DPWA    K-P TO SIGMA PI   9/73
R3   2         NOT SEEN                    LEA       73 DPWA    MULTICHNL K-MTRX  9/73

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                              REFERENCES FOR Y*1(1880)

SMART     68 PR 169 1330       W M SMART                                (LRL)IJP
BAILEY    69 THESIS UCRL-50617 CAVID SAAL BAILEY              (LRL LIVERMORE)IJP
ARMENTER 70 DUKE CONF 123      ARMENTEROS, BAILLON, +            (CERN, HEIDEL)IJP
GALTIERI 70 DUKE CONF 173      A BARBARO-GALTIERI                       (LRL)IJP
LITCHFIE 70 NP B22 269         P J LITCHFIELD                   (RUTHERFORD)IJP
KANE      72 PR D5 1583        D F KANE                                 (LBL)

LEA       73 NP B56 77         +MARTIN,MOORHOUSE+  (RHEL+LOUC+GLAS+AARHUS)IJP
DEVENISH 74 NP B81 330         DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
BAILLON   75 NP B94 39         P. BAILLON,P. J. LITCHFIELD      (CERN,RHEL)IJP
VANHORN   75 NP B87 145        A. J. VAN HORN                          (LBL)IJP
    ALSO  75 NP B87 157        A. J. VAN HCRN                          (LBL)IJP

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Σ(1915) F'_{15}

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46   Y*1(1915, JP=5/2+) I=1

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THIS RESCNANCE WAS FIRST SEEN IN THE TOTAL-CROSS-SEC-
TION MEASUREMENTS OF COOL 66.  IN THIS ENTRY, HOWEVER,
WE LIST ONLY THE RESULTS FROM PARTIAL-WAVE ANALYSES.
SEE THE NEXT ENTRY FOR THE PARAMETERS OF PEAKS SEEN AROUND 1900-1950
MEV IN CROSS SECTIONS AND INVARIANT-MASS CISTRIBUTIONS.  WE MAKE THIS
SEPARATION BECAUSE ONLY THE PARTIAL-WAVE ANALYSES ISOLATE THE F15 WAVE
(OR AT LEAST ATTEMPT TO -- THE SIGNAL IS WEAK).  THIS MASS REGION IS
COMPLICATED AND POORLY UNDERSTOOD AND THE PEAKS MAY CONTAIN MORE THAN
JUST THE Y*1(1915).  SEE ALSO THE NOTE TO THE NEXT ENTRY.

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                      46   Y*1(1915) MASS (MEV)

M          1902.0      11.0             SMART     68 DPWA -0 K-N TO LAMBDA PI  7/68
M          1910.0      20.0             BERTHON   70 DPWA  0 K-P TO LAMBDA PI  7/70
M          1900.0      15.0             BERTHON1  70 DPWA  0 K-P TO SIGMA PI  10/70
M    N     1936.0      (3.0)            BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
M          1903.0      10.0             COX       70 DPWA -  K-N TO LAMBDA PI  6/70
M          1905.0      30.0             GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
M          1895.0      10.0             LITCHFIEL 70 DPWA -0 K-N TO LAMBDA PI  6/70
M    B    (1985.0)    (21.0)            ISLAM     71 DPWA    KN--PI-SIG       .12/72
M    B  DISCREPANCY DUE POSSIBLY TO INSUFFICIENT STATISTICS
M          1910.       15.              LITCHFIE  71 DPWA    K-P TO KBAR N    10/71
M          1925.0       8.0             KANE      72 DPWA  0 K-P TO PI SIG    10/71
M          1920.       30.              BAILLON   75 IPWA    KBAR N TO LAM PI 11/75*
M          1914.       10.              HEMINGWA  75 DPWA  0 K- P TO KBAR N   11/75*
M          1920.       15.       20.    VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
M          1920.       10.              RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
M    N    ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED   1/71
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                      46   Y*1(1915) WIDTH (MEV)

W    A      (50.0)    (20.0)            ARMENTER1 67 DPWA  0 ELASTIC, CH EXCH 11/67
W            52.0      25.0             SMART     68 DPWA -0 K-N TO LAMBDA PI  7/68
W            60.0      20.0             BERTHON   70 DPWA  0 K-P TO LAMBDA PI  7/70
W            75.0      20.0             BERTHON1  70 DPWA  0 K-P TO SIGMA PI  10/70
W           135.0      12.0             BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
W            77.0      27.0             COX       70 DPWA -  K-N TO LAMBDA PI  6/70
W            70.0      20.0             GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
W            70.0      15.0             LITCHFIEL 70 DPWA -0 K-N TO LAMBDA PI  6/70
W    B     (159.0)    (80.0)            ISLAM     71 DPWA    KN--PI-SIG       12/72
W            70.       15.              LITCHFIE  71 DPWA    K-P TO KBAR N    10/71
W           146.0      22.0             KANE      72 DPWA  0 K-P TO PI SIG    10/71
W            70.       20.              BAILLCN   75 IPWA    KBAR N TO LAM PI 11/75*
W            85.       15.              HEMINGWA  75 DPWA  0 K- P TO KBAR N   11/75*
W           102.       18.              VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
W           130.       10.              RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
W    A   LACK OF CATA PREVENTS FROM DETERMINING UNAMB. THIS AMPLITUDE         11/67
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.9)

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                      46   Y*1(1915) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      Y*1(1915) INTO KBAR N                               497+ 939
P2      Y*1(1915) INTO LAMBDA PI                           1115+ 139
P3      Y*1(1915) INTO SIGMA PI                            1197+ 139

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Data Card Listings

For notation, see key at front of Listings.

Baryons

Σ(1915), Σ(1940)

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                    46  Y*1(1915) BRANCHING RATIOS

R1      Y*1(1915) INTO (KBAR N)/TOTAL                          (P1)
R1  A          (0.12)     (.01)          ARMENTER1 67 DPWA   0 ELASTIC, CH EXCH 11/67
R1              0.18      (0.02)         BRICMAN1  70 DPWA     SIGTOT,ELAS,CHEX  1/71
R1              0.11      (0.03)         CONFORTO  71 DPWA   0 ELASTIC, CH EXCH  6/70
R1              0.15      (0.04)         LITCHFIE  71 DPWA     K-P TO KBAR N    10/71
R1               .11      (.04)          HEMINGWA  75 DPWA   0 K- P TO KBAR N   11/75*
R1               .05      (.03)          RLIC      76 DPWA     KBAR N MULTICHNL  1/76*

R2      Y*1(1915) FROM KBAR N INTO LAMBDA PI              SQRT(P1*P2)
R2             -0.08      (0.02)         SMART     68 DPWA -0 K-N TO LAMBDA PI   7/68
R2             -0.1       (0.02)         BERTHON   70 DPWA  0 K-P TO LAMBDA PI   7/70
R2             -0.09      (0.02)         COX       70 DPWA -  K-N TO LAMBDA PI   6/70
R2             -0.11      (0.03)         GALTIERI  70 DPWA  0 K-P TO LAMBDA PI   7/70
R2             -0.07      (0.015)        LITCHFIEL 70 DPWA -0 K-N TO LAMBDA PI   6/70
R2             -.087      (.056)         DEVENISH  74       0 FIXED T DISP REL   4/75*
R2             -.06       (.02)          BAILLON   75 IPWA    KBAR N TO LAM PI  11/75*
R2             -.09       (.02)          VANHORN   75 DPWA  0 K- P TO LAM PIO   11/75*
R2             -.09       (.03)          RLIC      76 DPWA    KBAR N MULTICHNL   1/76*

R3      Y*1(1915) FROM KBAR N INTO SIGMA PI               SQRT(P1*P3)
R3  A          (0.00)     (0.01)         ARMENTERO 67 DPWA  0 K-P TO SIGMA PI   11/67
R3             -0.13      (0.03)         BERTHON1  70 DPWA  0 K-P TO SIGMA PI   10/70
R3             -0.06      (0.03)         GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70
R3  B          (0.06)     (0.02)         ISLAM     71 DPWA    KN--PI-SIG        12/72
R3             -0.137     (0.015)        KANE      72 DPWA  0 K-P TO PI SIG     10/71
R3              -.19      (.03)          RLIC      76 DPWA    KBAR N MULTICHNL   1/76*

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REFERENCES FOR Y*1(1915)


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ARMENTER 67 PL 24B 198          ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)
ARMENTE1 67 NP B3 592           ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)
SMART    68 PR 169 1330         W M SMART                           (LRL)IJP

BERTHON  70 NP B20 476          +RANGAN, VRANA, +(COL FRANCE, RHEL, SACLAY)IJP
BERTHON1 70 NP B24 417          +VRANA, BUTTERWORTH, + (CDEF, RHEL, SACLAY)IJ
BRICMAN1 70 PL 33B 511          +FERRO-LUZZI,LAGNAUX                  (CERN)
COX      70 NP B19 61           +ISLAM, COLLEY, +      (BIRM,EDIN,GLAS,LOIC)IJP
GALTIERI 70 DUKE CONF 173       A BARBARO-GALTIERI                  (LRL)IJP
LITCHFIE 70 NP B22 269          P J LITCHFIELD              (RUTHERFORD)IJP

CONFORTO 71 NP  B34  41         +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
ISLAM    71 PJSIR 14 305        +COX,COLLEY,HEATHCOTE                 (BIRM) IJP
   PAKISTAN J. SCI. IND. RES.
LITCHFIE 71 NP  B30 125         LITCHFIELD,...+LESQUOY,+.. (RHEL+CDEF+SACL)IJP
KANE     72 PR D5 1583          D F KANE                            (LBL)IJP
DEVENISH 74 NP B81 330          DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LCUC)

BAILLCN  75 NP B94 39           P. BAILLON,P. J. LITCHFIELD     (CERN,RHEL)IJP
HEMINGWA 75 NP B91 12           HEMINGWAY,EADES,HARMSEN+   (CERN,HEID,MPIM)IJP
VANHCRN  75 NP B87 145          A. J. VAN HORN                      (LBL)IJP
   ALSO  75 NP B87 157          A. J. VAN HORN                      (LBL)IJP

RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+    (RHEL+LOIC)IJP
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PAPERS NOT REFERRED TO IN DATA CARDS


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SMART    66 PRL 17 556          W M SMART,A KERNAN,G E KALMUS,R P ELY (LRL)IJP
   SUPERSEDED BY SMART 68.
CONFORTO 68 NP B8 265           +HARMSEN, LASINSKI, +      (CHICAGO, HEIDEL)
   SUPERSEDED BY CONFORTO 71.
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1915 MEV REGION – PRODUCTION AND σ_{TOTAL} EXP'TS

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                    29  Y*1(1915, JP=     ) I=1        PRODUCTION EXPERIMENTS

                    SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                    SEE THE NOTES TO THE Y*1(1915) AND Y*1(1940), WHICH
                    IMMEDIATELY PRECEDE AND FOLLOW THIS ENTRY.  HERE WE
                    LIST ONLY PARAMETERS OF PEAKS SEEN IN CROSS SECTIONS
   AND INVARIANT-MASS DISTRIBUTIONS.  THE CROSS-SECTION PEAKS ARE ALMOST
   CERTAINLY ASSOCIATED WITH THE F15 Y*1(1915) SEEN IN PARTIAL-WAVE
   ANALYSES.  THE INVARIANT-MASS PEAKS SEEM MORE LIKELY TO BE ASSOCIATED
   WITH THE NOT-COMPLETELY-ESTABLISHED WITH THE D13 Y*(1940).

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                    29  Y*1(1915) MASS (MEV) (PROD. EXP.)

M          CROSS-SECTION PEAKS --
M            1905.0       5.0            BUGG      68 CNTR    K-P, D TOTAL      11/66
M            1906.0       6.0            BRICMAN   70 CNTR  0 TOTAL AND CH EX    6/70
M            1912.0      10.0            COOL      70 CNTR    K-P, D TOTAL      10/70
M          INVARIANT-MASS-DISTRIBUTION PEAKS --
M           (1942.0)     (9.0)           BOCK      65 HBC     PBAR P 5.7 BEV/C
M            1940.0      11.0            AGUILAR   70 HBC  +  3.9-4.6 GEV/C K-   5/70
M          ELASTIC DCS --                                                        2/73
M    1       1931.       9.              DADO      72 HBC   0 K-P ELSTC DCS    . 2/73
M    1  G7 INDICATED BY LEGENDRE COEFFS.,G9 NOT RULED OUT.                       2/73
M             . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.9)

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                    29  Y*1(1915) WIDTH (MEV) (PROD. EXP.)

W          CROSS-SECTION PEAKS --
W              60.0      10.0            BUGG      68 CNTR                      11/66
W              50.0      12.0            BRICMAN   70 CNTR  0 TOTAL AND CH EX    6/70
W             (30.0)                     COOL      70 CNTR    K-P, D TOTAL      10/70
W          INVARIANT-MASS-DISTRIBUTION PEAKS --
W             (36.0)    (20.0)   (36.0)  BOCK      65 HBC
W              90.0      20.0            AGUILAR   70 HBC  +  3.9-4.6 GEV/C K-   5/70
W          ELASTIC DCS --                                                        2/73
W    1         70.       14.             DADO      72 HBC   0 K-P ELSTC DCS      2/73
W             . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

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                    29  Y*1(1915) PARTIAL DECAY MODES (PROD. EXP.)

                                                           DECAY MASSES
P1      Y*1(1915) INTO KBAR N                              497+ 939
P2      Y*1(1915) INTO LAMBDA PI                           1115+ 134
P3      Y*1(1915) INTO SIGMA PI                            1197+ 139

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                    29  Y*1(1915) BRANCHING RATIOS (PROD. EXP.)

R1      Y*1(1915) INTO (KBAR N)/TOTAL                          (P1)
R1         THESE VALUES OF ELASTICITIES ASSUME J=5/2 --
R1              0.06                     BUGG      68 CNTR    ASSUMING J=5/2     6/68
R1              0.07      0.02           BRICMAN   70 CNTR  0 TOTAL AND CH EX    6/70
R1              0.07                     COOL      70 CNTR    K-P, D TOTAL      10/70
R1   1  THIS ELASTICITY ASSUMES J=7/2                                            2/73
R1   1          .62       .08            DADO      72 HBC   0 K-P ELSTC DCS      2/73
R1             . . . . . . . . .
R1  AVG         0.10      0.13    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 6.7)
R1  STUDENT     0.077     0.022   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R2      Y*1(1915) INTO (KBAR N)/(SIGMA PI)                   (P1)/(P3)
R2             (.37) OR LESS             BARNES    69 HBC  +  1 STAN. DEV.      10/69

R3      Y*1(1915) INTO (LAMBDA PI)/(SIGMA PI)                (P2)/(P3)
R3             (.28) OR LESS             BARNES    69 HBC  +  1 STAN. DEV.      10/69

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REFERENCES FOR Y*1(1915) (PROD. EXP.)


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BOCK     65 PL 17 166           +COOPER,FRENCH,KINSON, +       (CERN,SACLAY) I
COOL     66 PRL 16 1228         +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
   SUPERSEDED BY COOL 70.
BUGG     68 PR 168 1466         +GILMORE,KNIGHT,DAVIES+     (BIRM,CAVE,RHEL)I
BARNES   69 PRL 22 479          +FLAMINIO,MONTANET,SAMIOS +        (BNL+SYRA)

AGUILAR  70 PRL 25 58           AGUILAR-BENITEZ, BARNES, +        (BNL,SYRA)
BRICMAN  70 PL 31B 152          +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL     70 PR D1 1887          +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
DADO     72 PRL 29 1695         +BIRMAN,GOLDBERG,WEISS                (HAIF)JP
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PAPERS NOT REFERRED TO IN DATA CARDS


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PRIMER   68 PRL 20 610          +GOLDBERG,JAEGER,BARNES,DORNAN + (SYRA,BNL)
   SUPERSEDED BY BARNES 69 AND AGUILAR-BENITEZ 70.
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Σ(1940) D'''_{13}

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                    98  Y*1(1940, JP=3/2-) I=1

                    SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                    SUCH A RESONANCE IS SUGGESTED BY SOME BUT NOT ALL
                    PARTIAL-WAVE ANALYSES IN THIS REGION.  THIS
                    EFFECT IS PERHAPS ASSOCIATED WITH THE BUMPS SEEN
                    IN PRODUCTION EXPERIMENTS NEAR THIS MASS.  SEE
                    THE PRECEDING ENTRY.

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                    98  Y*1(1940) MASS (MEV)

M            1940.0      50.0            GALTIERI  70 DPWA    K- N TO LAM PI     7/70
M            1940.0      40.0            GALTIERI  70 DPWA    K-P TO SIGMA PI    7/70
M            1940.0      30.0            LITCHFIEL 70 DPWA    K- N TO LAM PI     7/70
M            1985.0      (5.0)           KANE      72 DPWA  0 K-P TO PI SIG     10/71
M    2      (1865.)                      LEA       73 DPWA    MULTICHNL K-MTRX   9/73
M    2  ONLY UNCONSTRAINED STATES FROM TABLE 1 OF LEA73 ARE IN LISTINGS.         9/73
M            1940.       20.             LITCHFI2  74 DPWA  0 K-P TO L(1520)PI 10/74*
M            1950.       20.             LITCHFI3  74 DPWA  0 K-P TO KBAR DEL  10/74*
M            1950.       30.             BAILLCN   75 IPWA    KBAR N TO LAM PI 11/75*
M            1949.       40.     60.     VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
M            1920.       50.             RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
M             . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                    98  Y*1(1940) WIDTH (MEV)

W             200.0      50.0            GALTIERI  70 DPWA    K- N TO LAM PI     7/70
W             200.0      50.0            GALTIERI  70 DPWA    K-P TO SIGMA PI    7/70
W             280.0      40.0            LITCHFIEL 70 DPWA    K- N TO LAM PI     7/70
W             208.0     (22.0)           KANE      72 DPWA  0 K-P TO PI SIG     10/71
W    2       (108.9)                     LEA       73 DPWA    MULTICHNL K-MTRX   9/73
W              60.       20.             LITCHFI2  74 DPWA  0 K-P TO L(1520)PI 10/74*
W              70.       30.     20.     LITCHFI3  74 DPWA  0 K-P TO KBAR DEL  10/74*
W             150.       75.             BAILLCN   75 IPWA    KBAR N TO LAM PI 11/75*
W             160.       70.     40.     VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
W             300.       80.             RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
W             . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 2.4)

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                    98  Y*1(1940) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      Y*1(1940) INTO KBAR N                              497+ 939
P2      Y*1(1940) INTO LAMBDA PI                           1115+ 139
P3      Y*1(1940) INTO SIGMA PI                            1197+ 139
P4      Y*1(1940) INTO Y*0(1520) PI P-WAVE                  134+1518
P5      Y*1(1940) INTO Y*0(1520) PI F-WAVE                  134+1518
P6      Y*1(1940) INTO KBAR DELTA(1232) S-WAVE              493+1232
P7      Y*1(1940) INTO KBAR DELTA(1232) D-WAVE              493+1232

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                    98  Y*1(1940) BRANCHING RATIOS

R1      Y*1(1940) FROM KBAR N INTO LAMBDA PI              SQRT(P1*P2)
R1             -0.12      0.04           GALTIERI  70 DPWA    K- N TO LAM PI     7/70
R1             -0.14      0.03           LITCHFIEL 70 DPWA    K- N TO LAM PI     7/70
R1   2         (-.11)                    LEA       73 DPWA    MULTICHNL K-MTRX   9/73
R1             -.153      .070           DEVENISH  74       0 FIXED T DISP REL   4/75*
R1             -.04       .02            BAILLCN   75 IPWA    KBAR N TO LAM PI 11/75*
R1             -.05       .03      .02   VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
R1             -.06       .03            RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R1             . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.5)

R2      Y*1(1940) FROM KBAR N INTO SIGMA PI               SQRT(P1*P3)
R2             -0.12      0.03           GALTIERI  70 DPWA    K-P TO SIGMA PI    7/70
R2             -0.093     (0.006)        KANE      72 DPWA  0 K-P TO PI SIG     10/71
R2   2      NOT SEEN                     LEA       73 DPWA    MULTICHNL K-MTRX   9/73
R2             -.08       .04            RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R2             . . . . . . . . .
R2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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Baryons

Σ(1940), Σ(2000), Σ(2030)

Data Card Listings

For notation, see key at front of Listings.

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R3      Y*1(1940) INTO KBAR N                          (P1)              9/73
R3   2        (.21)                 LEA       73 DPWA    MULTICHNL K-MTRX  9/73
R3            LESS THAN .04         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R3    NO SIGNAL FOR THIS STATE WITH X LARGER THAN ABOUT .03 IN THE        11/75*
R3    ANALYSIS OF HEMINGWAY 75.                                            11/75*

R4      Y*1(1940) FROM KBAR N TO Y*0(1520) PI P-WAVE     SQRT(P1*P4)
R4   1        -.11        .04          LITCHFI2  74 DPWA  0 K-P TO L(1520)PI 10/74*
R4   1  ASSUMES LAMBDA(1520) ELASTICITY=.45,SIGN RLTV. TC SIG(2030) DECAY.  10/74*

R5      Y*1(1940) FROM KBAR N TO Y*0(1520) PI F-WAVE     SQRT(P1*P5)
R5   1        -.08        .04          LITCHFI2  74 DPWA  0 K-P TO L(1520)PI 10/74*
R5   1  ASSUMES LAMBCA(1520) ELASTICITY=.45,SIGN RLTV. TC SIG(2030) DECAY.  10/74*

R6      Y*1(1940) FROM KBAR N TO KBAR DELTA(1232) S-WAVE SQRT(P1*P6)
R6   3        -.16        .05          LITCHFI3  74 DPWA  0 K-P TO KBAR DEL  10/74*
R6   3  SIGN RELATIVE TO SIGMA(2030) DECAY                                  10/74*

R7      Y*1(1940) FROM KBAR N TC KBAR CELTA(1232) D-WAVE SQRT(P1*P7)
R7   3        -.14        .05          LITCHFI3  74 DPWA  0 K-P TO KBAR DEL  10/74*
R7   3  SIGN RELATIVE TO SIGMA(2030) DECAY                                  10/74*

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REFERENCES FOR Y*1(1940)


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GALTIERI 70 DUKE CCNF 173      A BARBARO-GALTIERI                      (LRL)IJP
LITCHFIE 70 NP B22 269         P J LITCHFIELD                   (RUTHERFORD)IJP
KANE     72 PR D5 1583         D F KANE                                (LBL)IJP
LEA      73 NP B56 77          +MARTIN,MOORHOUSE+  (RHEL+LOUC+GLAS+AARHUS)IJP

DEVENISH 74 NP B81 330         DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
LITCHFI2 74 NP B74 19          LITCHFIELD,HEMINGWAY,BAILLCN,+  (CERN+HEID)IJP
LITCHFI3 74 NP B74 39          LITCHFIELD,HEMINGWAY,BAILLCN,+  (CERN+HEID)IJP

BAILLCN  75 NP B94 39          P. BAILLON,P. J. LITCHFIELC     (CERN,RHEL)IJP
VANHORN  75 NP B87 145         A. J. VAN HORN                          (LBL)IJP
   ALSO  75 NP B87 157         A. J. VAN HORN                          (LBL)IJP

RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMLS,MCPHERSCN,ROSS+     (RHEL+LOIC)IJP

                               PAPERS NOT REFERRED TO IN CATA CARDS.

HEMINGWA 75 NP B91 12          HEMINGWAY,EADES,HARMSEN+   (CERN,HEID,MPIM)IJP
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Σ(2000) → 02 Y*1(2000, JP=1/2-) I=1 S'''_{11}

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                  02  Y*1(2000) MASS (MEV)

M         2004.       40.              VANHORN   75 CPWA  0 K-P TO LAM PIO   11/75*
M         1955.       15.              RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                  02  Y*1(2000) WIDTH (MEV)

W          116.       40.              VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75*
W          170.       40.              RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                  02  Y*1(2000) PARTIAL DECAY MCDES

                                                          DECAY MASSES
P1      Y*1(2000) INTO KBAR N                           497+ 939
P2      Y*1(2000) INTO LAMBCA PI                       1115+ 134
P3      Y*1(2000) INTO SIGMA PI                        1197+ 139

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                  02  Y*1(2000) BRANCHING RATIOS

R1      Y*1(2000) FROM KBAR N INTO LAMBDA PI           SQRT(P1*P2)
R1          NOT SEEN                   BAILLON   75 IPWA    KBAR N TO LAM PI 11/75*
R1          +.07        .02       .01  VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75*
R1           .08        .03            RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R2      Y*1(2000) INTO (KBAR N)/TOTAL                  (P1)               1/76*
R2           .44        .05            RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R3      Y*1(2000) FROM KBAR N INTO SIGMA PI            SQRT(P1*P3)        1/76*
R3          +.20        .04            RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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REFERENCES FOR Y*1(2000)


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BAILLCN  75 NP B94 39          P. BAILLON,P. J. LITCHFIELD     (CERN,RHEL)IJP
VANHORN  75 NP B87 145         A. J. VAN HCRN                          (LBL)IJP
   ALSO  75 NP B87 157         A. J. VAN HCRN                          (LBL)IJP

RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSCN,ROSS+     (RHEL+LOIC)IJP
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Σ(2030) 47 Y*1(2030, JP=7/2+) I=1 F_{17}

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THIS ENTRY ONLY INCLUDES RESULTS FROM PARTIAL-WAVE ANALYSES. PARAMETERS OF PEAKS SEEN IN CROSS-SECTIONS AND INVARIANT-MASS DISTRIBUTIONS ARCUND 2030 MEV ARE GIVEN IN THE NEXT ENTRY. EVENTUALLY THE PARTIAL-WAVE ANALYSES SHOULD GIVE THE BEST RESULTS, AS THEY ISOLATE THE F17 WAVE. THIS SUPERIORITY IS, HOWEVER, PROBABLY NCT YET ATTAINED, AND WE RELY CN BOTH ENTRIES FOR PARAMETERS GIVEN IN THE MAIN BARYON TABLE.

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                  47  Y*1(2030) MASS (MEV)

M      (2030.0)    (20.0)              WOHL       66 HBC    0 K-P TO LAM PIO    7/66
M       2032.0       6.0               SMART      68 DPWA - K-N TO LAMBDA PI  6/68
M       2030.0      10.0               BERTHON    70 DPWA  0 K-P TO LAMBDA PI  7/70
M       2035.0      10.0               BERTHON1   70 DPWA  0 K-P TO SIGMA PI  10/70
M       2027.0       6.0               COX        70 DPWA - K-N TO LAMBDA PI  6/70
M       2010.0      15.0               GALTIERI   70 DPWA  0 K-P TO LAMBDA PI  7/70
M       2000.0      20.0               GALTIERI   70 DPWA  0 K-P TO SIGMA PI   7/70
M       2022.0       4.0               LITCHFIEL  70 DPWA -0 K-N TO LAMBDA PI  6/70
M       2025.       15.                LITCHFIE   71 DPWA    K-P TO KBAR N    10/71
M       2034.0      14.0               KANE       72 DPWA  0 K-P TO PI SIG    10/71
M       2025.       10.                LITCHFI1   74 DPWA  0 K-P TO L(1815)PI 10/74*
M       2035.       10.                LITCHFI2   74 DPWA  0 K-P TO L(1520)PI 10/74*
M       2020.       30.                LITCHFI3   74 DPWA  0 K-P TO KBAR DEL  10/74*
M       2035.       15.                BAILLCN    75 IPWA    KBAR N TO LAM PI 11/75*
M       2038.       10.                HEMINGWA   75 DPWA  0 K- P TO KBAR N   11/75*
M       2042.       11.                VANHORN    75 DPWA  0 K-P TO LAM PIO   11/75*
M       2040.        5.                RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
M              . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                  47  Y*1(2030) WIDTH (MEV)

W       (170.0)                        WOHL       66 HBC    0                   7/66
W        160.0      16.0               SMART      68 DPWA - K-N TO LAMBDA PI  6/68
W        165.0      30.0      15.0     BERTHON    70 DPWA  0 K-P TO LAMBDA PI  7/70
W        150.0      20.0               BERTHCN1   70 DPWA  0 K-P TO SIGMA PI  10/70
W        158.0      16.0               COX        70 DPWA - K-N TO LAMBDA PI  6/70
W        115.0      15.0               GALTIERI   70 DPWA  0 K-P TO LAMBDA PI  7/70
W        100.0      40.0               GALTIERI   70 DPWA  0 K-P TO SIGMA PI   7/70
W        170.0      15.0               LITCHFIEL  70 DPWA -0 K-N TO LAMBDA PI  6/70
W        200.       30.                LITCHFIE   71 DPWA    K-P TO KBAR N    10/71
W        118.0      12.0               KANE       72 DPWA  0 K-P TO PI SIG    10/71
W         70. TO   125.                LITCHFI1   74 DPWA  0 K-P TO L(1815)PI 10/74*
W        160.       20.                LITCHFI2   74 DPWA  0 K-P TO L(1520)PI 10/74*
W        200.       30.                LITCHFI3   74 DPWA  0 K-P TO KBAR DEL  10/74*
W        180.       20.                BAILLON    75 IPWA    KBAR N TO LAM PI 11/75*
W        172.       15.                HEMINGWA   75 DPWA  0 K- P TO KBAR N   11/75*
W        178.       13.                VANHORN    75 DPWA  0 K-P TO LAM PIO   11/75*
W        190.       10.                RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
W              . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)

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                  47  Y*1(2030) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      Y*1(2030) INTO KBAR N                           497+ 939
P2      Y*1(2030) INTO LAMBDA PI                       1115+ 134
P3      Y*1(2030) INTO SIGMA PI                        1197+ 139
P4      Y*1(2030) INTO XI K                            1321+ 497
P5      Y*1(2030) INTO Y*0(1815) PI P-WAVE              134+1820
P6      Y*1(2030) INTO Y*0(1520) PI D-WAVE              134+1518
P7      Y*1(2030) INTO Y*0(1520) PI G-WAVE              134+1518
P8      Y*1(2030) INTO KBAR DELTA(1232) F-WAVE          493+1232
P9      Y*1(2030) INTO KBAR CELTA(1232) H-WAVE          493+1232

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                  47  Y*1(2030) BRANCHING RATICS

R1      Y*1(2030) INTO (KBAR N)/TCTAL                  (P1)
R1           (0.25)                    WOHL       66 HBC    0 K-P CH EX         7/66
R1   D       (0.11)                    DAUM       68 CNTR    K-P ELA,POL,SIGT  7/70
R1            0.17       0.04          CAMPBELL   71 CBC  -  K- NEUTRON ELAST  1/71
R1            0.18       0.02          LITCHFIE   71 DPWA    K-P TO KBAR N    .10/71
R1             .18        .03          HEMINGWA   75 DPWA  0 K- P TO KBAR N   11/75*
R1             .24        .02          RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
R1   D   DAUM 68 ASSUMES (J+1/2)*P1 VALUE SEEN IN TOTAL CROSS SECTION.
R1             . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

R2      Y*1(2030) FROM KBAR N INTO LAMBCA PI            SQRT(P1*P2)
R2           (0.20)                    WOHL       66 HBC    0 K-P TO LAMBDA PI  7/66
R2           +0.21       0.01          SMART      68 DPWA - K-N TO LAMBDA PI  6/68
R2           +0.2        0.02          BERTHON    70 DPWA  0 K-P TO LAMBDA PI  7/70
R2           +0.19       0.01          COX        70 DPWA - K-N TO LAMBDA PI  6/70
R2           +0.16       0.03          GALTIERI   70 DPWA  0 K-P TO LAMBDA PI  7/70
R2           +0.20       0.008         LITCHFIEL  70 DPWA -0 K-N TO LAMBDA PI  6/70
R2           +.195        .053         DEVENISH   74       0 FIXED T DISP REL  4/75*
R2           +.18         .02          BAILLON    75 IPWA    KBAR N TO LAM PI 11/75*
R2           +.20         .01          VANHORN    75 DPWA  0 K-P TO LAM PIO   11/75*
R2           +.18         .02          RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
R2             . . . . . . . . .
R2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R3      Y*1(2030) FROM KBAR N INTO SIGMA PI             SQRT(P1*P3)
R3   L      (-0.09)     (0.02)         BERTHON1   70 DPWA  0 K-P TO SIGMA PI  10/70
R3          -0.052       0.010         GALTIERI   70 DPWA  0 K-P TO SIGMA PI   7/70
R3          -0.10        0.03          LITCHFIE   71 DPWA    K-P TO SIG PI     3/72
R3   L   LITCHFIELD 71 IS AN UPCATE OF BERTHON1 70                            3/72
R3          -0.086       0.014         KANE       72 DPWA  0 K-P TO PI SIG    10/71
R3           -.15         .03          RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
R3             . . . . . . . . .
R3   AVERAGE MEANINGLESS (SCALE FACTOR = 2.1)

R4      Y*1(2030) FROM KBAR N INTC XI K                SQRT(P1*P4)
R4           (0.05) OR LESS            TRIPP      67 RVUE  0 K-P TO XI K        8/67
R4           (0.05) OR LESS            BURGUN     68 DPWA  0 K-P TO XI K       10/69
R4           (0.023)                   MULLER     69 DPWA  0                    7/70

R5      Y*1(2030) FROM KBAR N TO Y*0(1815) PI P-WAVE     SQRT(P1*P5)
R5   1         .18        .04          LITCHFI1   74 DPWA  0 K-P TO L(1815)PI 10/74*
R5   1  ASSUMES LAMBDA(1815) ELASTICITY=.6                                  10/74*
R5             .14        .02          CORDEN2    75 DBC   - KBAR PI- NUCLEON 11/75*
R5             . . . . . . . . .
R5   AVG       0.148      0.018    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5   STUDENT   0.148      0.020    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R6      Y*1(2030) FROM KBAR N TO Y*0(1520) PI D-WAVE     SQRT(P1*P6)
R6   2         .14        .03          LITCHFI2   74 DPWA  0 K-P TO L(1520)PI 10/74*
R6   2  ASSUMES LAMBDA(1520) ELASTICITY=.45                                 10/74*
R6   3        (.10)      (.03)         CORDEN2    75 DBC   - KBAR PI- NUCLEON 11/75*
R6   3  UPPER LIMIT                                                         11/75*

R7      Y*1(2030) FROM KBAR N TO Y*0(1520) PI G-WAVE     SQRT(P1*P7)
R7   2         .02        .02          LITCHFI2   74 DPWA  0 K-P TO L(1520)PI 10/74*
R7   2  ASSUMES LAMBDA(1520) ELASTICITY=.45                                 10/74*
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Data Card Listings

For notation, see key at front of Listings.

Baryons

Σ(2030), Σ(2070), Σ(2080)

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R8       Y*1(2030) FRCM KBAR N TO KBAR CELTA(1232) F-WAVE SQRT(P1*P8)
R8             .16       .03            LITCHFI3  74 DPWA  O K-P TO KBAR DEL  10/74*
R8   3       (.17)     (.03)            CORDEN2   75 DBC   - KBAR PI- NUCLEON 11/75*
R8   3   UPPER LIMIT                                                          11/75*

R9       Y*1(2030) FROM KBAR N TO KBAR DELTA(1232) H-WAVE SQRT(P1*P9)
R9             .00       .02            LITCHFI3  74 DPWA  O K-P TO KBAR DEL  10/74*

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REFERENCES FOR Y*1(2030)


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WOHL      66 PRL 17 107        C G WOHL, F T SOLMITZ, M L STEVENSON  (LRL)IJP
TRIPP     67 NP B3 10          + LEITH, +     (LRL,SLAC,CERN,HEIDEL,SACLAY)
BURGUN    68 NP B8 447         +MEYER,PAULI,TALLINI +      (SACL+CDEF+RHEL)
DAUM      68 NP B7 19          +ERNE,LAGNAUX,SENS,STEUER,UDO          (CERN)JP
    CCNFIRMS THE SPIN-PARITY ASSIGNMENT.
SMART     68 PR 169 1336       W M SMART                              (LRL)IJP
MULLER    69 THESIS,UCRL 19372 R A MULLER                             (LRL)

BERTHON   70 NP B20 476        +RANGAN, VRANA, +(COL FRANCE, RHEL, SACLAY)IJP
BERTHON1  70 NP B24 417        +VRANA, BUTTERWORTH, + (CDEF, RHEL, SACLAY)IJP
COX       70 NP B19 61         +ISLAM, COLLEY, +      (BIRM,EDIN,GLAS,LOIC)IJP
GALTIERI  70 DUKE CONF 173     A BARBARO-GALTIERI                     (LRL)IJP
LITCHFIE  70 NP B22 269        P J LITCHFIELD                  (RUTHERFORD)IJP

CAMPBELL  71 NP B25 75         +MORTON, NEGUS, GOYAL, MILLER  (GLAS, LOIC)IJP
LITCHFIE  71 NP  B30 125       LITCHFIELD,...+LESQUOY,+.. (RHEL+CDEF+SACL)IJP
KANE      72 PR D5 1583        D F KANE                               (LBL)IJP

DEVENISH  74 NP B81 330        DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
LITCHFI1  74 NP B74 12         LITCHFIELD,HEMINGWAY,BAILLON,+  (CERN+HEID)IJP
LITCHFI2  74 NP B74 19         LITCHFIELD,HEMINGWAY,BAILLCN,+  (CERN+HEID)IJP
LITCHFI3  74 NP B74 39         LITCHFIELD,HEMINGWAY,BAILLON,+  (CERN+HEID)IJP

BAILLON   75 NP B94 39         P. BAILLON,P. J. LITCHFIELC     (CERN,RHEL)IJP
CORDEN2   75 NP B92 365        +COX,DARTNELL,KENYON,ONEALE,SUMOROK+ (BIRM)IJP
HEMINGWA  75 NP B91 12         HEMINGWAY,EADES,HARMSEN+   (CERN,HEID,MPIM)IJP
VANHORN   75 NP B87 145        A. J. VAN HORN                         (LBL)IJP
     ALSO 75 NP B87 157        A. J. VAN HORN                         (LBL)IJP

RLIC      76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSCN,ROSS+    (RHEL+LOIC)IJP
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2030 MEV REGION – PRODUCTION AND σ_{TOTAL} EXP'TS

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                     28  Y*1(2030, JP=     ) I=1       PRCDUCTION EXPERIMENTS

                     SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                     SEE THE NOTE TO THE F17 Y*1(2030), WHICH PRECEDES THIS
                     ENTRY.  HERE WE LIST ONLY PARAMETERS OF PEAKS IN CROSS
                     SECTIONS AND INVARIANT-MASS DISTRIBUTIONS.  THE CROSS-
   SECTION PEAKS ARE AT LEAST DOMINANTLY ASSOCIATED WITH THE Y*1(2030),
   BUT MAY CONTAIN A SMALL CONTRIBUTION FROM THE SUGGESTED BUT NOT ESTAB-
   LISHED OTHER RESONANCES IN THIS REGION.

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                     28  Y*1(2030) MASS (MEV) (PROD. EXP.)

M          (2022.0)   (20.0)            BLANPIED  65 CNTR  O GAMMA P TO K+ Y*
M           2020.0      7.0             BUGG      68 CNTR    K-P, D TOTAL      6/68
M           2049.0      4.0             BRICMAN   70 CNTR  O TOTAL AND CH EX   6/70
M           2025.0     10.0             COOL      70 CNTR    K-P, D TOTAL     10/70
M          (2025.0)   (20.0)            LU        70 CNTR  O GAMMA P TO K+ Y*  1/71
M             . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 2.8)

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                     28  Y*1(2030) WIDTH (MEV) (PROD. EXP.)

W           (120.0)   (20.0)            BLANPIED  65 CNTR  O
W            130.0     10.0             BUGG      68 CNTR                      6/68
W            126.0     11.0             BRICMAN   70 CNTR  O TOTAL AND CH EX   6/70
W            165.0                      COOL      70 CNTR    K-P, D TOTAL     10/70
W            (80.0)                     LU        70 CNTR  O GAMMA P TO K+ Y*  1/71
W             . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                     28  Y*1(2030) PARTIAL DECAY MCDES (PROD. EXP.)

                                                             DECAY MASSES
P1       Y*1(2030) INTO KBAR N                             497+ 939
P2       Y*1(2030) INTO KBAR N PI                          497+ 939+ 139

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                     28  Y*1(2030) BRANCHING RATICS (PROD. EXP.)

R1       Y*1(2030) INTO (KBAR N)/TOTAL                    (P1)
R1          THESE VALUES OF ELASTICITIES ASSUME J=7/2 --
R1             0.131                    BUGG      68 CNTR                      6/68
R1             0.27     (0.02)          BRICMAN   70 CNTR  O TOTAL AND CH EX   6/70
R1             0.12        -            COOL      70 CNTR    K-P, D TOTAL     10/70

R2       Y*1(2030) INTO KBAR N PI                         (P2)
R2                 SEEN                 BOCK      HBC

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REFERENCES FOR Y*1(2030) (PROD. EXP.)


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BLANPIED 65 PRL 14 741         +GREENBERG,HUGHES,KITCHING,LU,+ (YALE(CEA))
COOL      66 PRL 16 1228       +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
   SUPERSEDED BY COOL 7C.
BUGG      68 PR 168 1466       +GILMORE,KNIGHT, +          (RHEL,BIRM,CAVE) I

BRICMAN   70 PL 31B 152        +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL      70 PR D1 1887        +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
LU        70 PR D2 1846        +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)
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Σ(2070) → F''_{15}

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                     34  Y*1(2070, JP=5/2+) I=1

                     THIS STATE HAS BEEN SUGGESTED BY ONLY CNE PARTIAL
                     WAVE ANALYSIS ACROSS THIS REGICN. IT NEEDS CONFIRMATICN
                     THE RESCNANCE PROPOSED BY KANE IS TOO BROAD TO
                     BE LSED AS EVIDENCE.

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                     34  Y*1(2070) MASS (MEV)

M          (2070.)    (10.)             BERTHCN1  70 DPWA -  K- P TO SIG PI     1/71
M          (2057.0)                     KANE      72 DPWA    K-P TO SIGMA PI    1/73

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                     34  Y*1(2C70) WIDTH (MEV)

W           (140.)    (20.)             BERTHON1  70 DPWA -  K- P TO SIG PI     1/71
W           (906.0)                     KANE      72 DPWA    K-P TO SIGMA PI    1/73

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                     34  Y*1(2070) PARTIAL DECAY MODES

                                                             CECAY MASSES
P1       Y*1(2070) INTO KBAR N                             497+ 939
P2       Y*1(2070) INTO SIGMA PI                          1197+ 139

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                     34  Y*1(2C70) BRANCHING RATIOS

R1       Y*1(2070) FROM KBAR N TC SIGMA                  SQRT(P1*P2)
R1             (+.12)    (.02)          BERTHON1  70 DPWA -  K- P TO SIG PI     1/71
R1            (+0.104)                  KANE      72 DPWA    K-P TO SIGMA PI    1/73

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REFERENCES FOR Y*1(2070)


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BERTHCN1 70 NP B24 417         +VRANA,BUTTERWORTH,+       (CDEF,RHEL,SACLAY)IJP
KANE      72 PR D5 1583        D F KANE                                   (LBL)
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Σ(2080) → P'''_{13}

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                     88  Y*1(2080, JP=3/2+) I=1

                     SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                     SUCH A RESCNANCE IS SUGGESTEC BY SCME BUT NOT ALL
                     PARTIAL-WAVE ANALYSES ACROSS THIS REGION.  UNTIL THERE
                     IS MORE EVICENCE, WE CMIT THIS STATE FROM THE MAIN
                     BARYON TABLE.

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                     88  Y*1(2080) MASS (MEV)

M          (2082.0)    (4.0)            COX       70 DPWA -  K- N TC LAM PI     6/70
M          (2070.0)   (30.0)            LITCHFIEL 70 DPWA -0 K- N TO LAM PI     6/70
M    1      2120.      40.              BAILLCN   75 IPWA    KBAR N TC LAM PI 11/75*
M    1  FROM SOLUTION 1 OF EAILLCN 75.                                         1/76*
M    2      2140.      40.              BAILLCN   75 IPWA    KBAR N TO LAM PI  1/76*
M    2  FROM SOLUTION 2 OF BAILLON 75.                                         1/76*
M           2140.      30.              BELLEFO1  75 DPWA  O K- P TO LAM PIO  11/75*
M             . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                     88  Y*1(2080) WIDTH (MEV)

W            (87.0)   (20.0)            COX       70 DPWA -  K- N TO LAM PI     6/70
W           (250.0)   (40.0)            LITCHFIEL 70 DPWA -0 K- N TO LAM PI     6/70
W    1       240.      50.              BAILLCN   75 IPWA    KBAR N TO LAM PI 11/75*
W    2       200.      50.              BAILLON   75 IPWA    KBAR N TO LAM PI  1/76*
W            180.      20.              BELLEFC1  75 DPWA  O K- P TO LAM PIO  11/75*
W             . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                     88  Y*1(2080) PARTIAL DECAY MCDES

                                                             DECAY MASSES
P1       Y*1(2080) INTO KBAR N                             497+ 939
P2       Y*1(2080) INTO LAMBDA PI                         1115+ 139

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                     88  Y*1(2080) BRANCHING RATIOS

R1       Y*1(2080) FRCM KBAR N TO LAMBDA PI               SQRT(P1*P2)
R1            (-0.16)   (0.03)          COX       70 DPWA -  K- N TO LAM PI     6/70
R1            (-0.09)   (0.03)          LITCHFIEL 70 DPWA -0 K- N TO LAM PI     6/70
R1   1          -.13      .04           BAILLON   75 IPWA    KBAR N TO LAM PI 11/75*
R1   2          -.13      .04           BAILLCN   75 IPWA    KBAR N TO LAM PI  1/76*
R1              +.19      .03           BELLEFO1  75 DPWA  O K- P TO LAM PIO  11/75*
R1            . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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REFERENCES FOR Y*1(2080)


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COX       70 NP B19 61         +ISLAM, CCLLEY, +      (BIRM,EDIN,GLAS,LOIC)IJP
LITCHFIE  70 NP B22 269        P J LITCHFIELD                  (RUTHERFORD)IJP
BAILLON   75 NP B94 39         P. BAILLON,P. J. LITCHFIELC     (CERN,RHEL)IJP
BELLEFO1  75 NP B90 1          DE BELLEFON,BERTHON,BRUNET+     (CDEF,SACL)IJP
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Baryons
Σ(2100), Σ(2250), Σ(2455)

Data Card Listings
For notation, see key at front of Listings.

Σ(2100) **G_{17}**

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26  Y*1(2100, JP=7/2-) I=1

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

SUCH A RESONANCE IS SUGGESTED BY SOME BUT NOT ALL
PARTIAL-WAVE ANALYSES ACROSS THIS REGION.  UNTIL THERE
IS MORE EVIDENCE, WE OMIT THIS STATE FROM THE MAIN
BARYON TABLE.

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              26  Y*1(2100) MASS (MEV)

M      (2060.0)  (20.0)          GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
M      (2120.0)  (30.0)          GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70

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              26  Y*1(2100) WIDTH (MEV)

W        (70.0)  (30.0)          GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
W       (135.0)  (30.0)          GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70

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              26  Y*1(2100) PARTIAL DECAY MODES

                                                       DECAY MASSES
P1     Y*1(2100) INTO KBAR N                           497+ 939
P2     Y*1(2100) INTO LAMBDA PI                        1115+ 134
P3     Y*1(2100) INTO SIGMA PI                         1197+ 139

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              26  Y*1(2100) BRANCHING RATIOS

R1     Y*1(2100) FROM KBAR N TO LAMBDA PI              SQRT(P1*P2)
R1        (-0.07)  (0.02)        GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70

R2     Y*1(2100) FROM KBAR N TO SIGMA PI               SQRT(P1*P3)
R2        (+0.13)  (0.02)        GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70

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                   REFERENCES FOR Y*1(2100)
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GALTIERI 70 DUKE CCNF 173      A BARBARO-GALTIERI                   (LRL)IJP
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Σ(2250) BUMPS

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48  Y*1(2250, JP=    ) I=1          PRODUCTION EXPERIMENTS

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THE PARTIAL-WAVE ANALYSIS RESULTS ARE TOO WEAK TO
WARRANT SEPARATING THEM FROM THE PRODUCTION AND CROSS-
SECTION EXPERIMENTS.
   LASINSKI 71 IN KBAR N, USING A POMERON+RESONANCES MODEL, AND
BELLEFON1 75,76 IN DPWA*S OF LAMBDA PI AND SIGMA PI SUGGEST THE
PRESENCE OF TWO RESONANCES AROUND THIS MASS VALUE.

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              48  Y*1(2250) MASS (MEV) (PROD. EXP.)

M        (2245.0)                    BLANPIED  65 CNTR    GAMMA P TO K+ Y*
M        (2299.0)   (6.0)            BOCK      65 HBC     PBAR P 5.7 BEV/C
M         2250.0     7.0             BUGG      68 CNTR    K-P, D TOTAL      6/68
M         2280.     14.0             AGUILAR   70 HBC  +  K- 3.9-4.6 GEV/C  5/70
M         2237.0    11.0             BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
M         2255.0    10.0             COOL      70 CNTR    K-P, D TOTAL     10/70
M        (2250.0)  (20.0)            LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71
M    B   (2260.)   (30.)             BELLEFO1  75 DPWA    D5 WAVE          11/75*
M    B   (2215.)   (10.)             BELLEFO1  75 DPWA    G9 OR H11 WAVE   11/75*
M    B   EVIDENCE FOR 2 RESONANCES IN THIS LAMBDA PI DPWA                  11/75*
M    1    2300.     30.              BELLEFO2  75 HBC   0 K- P TO XI*0 KO  11/75*
M    V    2251.     30.      20.     VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75*
M    V    VANHORN72 VALUE FROM A DPWA THAT FINDS JP=5/2+.                  11/75*
M         2270.     10.              BELLEFCN  76 DPWA  0 D5 WAVE           1/76*
M         2210.     10.              BELLEFCN  76 DPWA  0 G9 WAVE           1/76*
M         . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 2.0)

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              48  Y*1(2250) WIDTH (MEV) (PROD. EXP.)

W        (150.0)                     BLANPIED  65 CNTR    GAMMA P TO K+ Y*
W         (21.0)  (17.0)   (21.0)    BOCK      65 HBC     PBAR P 5.7 GEV/C
W         230.0    20.0              BUGG      68 CNTR    K-P, D TOTAL      6/68
W         100.0    20.0              AGUILAR   70 HBC  +  K- 3.9-4.6 GEV/C  5/70
W         164.0    50.0              BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
W        (170.0)                     COOL      70 CNTR    K-P, D TOTAL     10/70
W        (125.0)                     LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71
W    B   (100.)   (20.)              BELLEFO1  75 DPWA    D5 WAVE          11/75*
W    B    (60.)   (40.)    (20.)     BELLEFO1  75 DPWA    G9 OR H11 WAVE   11/75*
W    1    130.     20.               BELLEFO2  75 HBC   0 K- P TC XI*0 KO  11/75*
W    V    192.     30.               VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75*
W          70.     20.               BELLEFCN  76 DPWA  0 D5 WAVE           1/76*
W          60.     10.               BELLEFCN  76 DPWA  0 G9 WAVE           1/76*
W         . . . . . . . . .
W    AVG      102.5    23.9   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.5)
W    STUDENT   96.0    14.4   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
             SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

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              48  Y*1(2250) PARTIAL DECAY MODES (PROD. EXP.)

                                                       DECAY MASSES
P1     Y*1(2250) INTO KBAR N                           497+ 939
P2     Y*1(2250) INTO LAMBDA PI                        1115+ 134
P3     Y*1(2250) INTO SIGMA PI                         1197+ 139
P4     Y*1(2250) INTO KBAR N PI                         497+ 939+ 139
P5     Y*1(2250) INTO XI*1/2(1530) K                   1533+ 497

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              48  Y*1(2250) BRANCHING RATIOS (PROD. EXP.)

R1     Y*1(2250) INTO (KBAR N)/TOTAL                         (P1)
R1       J IS NOT DETERMINED.  THE FOLLOWING IS (J+1/2)*P1.
R1           (0.47)                  BUGG      68 CNTR                      6/68
R1           (0.16)   (0.12)         BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
R1           (0.42)                  COOL      70 CNTR    K-P, D TOTAL     10/70

R2     Y*1(2250) FROM KBAR N TO LAMBDA PI              SQRT(P1*P2)
R2          (-0.18)(FOR JP=9/2-)     GALTIERI  70 DPWA    K-P TO LAMBDA PI 10/70
R2   B       (+.12)    (.03)         BELLEFO1  75 DPWA    D5 WAVE          11/75*
R2   B       (-.09)    (.02)         BELLEFO1  75 DPWA    G9 OR H11 WAVE   11/75*
R2     V      -.16      .03          VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75*
           SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

R3     Y*1(2250) FROM KBAR N TO SIGMA PI               SQRT(P1*P3)
R3          (+0.07)(FOR JP=9/2-)     GALTIERI  70 DPWA    K-P TO SIGMA PI  10/70
R3            +.06      .02          BELLEFCN  76 DPWA  0 D5 WAVE           1/76*
R3            -.03      .01          BELLEFON  76 DPWA  0 G9 WAVE           1/76*
R3         . . . . . . . . .
R3   AVERAGE MEANINGLESS (SCALE FACTOR = 1.3)

R4     Y*1(2250) INTO (KBAR N)/(SIGMA PI)              (P1)/(P3)
R4           (0.18) OR LESS          BARNES    69 HBC  +  1 STAN DEV LIMIT 10/69

R5     Y*1(2250) INTO (LAMBDA PI)/(SIGMA PI)           (P2)/(P3)
R5           (0.18) OR LESS          BARNES    69 HBC  +  1 STAN DEV LIMIT 10/69

R6     Y*1(2250) FROM K- P TO XI*1/2(1530)0 KO         SQRT(P1*P5)         11/75*
R6   1        .09       .02          BELLEFO2  75 HBC   0 K- P TO XI*0 KO  11/75*
R6   1   SEEN IN DD5 WAVE IN NEUTRAL CHANNEL ONLY, ISOSPIN UNDETERMINED.   11/75*

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                   REFERENCES FOR Y*1(2250) (PROD. EXP.)
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BLANPIED 65 PRL 14 741         +GREENBERG,HUGHES,KITCHING, +     (YALE(CEA))
BOCK     65 PL 17 166          +COOPER,FRENCH,KINSON, +       (CERN,SACLAY)
BUGG     68 PR 168 1466        +GILMORE,KNIGHT, +          (RHEL,BIRM,CAVE) I
BARNES   69 PRL 22 479         +FLAMINIO,MONTANET,SAMIOS +      (BNL+SYRA)

AGUILAR  70 PRL 25 58          AGUILAR-BENITEZ, BARNES, +       (BNL,SYRA)
BRICMAN  70 PL 31B 152         +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL     70 PR D1 1887         +GIACOMELLI, KYCIA, LEONTIC, LI, +   (BNL) I
GALTIERI 70 DUKE CONF 173      A BARBARO-GALTIERI                  (LRL)IJP
LU       70 PR D2 1846         +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)

BELLEFO1 75 NP B90 1           DE BELLEFCN,BERTHON,BRUNET+     (CDEF+SACL)IJP
BELLEFO2 75 NC 28A 289         DE BELLEFON,BERTHON,BILLOIR+    (CDEF,SACL)
VANHORN  75 NP B87 145         A. J. VAN HORN                       (LBL)IJP
   ALSO  75 NP B87 157         A. J. VAN HORN                       (LBL)IJP

BELLEFCN 76 SBMTD. TO NP       DE BELLEFCN,BILLOIR,BERTHON+    (CDEF+SACL)IJP

                   PAPERS NOT REFERRED TO IN DATA CARDS

COOL     66 PRL 16 1228        +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
   SUPEREDED BY COOL 70.
DAUBER   66 PL 23 154          +SCHLEIN, SLATER, STORK, TICHO  (UCLA(LRL)) J
  SUGGESTS J#9/2 RESONANT BEHAVIOR IN SIGMA- PI+, BUT APPEARS
        INCONSISTENT WITH PARAMETERS OF COOL 66.
DAUM     68 NP B7 19           +ERNE, LAGNAUX, SENS, STEUER, UDO    (CERN)JP
LASINSKI 71 NP  B29  125       T A LASINSKI                         (EFI)IJP
HEMINGWA 75 NP B91 12          HEMINGWAY,EADES,HARMSEN+     (CERN,HEID,MPIM)IJP
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Σ(2455) BUMPS

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53  Y*1(2455, JP=    ) I=1          PRODUCTION EXPERIMENTS

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.
THERE IS ALSO SOME SLIGHT EVIDENCE FOR Y* STATES IN
THIS MASS REGION FROM THE REACTION GAMMA + P TO K+ + MISSING MASS --
SEE GREENBERG 68.

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              53  Y*1(2455) MASS (MEV) (PROD. EXP.)

M         2455.0     7.0             BUGG      68 CNTR    K-P, D TOTAL      6/68
M         2455.0    10.0             ABRAMS    70 CNTR    K-P, D TOTAL     10/70
M         . . . . . . . . .
M    AVG      2455.0    5.7    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    STUDENT2455.0      6.1    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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              53  Y*1(2455) WIDTH (MEV) (PROD. EXP.)

W          100.0    20.0             BUGG      68 CNTR                      6/68
W          140.0                     ABRAMS    70 CNTR    K-P, D TOTAL     10/70

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              53  Y*1(2455) PARTIAL DECAY MODES (PROD. EXP.)

                                                       DECAY MASSES
P1     Y*1(2455) INTO KBAR N                           497+ 939

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              53  Y*1(2455) BRANCHING RATIOS (PROD. EXP.)

R1     Y*1(2455) INTO (KBAR N)/TOTAL                         (P1)
R1       J IS NOT KNOWN.  THE FOLLOWING IS (J+1/2)*P1.
R1           (0.3)                   BUGG      68 CNTR                      6/68
R1            0.39                   ABRAMS    70 CNTR    K-P, D TOTAL     10/70
R1   C       (0.05)   (0.05)         BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
R1   C   FIT OF TOTAL CROSS SECTION GIVEN BY BRICMAN 70 IS POOR IN
R1   C   THIS REGION.

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                   REFERENCES FOR Y*1(2455) (PROD. EXP.)
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BUGG     68 PR 168 1466        +GILMORE,KNIGHT, +          (RHEL,BIRM,CAVE) I
ABRAMS   70 PR 1D 1917         +COOL, GIACOMELLI, KYCIA, LEONTIC, +  (BNL) I
BRICMAN  70 PL 31B 152         +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)

                   PAPERS NOT REFERRED TO IN DATA CARDS
ABRAMS   67 PRL 19 678         +COOL,GIACOMELLI,KYCIA,LEONTIC,LI, +  (BNL)
   SUPERSEDED BY ABRAMS 70.
GREENBER 68 PRL 20 221         GREENBERG, HUGHES, LU, MINEHART, +   (YALE)
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Data Card Listings

Baryons

For notation, see key at front of Listings. Σ(2620), Σ(3000), EXOTIC HYPERONS, Ξ's, Ξ^-, Ξ^0

Σ(2620) BUMPS

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54  Y*1(2620, JP=    ) I=1        PRODUCTICN EXPERIMENTS
SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

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                 54  Y*1(2620) MASS (MEV) (PROD. EXP.)

M        2620.0     15.0            ABRAMS    70 CNTR    K-P, D TOTAL     10/70
M        2542.      22.             DIBIANCA  75 DBC     XI K PI           1/76*
M        . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 2.9)

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                 54  Y*1(2620) WIDTH (MEV) (PROD. EXP.)

W        (175.0)                    ABRAMS    70 CNTR    K-P, D TOTAL     10/70
W         221.       81.            DIBIANCA  75 DBC     XI K PI           1/76*

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                 54  Y*1(2620) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1     Y*1(2620) INTO KBAR N                            497+ 939

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                 54  Y*1(2620) BRANCHING RATIOS (PROD. EXP.)

R1     Y*1(2620) INTO (KBAR N)/TOTAL                   (P1)
R1         J IS NOT KNOWN.  THE FOLLOWING IS (J+1/2)*P1.
R1         (0.32)                   ABRAMS    70 CNTR    K-P, D TOTAL     10/70
R1           0.36      0.12         BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70

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                         REFERENCES FOR Y*1(2620) (PROD. EXP.)

ABRAMS   67 PRL 19 678        +COOL,GIACOMELLI,KYCIA,LEONTIC,LI, +  (BNL)
   SUPERSEDED BY ABRAMS 70.
ABRAMS   70 PR 1D 1917        +COOL, GIACOMELLI, KYCIA, LEONTIC, +  (BNL) I
BRICMAN  70 PL 31B 152        +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)

DIBIANCA 75 NP B98 137        DIBIANCA,ENDORFR                      (CARN)

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Σ(3000) BUMPS

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59  Y*1(3000, JP=    ) I=1        PRODUCTION EXPERIMENTS
SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.
ENHANCEMENT IN LAMBDA PI AND KBAR N INVARIANT MASS
SPECTRA AND IN MISSING MASS OF NEUTRALS RECOILING
AGAINST KO.  EVIDENCE NOT CONCLUSIVE.  OMITTED FROM
TABLE.

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                 59  Y*1(3000) MASS (MEV) (PROD. EXP.)

M        (3000.0)                   EHRLICH   66 HBC   0 PI-P 7.91 BEV/C   9/66

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                 59  Y*1(3000) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1     Y*1(3000) INTO KBAR N                            497+ 939
P2     Y*1(3000) INTO LAMBDA PI                         1115+ 139

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                         REFERENCES FOR Y*1(3000) (PROD. EXP.)

EHRLICH  66 PR 152 1194       R EHRLICH, W SELOVE, H YUTA    (PENN(BNL)) I

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EXOTIC HYPERON CROSS SECTION LIMITS

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THIS IS NOT A COMPLETE LIST.  WE TABULATE
ONLY FROM 1970 ON.

CS  UNITS MICROBARNS
CS  G      (20.)   OR LESS             GALTIERI  68 CBC    K-N TO SG-PI-PIO  7/70
CS  G  ABOVE LIMIT FOR MASS <  2.15 GEV AND GAMMA <  60 MEV- (2.1 GEV/C K-)  7/70
CS  A      (40.)   OR LESS             GALTIERI  68 CBC -- K-N TO SG-PI-PIO  7/70
CS  A  ABOVE LIMIT FOR MASS <  2.3 GEV AND GAMMA  < 120 MEV- (2.7 GEV/C K-)  7/70

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                         REFERENCES FOR EXOTIC HYPERONS

GALTIERI 68 PRL 21 573        A.BARBARO-GALTIERI,CHADWICK +    (LRL+SLAC)

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Note on Ξ Resonances

The Ξ resonance situation has long been unsettled. This is because 1) they can only be produced as part of a final state, $K^-+p \to \Xi^* +$ others, and 2) they are so produced with very small cross sections (< 50 μb). Thus the numbers of events available are small, and the analysis is more complicated than if direct formation were possible. Only the Ξ(1530) is really well established. There are apparently at least two Ξ states in the 1800-2000 MeV region, and there are indications of several more above 2000 MeV, but the situation is unclear. Two large bubble chamber experiments reported at the 1975 ANL Symposium on New Directions in Hadron Spectroscopy (BLOKZIJL 75 and MORRIS 75) may be able to clarify the situation. In the meantime, we are forced to group together rather disparate observations and await new results. Figures in the listings point out disagreements among various experiments. The table following this note gives our evaluation of the status of the Ξ resonances, based on the data available at this time.

STATUS OF XI* RESONANCES

THOSE WITH AN OVERALL STATUS OF *** OR **** ARE INCLUDED IN THE MAIN BARYON TABLE. THE OTHERS AWAIT CONFIRMATION.

			STATUS AS SEEN IN --				
PARTICLE	LIJ	OVERALL STATUS	XI PI	LAM K	SIG K	XI* PI	OTHER CHANNELS
XI(1320)	P11	****					WEAK TO LAM PI
XI(1530)	P13	****	****				
XI(1630)		**	**				
XI(1820)		***	***	***	**	***	
XI(1940)		***	***			***	
XI(2030)		**		**	**		3-BODY DECAYS
XI(2250)		*					3-BODY DECAYS
XI(2500)		**		**	**		3-BODY DECAYS

```
****  GOOD, CLEAR, AND UNMISTAKABLE.
 ***  GOOD, BUT IN NEED OF CLARIFICATION OR NOT ABSOLUTELY CERTAIN.
  **  NEEDS CONFIRMATION.
   *  WEAK.

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S=−2 I=1/2 HYPERON STATES (Ξ)

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Ξ^-

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22  XI-(1321, JP=1/2 ) I=1/2
SEE STABLE PARTICLE DATA CARD LISTINGS

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Ξ^0

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23  XIO(1314, JP=1/2 ) I=1/2
SEE STABLE PARTICLE DATA CARD LISTINGS

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Baryons
Ξ(1530), Ξ(1630)

Data Card Listings
For notation, see key at front of Listings.

Ξ(1530) P_{13}

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49  XI*1/2(1530, JP=3/2+) I=1/2
    THIS IS THE ONLY REALLY WELL-ESTABLISHED XI*.  THE
    QUANTUM NUMBERS 3/2+ ARE FAVORED BY THE DATA.

   WE DO NOT USE  DETERMINATIONS OF THE MASS AND THE WIDTH OF THIS
STATE UNLESS THEY ARE ACCOMPANIED BY SOME DISCUSSION OF SYSTEMATICS
AND RESOLUTION.

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                    49  XI*1/2(1530) MASS (MEV)

M       55(1529.0)   (5.0)         PJERROU    62 HBC   -0 K-P 1.8 GEV/C
M         (1532.0)   (2.0)         BADIER     64 HBC   -0 K-P 3 GEV/C
M-      38 1535.7     3.2          LONDON     66 HBC   -  K-P 2.24 GEV/C    7/66
M-     334(1534.7)   (1.1)         BALTAY     72 HBC   -  K-P 1.75 GEV      1/73
M-     185 1536.2     1.6          KIRSCH     72 HBC   -  K-P 2.87GEV/C     2/72
M-         1535.3     2.0          ROSS2      73          XI KBAR PI (PI)   2/74
M-      48(1540.)    (3.)          BERTHON    74 HBC   0 QUASI 2 BODY CS   10/74*
M-         1534.5     1.2          BELLEFO2   75 HBC   0 K-P TO XI- K PI   11/75*
M-         . . . . . . . . . .
M-  AVG    1535.18    0.84   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M-  STUDENT1535.18    0.92   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
M-  FIT    1534.97    0.63  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
MO      76 1528.7     1.1          LONDON     66 HBC   0 K-P 2.24 GEV/C     7/66
MO      59 1531.4     0.8          BADIER     72 HBC   0 K-P AT 3.95GEV/C  10/71
MO    1262 1532.0     0.4          BALTAY     72 HBC   0 K-P 1.75 GEV       1/73
MO     324 1531.3     0.6          BORENSTEI  72 HBC   0 K-P 2.2GEV/C       2/72
MO     286 1532.3     0.7          KIRSCH     72 HBC   0 K-P 2.87GEV/C      2/72
MO         1533.0     1.0          ROSS2      73         XI KBAR PI (PI)    2/74
MO      97(1533.6)   (1.4)         BERTHON    74 HBC   0 QUASI 2 BODY CS   10/74*
MO         1532.2      .7          BELLEFO2   75 HBC   0 K-P TO XI- K PI   11/75*
MO         . . . . . . . . . .
MO  AVG    1531.78    0.34   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
MO  STUDENT1531.84    0.28   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
MO  FIT    1531.80    0.31  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

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                 49  (XI*-) - (XI*0) MASS DIFFERENCE (MEV)

D           5.7       3.0          PJERRCU    65 HBC   -0 1.8-1.95 GEV/C    7/66
D    R     (7.0)     (4.0)         LONDON     66 HBC   -0 2.24 GEV/C        7/66
D           2.0       3.2          MERRILL    66 HBC   -0 1.7-2.7 GEV/C     7/66
D           2.7       1.0          BALTAY     72 HBC   -0 K-P 1.75 GEV      1/73
D    R     (3.9)     (1.8)         KIRSCH     72 HBC   -0 K- P 2.8 GEV/C    2/72
D    R   REDUNDANT WITH DATA IN MASS LISTING.
D          . . . . . . . . . .
D   AVG     2.92      0.91   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D   STUDENT 2.90      0.99   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
D   FIT     3.17      0.64  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                    49  XI*1/2(1530) WIDTH (MEV)

WO          7.0       2.0          SCHLEIN    63 HBC   0 1.8, 1.95 GEV/C
WO          7.0       7.0          BERGE      66 HBC   0 1.5-1.7 GEV/C      7/66
WO          8.5       3.5          LONDON     66 HBC   0 2.24 GEV/C         7/66
WO         11.0       2.0          BADIER     72 HBC   0 K-P AT 3.95GEV/C  10/71
WO          9.0       0.7          BALTAY     72 HBC   0 K-P 1.75 GEV       1/73
WO          8.4       1.4          BORENSTEI  72 HBC   0 XI- PI+ MODE       2/72
WO         11.0       1.8          KIRSCH     72 HBC   0 XI- PI+            2/72
WO          9.1       2.4          ROSS2      73         XI KBAR PI (PI)    2/74
WO          9.5       1.2          BELLEFO2   75 HBC   0 K-P TO XI- K PI   11/75*
WO         . . . . . . . . . .
WO  AVG     9.14      0.48   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
WO  STUDENT 9.13      0.53   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                             (SEE IDEOGRAM BELOW )
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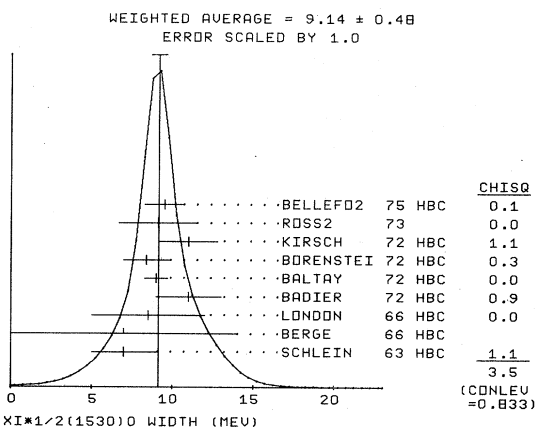


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W-          7.8       3.5    7.8   BALTAY     72 HBC   -  K-P 1.75 GEV      1/73
W-         16.2       4.6          KIRSCH     72 HBC   -  XI- PIO,XIO PI-   2/72
W-          8.3       3.6          ROSS2      73          XI KBAR PI (PI)   2/74
W-          9.6       2.8          BELLEFO2   75 HBC   0 K-P TO XI- K PI   11/75*
W-         . . . . . . . . . .
W-  AVG    10.1       1.9    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W-  STUDENT 10.0      2.1    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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             49  XI*1/2(1530) REAL PART OF POLE PCSITION                4/75*

REO       1531.6      0.4          LICHTENB   74        0 EXTRAP HABIBI73   4/75*
RE-       1534.4      1.1          LICHTENB   74        - EXTRAP HABIBI73   4/75*

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             49  XI*1/2(1530) IMAGINARY PART OF POLE POSITION           4/75*

IMO        4.45       0.35         LICHTENB   74        0 EXTRAP HABIBI73   4/75*
IM-        3.9        1.75    3.9  LICHTENB   74        -  EXTRAP HABIBI73  4/75*

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                 49  XI*1/2(1530) PARTIAL DECAY MODES

                                                                 DECAY MASSES
P1      XI*1/2(1530) INTO XI PI                                   1321+ 139
        OTHER STRONG DECAYS ARE FORBIDDEN BY ENERGY CONSERVATION.
P2      XI*1/2(1530) INTO XI GAMMA                                1321+   0

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                 49  XI*1/2(1530) BRANCHING RATIOS (MEV)

R1      XI*1/2(1530) INTO (XI GAMMA)/TOTAL                  (P2)             1/76*
R1             LESS THAN 0.04            KALBFLEI  75 HBC  -  90 PCT CFDNC LVL  1/76*

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                        REFERENCES FOR XI*1/2(1530)

PJERRCU  62 PRL 9 114        +PROWSE,SCHLEIN,SLATER,STORK,TICHO     (UCLA) I
SCHLEIN  63 PRL 11 167       +CARMONY,PJERROU,SLATER,STORK,TICHO   (UCLA)IJP
BADIER   64 DUBNA I 593      +DEMOULIN,GOLDBERG, +      (EPOL,SACLAY,AMST) I
PJERRCU  65 PRL 14 275       +SCHLEIN,SLATER,SMITH,STORK,TICHO      (UCLA)

BERGE    66 PR 147 945       +EBERHARD,HUBBARD,MERRILL,B-SHAFER,+   (LRL) I
LCNDCN   66 PR 143 1034      +RAU,SAMIOS,YAMAMOTO,GOLDBERG,+   (BNL,SYRA) IJ
MERRILL  66 UCRL-16455 THESIS D W MERRILL                           (LRL) JP

BADIER   72 NP B37 429       +BARRELET,CHARLTCN,VIDEAU              (EPOL)
BALTAY   72 PL 42B 129       +BRIDGEWATER,COOPER,GERSHWIN,+    (COLU+BING)
  ALSO   73 NEVIS 199(THESIS) HABIBI                           (CCLUMBIA)
BORENSTE 72 PR D5 1559       BORENSTEIN,CANBURG,KALBFLEISCH++ (BNL,MICH) I
KIRSCH   72 NP B40 349       SCHMIDT+CHANG,HEMINGWAY(BRAN,UMD,SYRA,TUFT) I

ROSS2    73 PURDUE CCNF. 355 RCSS,LLCYD,RADCJICIC                 (OXFORD)
BERTHON  74 NC 21A 146       BERTHON,TRISTRAM,+       (CDEF+RHEL+SACL+STRB)   U
LICHTENB 74 PRD 10 3865      D B LICHTENBERG             (INDIANA UNIVERSITY)
  ALSO   74 PRIV. COMM.      D B LICHTENBERG             (INDIANA UNIVERSITY)
BELLEFC2 75 NC 28A 289       DE BELLEFON,BERTHON,BILLOIR+      (CDEF,SACL)
KALBFLEI 75 PRD 11 987       KALBFLEISCH,STRAND,CHAPMAN           (BNL+MICH)

                        PAPERS NOT REFERRED TO IN DATA CARDS

SHAFER   66 PR 142 883       BUTTCN-SHAFER,LINDSEY,MURRAY,SMITH     (LRL) JP
  A SPIN-PARITY DETERMINATION.
HABIBI   73 NEVIS 199(THESIS) HABIBI                                (COLU)
HUNGERBU 74 PRD 10 2051      HUNGERBUHLER,MAJKA,+       (YALE,FNAL,BNL,PITT)
BRIEFEL  75 PRD 12 1859      +GOUREVITCH,KIRSCH+       (BRAN+UMD+SYRA+TUFT)
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→ Ξ(1630)

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21  XI*1/2(1630, JP=    ) I=1/2
    THIS EFFECT NEEDS CCNFIRMATICN.
    BARTSCH 69 SEE A SMALL, BROAD ENHANCEMENT NEAR
    1650 MEV - IT IS NOT CLEAR THAT IT IS THE SAME
    PHENOMENON AS BMST 70, WHO FIND CS=3.6+-1.6
    MICROBARNS AT 2.87 GEV/C INCIDENT K- MOMENTUM.
  BORENSTEIN 72 SEE NC EFFECT IN THIS REGION.  THEY FIND
  CS<2 MICROBARNS AT 2.18.
     ROSS 72 ARGUE THAT THE EFFECT THEY SEE IS NOT THE SAME AS THAT
  SEEN BY BMST 70, AND FIND CS=2+-1 MICRCBARNS AT 3.3 GEV/C.
  BELLEFON 75B FIND A CS OF AROUND 10 MICROBARNS NEAR 2 GEV/C,
  BUT LESS THAN 3 MICROBARNS ARCUND 2.3 GEV/C.

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                    21  XI*1/2(1630) MASS (MEV)

M        40 1635.      10.          BMST       70 HBC   0 INTO  XI- PI+     7/70
M        29 1606.       6.          ROSS       72 HBC   0 K-P AT 3.1-3.7    3/72
M        34 1633.      12.          BELLEFO2   75 HBC   0 K-P TO XI- K PI  11/75*
M           . . . . . . . . . .
M    AVG    1616.7      9.7    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)
M    STUDENT1617.0      7.2    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    21  XI*1/2(1630) WIDTH (MEV)

W        40   57.      18.          BMST       70 HBC   0 K-P AT 2.87
W        29   21.       7.          ROSS       72 HBC   0 XI-PI+ K*0(890)   3/72
W        34   40.      15.          BELLEFC2   75 HBC   0 K-P TO XI- K PI  11/75*
W           . . . . . . . . . .
W    AVG      28.0      8.7    AVERAGE (ERRCR INCLUDES SCALE FACTOR OF 1.5)
W    STUDENT  27.7      7.3    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    21  XI*1/2(1630) PARTIAL DECAY MODES

                                                                 DECAY MASSES
P1      XI*1/2(1630) INTO XI PI                                   1321+ 139
        SEEN IN K- P TO XI- PI+ KO AND XI- PIO K+.

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                        REFERENCES FOR XI*1/2(1630)

BMST     70 DUKE 317         BRANDEIS+MARYLAND+SYRACUSE+TUFTS COLLABOR.
ROSS     72 PL 38B 177       +BURAN,LLOYD,MULVEY,RADOJICIC          (OXF) I
BELLEFO2 75 NC 28A 289       DE BELLEFCN,BERTHCN,BILLOIR+       (CDEF,SACL)

                        PAPERS NOT REFERRED TO IN DATA CARDS

APSELL   69 PRL 23 884       +     (BRANDEIS, MARYLAND, SYRACUSE, TUFTS)
   SUPERSEDED BY BMST 70.
BARTSCH  69 PL 28B 439       +          (AACHEN, BERLIN, CERN, LOIC, VIENNA)
KALBFLEI 70 DUKE CONF 331    G R KALBFLEISCH                          (BNL) I
   SUMMARIZES EVIDENCE FOR ISCSPIN 1                               (2.    )
BORENSTE 72 PR D5 1559       BORENSTEIN,DANBURG,KALBFLEISCH++ (BNL,MICH) I
SCHMIDT  73 PURDUE CONF. 363 SCHMIDT                            (BRANDEIS)
HUNGERBU 74 PRD 10 2051      HUNGERBUHLER,MAJKA,+       (YALE,FNAL,BNL,PITT)
BRIEFEL  75 PRD 12 1859      +GOUREVITCH,KIRSCH+       (BRAN+UMD+SYRA+TUFT)
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Data Card Listings

For notation, see key at front of Listings.

Baryons
Ξ(1820), Ξ(1940)

Ξ(1820)

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50  XI*1/2(1820, JP=    ) I=1/2

AS THE ACCOMPANYING IDEOGRAMS ILLUSTRATE, THE SITUATICN
IS CONFUSED.  UNTIL SOME FUTURE CLARIFICATICN, WE LIST
UNDER XI(1820) EVERYTHING REPORTED IN THE MASS RANGE
1750-1875 MEV.  WHEN BRANCHING RATICS ARE REPORTED, WE
QUOTE THEM, BUT ONLY THE MOST QUALITATIVE CONCLUSIONS ARE JUSTIFIED.

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                 50  XI*1/2(1820) MASS (MEV)

M          (1770.0)                    HALSTEINS 63 FBC  -0 K-FR 3.5 GEV/C
M       30 1814.0     4.0              BADIER    65 HBC   0 LAMBDA KBAR
M       29 1817.0     7.0              SMITH 1   65 HBC  -0 LAMBDA KBAR
M       40 1830.0    10.0              ALITTI    69 HBC  -  LAM, SIG KBAR      9/69
M       65 1795.     10.               BMST      70 HBC   0 XI-PI+ (2.9 K-P)   7/70
M       55 1820.     12.               BMST      70 HBC     XI(1530) PI        7/70
M       35 1854.     12.               BMST      70 HBC  -  SIGMA- KOBAR       7/70
M       65 1871.     11.               BMST      70 HBC   0 LAMBDA  KOBAR      7/70
M       25 1830.0    10.0              CRENNELL  70 DBC  -0 3.6, 3.9 GEV/C    10/70
M  B    28 1762.0     8.0              BADIER    72 HBC     XI PI,XI2PI,K Y   10/71
M  B    38 1838.0     5.0              BADIER    72 HBC     XI PI,XI2PI,K Y   10/71
M  B    BADIER 72 ADDS ALL CHANNELS AND DIVIDES PEAK IN LOWER AND HIGHER M
M    1  30 1821.      5.               ROSS1     73         LAMBDA K-/KBARO    2/74
M    1  LESS SIGNIFICANT ENHANCEMENT (M=1825,W=100) SEEN IN XI(1530)+PI        2/74
M      100 1823.      3.               BLOKZIJL  75 HBC     K- P AT 4.2 GEV    1/76*
M          1807.     27.               DIBIANCA  75 DBC     XI 2PI, XI* PI     1/76*
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 3.1)
                 (SEE IDEOGRAM BELOW )
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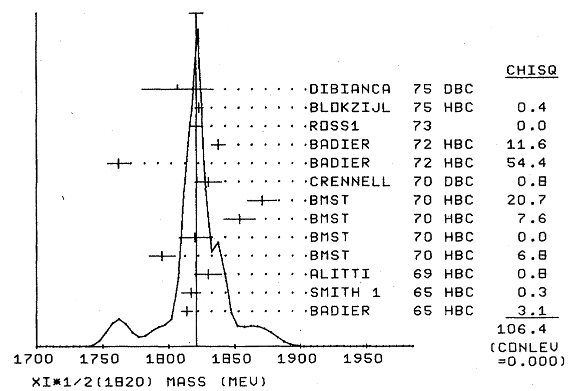


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                 50  XI*1/2(1820) WIDTH (MEV)

W            (80.0)  OR LESS           HALSTEINS 63 FBC  -0 K-FR 3.5 GEV/C
W            (12.0)   (4.0)            BADIER    65 HBC   0 LAMBDA KBAR
W             30.0     7.0             SMITH 2   65 HBC  -0
W             55.0    40.0     20.0    ALITTI    69 HBC  -  LAM, SIG KBAR      9/69
W        65   99.     31.              BMST      70 HBC     XI-PI+ (2.9 K-P)   7/70
W        55   82.     42.              BMST      70 HBC     XI(1530) PI        7/70
W        35   56.     14.              BMST      70 HBC  -  SIGMA- KOBAR       7/70
W        65   58.     39.              BMST      70 HBC   0 LAMBDA  KOBAR      7/70
W            103.0    38.0     24.0    CRENNELL  70 DBC  -0 3.6, 3.9 GEV/C    10/70
W  B          51.0    13.0             BADIER    72 HBC     LOWER MASS        10/71
W  B          58.0    13.0             BADIER    72 HBC     HIGHER MASS       10/71
W     1  30   12.      4.              ROSS1     73         LAMBDA K-/KBARO    2/74
W       100   19.      4.              BLOKZIJL  75 HBC     K- P AT 4.2 GEV    1/76*
W             85.     58.              DIBIANCA  75 DBC     XI 2PI, XI* PI     1/76*
W                SEE THE NOTES ACCOMPANYING THE MASSES QUOTED
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)
                 (SEE IDEOGRAM BELOW )
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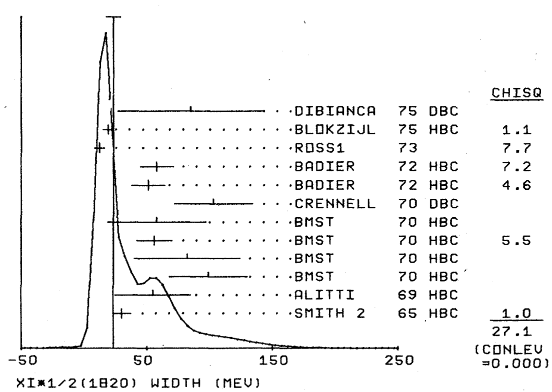


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                 50  XI*1/2(1820) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      XI*1/2(1820) INTO LAMBDA KBAR                         1115+ 497
P2      XI*1/2(1820) INTO XI PI                               1321+ 139
P3      XI*1/2(1820) INTO SIGMA KBAR                          1197+ 497
P4      XI*1/2(1820) INTO XI*1/2(1530) PI                     1533+ 139
P5      XI*1/2(1820) INTO XI PI PI (EXCLUDING P4)             1321+ 139+ 139

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                 50  XI*1/2(1820) BRANCHING RATIOS

R1      XI*1/2(1820) INTO (LAMBCA KBAR)/TOTAL                 (P1)
R1            0.3       0.15              ALITTI    69 HBC   -                  9/69

R2      XI*1/2(1820) INTO (XI PI)/TOTAL                       (P2)
R2            0.1       0.1               ALITTI    69 HBC   -                  9/69

R3      XI*1/2(1820) INTO (SIGMA KBAR)/TOTAL                  (P3)
R3          (0.02) OR LESS                TRIPP     67 RVUE                     8/67
R3            0.3       0.15              ALITTI    69 HBC   -                  9/69

R4      XI*1/2(182C) INTC (XI*1/2(1530) PI)/TOTAL             (P4)
R4            0.3       0.15              ALITTI    69 HBC   -                  9/69
R4          (0.25) OR LESS                DAUBER    69 HBC     K-P 2.7 BEV/C    9/69

R5      XI*1/2(182C) INTO (XI PI)/(LAMBDA KBAR)               (P2)/(P1)
R5            0.20      0.20              BADIER    65 HBC                      7/66
R5          (.42)+/-.02) OR LESS          BLOKZIJL  75 HBC     K- P AT 4.2 GEV  1/76*

R6      XI*1/2(1820) INTO (XI*(1530) PI)/(LAM KBAR)           (P4)/(P1)
R6            0.26      0.13              SMITH 1   65 HBC
R6             .77       .20              BLOKZIJL  75 HBC     K- P AT 4.2 GEV  1/76*
R6          . . . . . . . . . .
R6  AVG       0.41      0.23     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.1)
R6  STUDENT   0.39      0.14     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R7      XI*1/2(1820) INTO (XI PI PI)/(LAMBCA KBAR)            (P5)/(P1)
R7          (0.1)  OR MORE                SMITH 1   65 HBC

R8      XI*1/2(1820) INTO (XI PI)/(XI*1/2(1530) PI)           (P2)/(P4)
R8            1.5       0.6      0.4      APSELL    70 HBC   0                  6/70

R9      XI*1/2(1820) INTO (XI PI PI)/(XI*1/2(1530) PI)        (P5)/(P4)
R9            0.3       0.5               APSELL    70 HBC   0                  6/70

R10     XI*1/2(1820) INTO (SIGMA KBAR)/(LAMBDA KBAR)          (P3)/(P1)         1/76*
R10            .23       .06              BLCKZIJL  75 HBC     K- P AT 4.2 GEV  1/76*

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                 REFERENCES FOR XI*1/2(1820)

HALSTEIN 63 SIENA CONF 173    HALSTEINSLID,+ (BERGEN,CERN,EPOL,RHEL,LOUC) I
BADIER   65 PL 16 171         +DEMOULIN,GOLDBERG, +    (EPOL,SACLAY,AMST) I
SMITH 1  65 PRL 14 25         +LINDSEY,BUTTCN-SHAFER,MURRAY           (LRL)IJP
SMITH 2  65 ATHENS CONF 251   G A SMITH, J S LINDSEY                  (LRL)
TRIPP    67 NP 83 10          + LEITH, +    (LRL,SLAC,CERN,HEIDEL,SACLAY)
    USES DATA OF SMITH 1.

ALITTI   69 PRL 22 79         +BARNES,FLAMINIO,METZGER, +  (BNL,SYRACUSE) I
DAUBER   69 PR 179 1262       +BERGE, HUBBARD, MERRILL, MULLER         (LRL)
APSELL   70 PRL 24 777        +      (BRANDEIS, MARYLAND, SYRACUSE, TUFTS) I
BMST     70 DUKE 317          BRANDEIS+MARYLAND+SYRACUSE+TUFTS COLLABOR.
CRENNELL 70 PR 1D 847         +KARSHON, LAI, ONEALL, SCARR, SCHUMANN(BNL)
BADIER   72 NP B37 429        +BARRELET,CHARLTON,VIDEAU               (EPOL)
ROSS1    73 PURDUE CONF. 345  ROSS,LLCYD,RADOJICIC                  (OXFORD)

BLOKZIJL 75 ANL-HEP-CP-75-58  +DEGROOT,HOOGLAND+      (AMST+CERN+NIJM+OXF)
    ALSO 75 PALERMO CONF.     +DEGROOT,HOOGLAND+      (AMST+CERN+NIJM+OXF)
DIBIANCA 75 NP B98 137        DIBIANCA,ENDORFR                        (CARN)

                 PAPERS NOT REFERRED TO IN CATA CARDS

MERRILL  68 PR 167 1202       D W MERRILL, J BUTTON-SHAFER            (LRL)
    WEAK EVIDENCE CONCERNING JP.
APSELL   69 PRL 23 884        +      (BRANDEIS, MARYLAND, SYRACUSE, TUFTS)
    SUPERSEDED BY BMST  70.
SCHMIDT  73 PURDUE CONF. 363  SCHMIDT                           (BRANDEIS)
BRIEFEL  75 PRD 12 1859       +GOUREVITCH,KIRSCH+     (BRAN+UMD+SYRA+TUFT)

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Ξ(1940)

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52  XI*1/2(1940, JP=    ) I=1/2

WE LIST UNDER XI(1940) EVERYTHING REPORTED IN THE MASS
RANGE 1875-2000 MEV.

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                 52  XI*1/2(1940) MASS (MEV)

M       35 1933.0    16.0              BADIER    65 HBC   0 XI- PI+
M       27 1930.0    20.0              ALITTI    68 HBC   0 XI- PI+           11/68
M       66 1894.0    18.0              DAUBER    69 HBC  -  XI PI             11/68
M      110 1954.      9.               BMST      70 HBC   0 XI-PI+ (2.9 K-P)   7/70
M       40 1961.      8.               BMST      70 HBC     XI(1530) PI        7/70
M       21 1955.0    14.0              GOLDWASSE 70 HBC  -  XI PI             10/70
M       29 1956.0     6.0              BADIER    72 HBC     XI PI,XI2PI,K Y   10/71
M       25 1952.     11.               ROSS1     73         (XI PI)-           2/74
M          1900.     12.               DIBIANCA  75 DBC     XI PI              1/76*
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 2.0)
                 (SEE IDEOGRAM BELOW )
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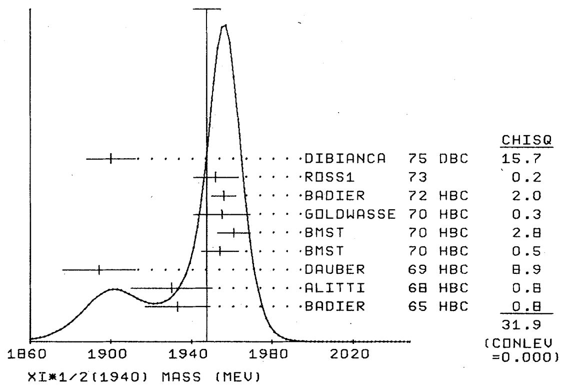
Baryons

Ξ(1940), Ξ(2030), Ξ(2250)

Data Card Listings

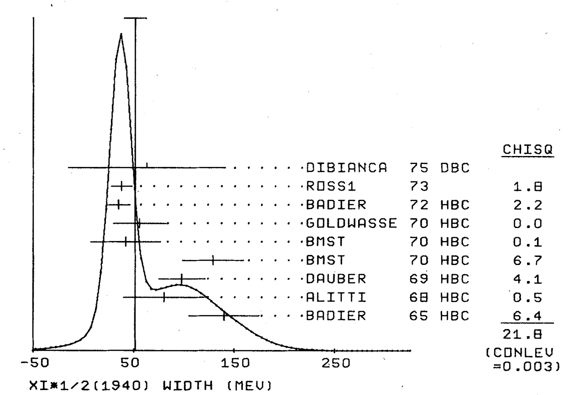
For notation, see key at front of Listings.



52 XI*1/2(1940) WIDTH (MEV)

W	35	140.0	35.0	BADIER	65	HBC	0	XI- PI+	
W	27	80.0	40.0	ALITTI	68	HBC	0	XI- PI+	11/68
W	66	98.0	23.0	DAUBER	69	HBC	-	XI PI	11/68
W	110	129.	30.	BMST	70	HBC	0	XI-PI+ (2.9 K-P)	7/70
W	40	42.	35.	BMST	70	HBC		XI(1530) PI	7/70
W	21	56.0	26.0	GOLDWASSE	70	HBC	-	XI PI	10/70
W	29	35.0	11.0	BADIER	72	HBC		XI PI,XI2PI,K Y	10/71
W		38.	10.	ROSS1	73			(XI PI)-	2/74
W		63.	78.	DIBIANCA	75	DBC		XI PI	1/76*

W . . . .
W AVERAGE MEANINGLESS (SCALE FACTOR = 1.8)
(SEE IDECGRAM BELOW)



52 XI*1/2(1940) PARTIAL DECAY MODES

		DECAY MASSES
P1	XI*1/2(1940) INTO XI PI	1321+ 139
P2	XI*1/2(1940) INTO XI*(1530) PI	1533+ 139
P3	XI*1/2(1940) INTO XI PI PI (EXCLUDING P2)	1321+ 139+ 139
P4	XI*1/2(1940) INTO XI0 PI-	1314+ 139
P5	XI*1/2(1940) INTO XI- PI0	1321+ 134

52 XI*1/2(1940) BRANCHING RATIOS

THE XI(1940) IS SEEN MAINLY IN XI PI AND SOME IN XI(1530) PI. IT HAS BEEN LOOKED FOR IN OTHER CHANNELS BUT NOT SEEN.

R1 XI*1/2(1940) INTO (XI PI)/(XI*1/2(1530) PI) (P1)/(P2)
R1 2.8 0.7 0.6 APSELL 70 HBC 0 6/70

R2 XI*1/2(1940) INTO (XI PI PI)/(XI*1/2(1530) PI) (P3)/(P2)
R2 0.0 0.3 APSELL 70 HBC 0 6/70

R3 XI*1/2(1940) INTO (XI0 PI-)/(XI- PI0) (P4)/(P5) 2/74
R3 1 25 2.6 6. 1.6 ROSS1 73 (XI PI)- 2/74
R3 1 THIS BR IS 2.0(0.5) FOR AN I=1/2(I=3/2) XI*(1940). 2/74

REFERENCES FOR XI*1/2(1940)

BADIER 65 PL 16 171 +DEMOULIN,GOLDBERG, + (EPOL,SACLAY,AMST) I
ALITTI 68 PRL 21 1119 +FLAMINIO,METZGER,RADOJICIC,+(BNL,SYRACUSE) I
DAUBER 69 PR 179 1262 +BERGE, HUBBARD, MERRILL, MULLER (LRL) I
APSELL 70 PRL 24 777 + (BRANDEIS, MARYLAND, SYRACUSE, TUFTS) I
BMST 70 DUKE 317 BRANDEIS+MARYLAND+SYRACUSE+TUFTS COLLABOR.
GOLDWASS 70 PR 1D 1960 E L GOLDWASSER, P F SCHULTZ (ILLINOIS)
BADIER 72 NP B37,429 +BARRELET,CHARLTON,VIDEAU (EPOL)
ROSS1 73 PURDUE CONF. 345 ROSS,LLOYD,RADOJICIC (OXFORD)

DIBIANCA 75 NP B98 137 DIBIANCA,ENDORFR (CARN)

PAPERS NOT REFERRED TO IN DATA CARDS

APSELL 69 PRL 23 884 + (BRANDEIS, MARYLAND, SYRACUSE, TUFTS)
SUPERSEDED BY BMST 70.
SCHMIDT 73 PURDUE CONF. 363 SCHMIDT (BRANDEIS)
BRIEFEL 75 PRD 12 1859 +GOUREVITCH,KIRSCH+ (BRAN+UMD+SYRA+TUFT)

Ξ(2030)

68 XI*1/2(2030, JP=) I=1/2

THE STATE AT 2129 MEV REPORTED BY BLOKZIJL 75 IS REALLY INTERMEDIATE BETWEEN XI*(2130) AND XI*(2250). WE LIST IT HERE TEMPORARILY.

68 XI*1/2(2030) MASS (MEV)

M	42	2030.0	10.0	ALITTI	69	HBC	-	K-P 3.9-5 BEV/C	9/69
M	40	2058.0	17.0	BARTSCH	69	HBC		K-P 10GEV/C	9/69
M	15	2019.	7.	ROSS1	73			SIGMA KBAR	2/74
M	25	2129.	5.	BLOKZIJL	75	HBC		K- P AT 4.2 GEV	1/76*
M		2044.	8.	DIBIANCA	75	DBC		XI 2PI, XI* PI	1/76*

M . . . .
M AVERAGE MEANINGLESS (SCALE FACTOR = 7.4)

68 XI*1/2(2030) WIDTH (MEV)

W		45.0	40.0	20.0	ALITTI	69	HBC	-		9/69
W		57.0	30.0		BARTSCH	69	HBC			9/69
W	15	33.	17.		ROSS1	73			SIGMA KBAR	2/74
W	25	21.	8.		BLOKZIJL	75	HBC		K- P AT 4.2 GEV	1/76*
W		60.	24.		DIBIANCA	75	DBC		XI 2PI, XI* PI	1/76*

W . . . .
W AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

68 XI*1/2(2030) PARTIAL DECAY MODES

		DECAY MASSES
P1	XI*1/2(2030) INTO XI PI	1321+ 139
P2	XI*1/2(2030) INTO LAMBDA KBAR	1115+ 497
P3	XI*1/2(2030) INTO SIGMA KBAR	1197+ 497
P4	XI*1/2(2030) INTO XI*1/2(1530) PI	1533+ 139
P5	XI*1/2(2030) INTO LAMBDA (OR SIGMA) KBAR PI	1115+ 497+ 139

68 XI*1/2(2030) BRANCHING RATIOS

R1 XI*1/2(2030) INTO (XI PI)/(MODES P1 TO P4) (P1)/(P1+P2+P3+P4)
R1 (0.30) OR LESS ALITTI 69 HBC - 1 STD DEV LIMIT 9/69

R2 XI*1/2(2030) INTO (LAM KBAR)/(MODES P1 TO P4) (P2)/(P1+P2+P3+P4)
R2 0.25 0.15 ALITTI 69 HBC - 9/69

R3 XI*1/2(2030) INTO (SIG KBAR)/(MODES P1 TO P4) (P3)/(P1+P2+P3+P4)
R3 0.75 0.20 ALITTI 69 HBC - 9/69

R4 XI*1/2(2030) INTO (XI* PI)/(MODES P1 THRU P4) (P4)/(P1+P2+P3+P4)
R4 (0.15) OR LESS ALITTI 69 HBC - 1 STD DEV LIMIT 9/69

R5 XI*1/2(2030) INTO LAMBDA (OR SIGMA) KBAR PI (P5)
R5 SEEN BARTSCH 69 HBC 9/69

REFERENCES FOR XI*1/2(2030)

ALITTI 69 PRL 22 79 +BARNES,FLAMINIO,METZGER, + (BNL,SYRACUSE) I
BARTSCH 69 PL 28B 439 + (AACHEN, BERLIN, CERN, LOIC, VIENNA)
ROSS1 73 PURDUE CONF. 345 ROSS,LLOYD,RADOJICIC (OXFORD)

BLOKZIJL 75 ANL-HEP-CP-75-58 +DEGROOT,HOOGLAND+ (AMST+CERN+NIJM+OXF)
ALSO 75 PALERMO CONF. +DEGROOT,HOOGLAND+ (AMST+CERN+NIJM+OXF)
DIBIANCA 75 NP B98 137 DIBIANCA,ENDORFR (CARN)

Ξ(2250)

22 XI*1/2(2250, JP=)

THE EVIDENCE FOR THIS STATE IS WEAK. BARTSCH 69 SEE A BUMP OF NOT MUCH STATISTICAL SIGNIFICANCE IN LAMBDA-KBAR-PI, SIGMA-KBAR-PI, AND XI-PI-PI MASS SPECTRA. GOLDWASSER 70 SEE A NARROWER BUMP IN XI-PI-PI AT A HIGHER MASS. PERHAPS THEY ARE THE SAME STATE, PERHAPS THEY ARE NOT, BUT SEE ALSO MORRIS 75.

22 XI*1/2(2250) MASS (MEV)

M	35	2244.0	52.0	BARTSCH	69	HBC		K-P 10 GEV/C	9/69
M	18	2295.0	15.0	GOLDWASSE	70	HBC	-	K-P 5.5 GEV/C	10/70

M . . . .
M AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

22 XI*1/2(2250) WIDTH (MEV)

W	130.0	80.0	BARTSCH	69	HBC			9/69
W	LESS THAN 30.0		GOLDWASSE	70	HBC	-	K-P 5.5 GEV/C	10/70

22 XI*1/2(2250) PARTIAL DECAY MODES

		DECAY MASSES
P1	XI*1/2(2250) INTO XI PI PI	1321+ 139+ 139
P2	XI*1/2(2250) INTO LAMBDA KBAR PI	1115+ 497+ 139
P3	XI*1/2(2250) INTO SIGMA KBAR PI	1197+ 497+ 139

Data Card Listings

For notation, see key at front of Listings.

Baryons

Ξ(2250), Ξ(2500), Ω⁻

REFERENCES FOR XI*1/2(2250)

BARTSCH 69 PL 28B 439 + (AACHEN, BERLIN, CERN, LOIC, VIENNA)
GOLDWASS 70 PR 1D 1960 E L GOLDWASSER, P F SCHULTZ (ILLINOIS)

PAPERS NOT REFERRED TO IN DATA CARDS.

MORRIS 75 ANL-HEP-CP-75-58 MORRIS,CH,PARKER,SMITH,WHITMORE (MSU)

Ξ(2500)

99 XI*1/2(2500, JP=) I=1/2

→ IT IS QUITE POSSIBLE THAT THE REASON THE EXPERIMENTS DISAGREE ABOUT THE MASS AND WIDTH IS THAT THEY ARE SEEING DIFFERENT XI*S. FOR NOW, HOWEVER, WE GROUP THEM TOGETHER.

99 XI*1/2(2500) MASS (MEV)

M	30	2430.0	20.0	ALITTI	69 HBC	-	K-P 4.6-5 GEV/C	9/69
M	45	2500.0	10.0	BARTSCH	69 HBC	-0	K-P 10 GEV/C	9/69
M		2392.	27.	DIBIANCA	75 DBC		XI 2PI	1/76*
M		. . . .						
M	AVERAGE MEANINGLESS (SCALE FACTOR = 3.2)							

99 XI*1/2(2500) WIDTH (MEV)

W	150.0	60.0	40.0	ALITTI	69 HBC	-		9/69
W	59.0	27.0		BARTSCH	69 HBC	-0		9/69
W	75.	69.		DIBIANCA	75 DBC		XI 2PI	1/76*
W	. . . .							
W	AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)							

99 XI*1/2(2500) PARTIAL DECAY MODES

		DECAY MASSES
P1	XI*1/2(2500) INTO XI PI	1321+ 139
P2	XI*1/2(2500) INTO LAMBDA KBAR	1115+ 497
P3	XI*1/2(2500) INTO SIGMA KBAR	1197+ 497
P4	XI*1/2(2500) INTO XI*1/2(1530) PI	1533+ 139
P5	XI*1/2(2500) INTO LAMBDA (OR SIGMA) KBAR PI	1115+ 497+ 139
P6	XI*1/2(2500) INTO XI PI PI	1321+ 139+ 139

99 XI*1/2(2500) BRANCHING RATIOS

R1	XI*1/2(2500) INTO (XI PI)/(MODES P1 THRU P4)			(P1)/(P1+P2+P3+P4)	
R1	(0.5) OR LESS	ALITTI	69 HBC	1 STD DEV LIMIT	9/69
R2	XI*1/2(2500) INTO (LAM KBAR)/(MODES P1 THRU P4)			(P2)/(P1+P2+P3+P4)	
R2	0.5 0.2	ALITTI	69 HBC	-	9/69
R3	XI*1/2(2500) INTO (SIG KBAR)/(MODES P1 THRU P4)			(P3)/(P1+P2+P3+P4)	
R3	0.5 0.2	ALITTI	69 HBC	-	9/69
R4	XI*1/2(2500) INTO (XI* PI)/(MODES P1 THRU P4)			(P4)/(P1+P2+P3+P4)	
R4	(0.2) OR LESS	ALITTI	69 HBC	1 STD DEV LIMIT	9/69
R5	XI*1/2(2500) INTO (LAMBDA (OR SIGMA) KBAR PI)/TOTAL				
R5				(P5)	
R5	SEEN	BARTSCH	69 HBC	-0	9/69
R6	XI*1/2(2500) INTO (XI PI PI)/TOTAL			(P6)	
R6	SEEN	BARTSCH	69 HBC	-0	9/69

REFERENCES FOR XI*1/2(2500)

ALITTI 69 PRL 22 79 +BARNES,FLAMINIO,METZGER, + (BNL,SYRACUSE) I
BARTSCH 69 PL 28B 439 + (AACHEN, BERLIN, CERN, LOIC, VIENNA)

DIBIANCA 75 NP B98 137 DIBIANCA,ENDORFR (CARN)

S=−3 I=0 HYPERON STATE (Ω)

Ω⁻

24 OMEGA-(1675, JP=3/2+) I=0

SEE STABLE PARTICLE DATA CARD LISTINGS

Appendix I

TEST OF ΔI=1/2 RULE FOR K DECAYS

The quantities of interest for making tests of theoretical predictions regarding the ΔI=1/2 rule for K decay are usually partial decay rates for single channels or special sums of channels. It is not possible to compute the errors on sums, differences, and ratios of partial decay rates from the information given in the Table of Stable Particles because of the presence of off-diagonal terms in the error matrix. For this reason we give some of these quantities in Table I. Throughout this Appendix, italics are used to indicate that a quantity has changed by more than one (old) standard deviation since our previous edition, and S gives the scale factor included in the quoted error because of inconsistencies in the data (see footnote at end of Stable Particle Table for definition of S).

Table I. (000) and (+−0) refer to the sign of the pions into which the K_L decays.

$\Gamma_{K^+_{\ell 3}} = \Gamma_{K^+_{e3}} + \Gamma_{K^+_{\mu 3}}$	$= (6.483\pm0.090)10^6\ \text{sec}^{-1}$	
$\Gamma_{K^+_{\mu 3}} / \Gamma_{K^+_{e3}}$	$= 0.663\pm0.018$	S=1.7*
$\Gamma_{K^+_{\tau}} / \Gamma_{K^+_{\tau'}}$	$= 3.227\pm0.083$	
$\Gamma_{K^0_{\ell 3}} = \Gamma_{K^0_{e3}} + \Gamma_{K^0_{\mu 3}}$	$= (12.75\pm0.15)10^6\ \text{sec}^{-1}$	S=1.1*
$\Gamma_{K^0_{\mu 3}} / \Gamma_{K^0_{e3}}$	$= 0.696\pm0.017$	
$\Gamma_{K^0(000)} / \Gamma_{K^0(+-0)}$	$= 1.747\pm0.070$	S=1.1*

1. Leptonic decay rates

The $\Gamma_{K_{\ell 3}}$ rates are useful in testing the leptonic ΔI=1/2 rule in the way suggested by Trilling.[1] The predictions are

$$\Gamma_{K^0_{\ell 3}} / 2\Gamma_{K^+_{\ell 3}} = 1.012, \text{ a phase-space factor,}^2$$

and

$$\Gamma_{K^0_{\mu 3}} / \Gamma_{K^0_{e3}} = \Gamma_{K^+_{\mu 3}} / \Gamma_{K^+_{e3}} .$$

From Table 1,

$$\Gamma_{K^0_{\ell 3}} / 2\Gamma_{K^+_{\ell 3}} = 0.983\pm0.018$$

and

$$\frac{\Gamma_{K^0_{\mu 3}}}{\Gamma_{K^0_{e3}}} \left[\frac{\Gamma_{K^+_{\mu 3}}}{\Gamma_{K^+_{e3}}}\right]^{-1} = 1.050\pm0.038 .$$

These results seem to show a less than 2σ disagreement with the predictions, but the errors should be regarded with caution in view of the internal disagreements in the data. (Note the ideograms in the Data Listings for the charged K meson.)

2. Three-pion decays

We follow here the tests done by Mast et al.,[3] based on the general analysis of K decays suggested by Zemach.[4] Both decay rates (Γ) and slopes (g, the energy dependence of the Dalitz plot distributions) are used. The ΔI=1/2 rule predicts that the following test quantities are all equal to zero:

$$\text{Test } 1 = \frac{2}{3}\ \frac{\Gamma_{K^0(000)}}{\phi_1} \left[\frac{\Gamma_{K^0(+-0)}}{\phi_2}\right]^{-1} -1 ,$$

$$\text{Test } 2 = \frac{1}{4}\ \frac{\Gamma_{K^+_{\tau}}}{\phi_3} \left[\frac{\Gamma_{K^+_{\tau'}}}{\phi_4}\right]^{-1} -1 ,$$

$$\text{Test } 3 = \frac{1}{2}\ \frac{\Gamma_{K^+_{\tau}}}{\phi_3} \left[\frac{\Gamma_{K^0(+-0)}}{\phi_2}\right]^{-1} -1 ,$$

$$\text{Test } 4 = \frac{1}{2} g_{K^+_{\tau'}} + g_{K^+_{\tau}} ,$$

$$\text{Test } 5 = g_{K^0(+-0)} + g_{K^+_{\tau}} - \frac{1}{2} g_{K^+_{\tau'}} .$$

The ϕ_i are phase-space factors which have been calculated as described in Mast et al.[3] by use of a relativistic formulation and the masses and slopes from this edition. The factors labeled UDP are the relative areas of the Dalitz plots, assuming a uniform distribution. The NUDP include the observed slopes (see below). The CNUDP have been calculated by including the final-state Coulomb interaction.
The values are:

	Method		
	UDP	NUDP	CNUDP
$\phi_1(000) =$	1.489	1.489	1.444
$\phi_2(+-0) =$	1.221	1.300	1.284
$\phi_3(++-) =$	1.000	1.000	1.000
$\phi_4(+00) =$	1.247	1.180	1.144

For convenience, we repeat the slope parameters tabulated in the Stable Particle Table. They are as follows:

$g_{K^+_{\tau}}$	$= -0.214\pm0.005$	S=1.7*
$g_{K^-_{\tau}}$	$= -0.214\pm0.007$	S=2.7*
$\overline{g}_{K^\pm_{\tau}}$	$= -0.214\pm0.004$	
$g_{K^+_{\tau'}}$	$= 0.550\pm0.020$	*S=1.6**
$g_{K^0(+-0)}$	$= 0.646\pm0.014$	*S=2.5**

A difference in the τ^+ and τ^- slopes would be an indication of CP violation in this decay. Since no difference is observed at this time, we average he two and use this value in Test 4 and Test 5.

We use the CNUDP factors and the rates and slopes reported in this edition to compute the five test quantities which the $\Delta I=1/2$ rule predicts to be zero. The results are:

Test 1 = 0.036±0.042
Test 2 = −0.077±0.024
Test 3 = 0.227±0.021
Test 4 = *0.061±0.011*
Test 5 = 0.157±0.018

The three-pion final state can be in isospin states I = 1,2,3. Tests 1 and 2 test the existence of isospin I = 3 in the final state. Since the rate tests (Tests 1, 2, and 3) could differ from zero by as much as 0.1 owing to the mass differences and the occurrence of big slopes[5], no evidence for I=3 is found. Test 4 is related to the I=2 amplitude in the final state and indicates the presence of I=2. Tests 3 and 5 give information on the $\Delta I=3/2$ part of the I=1 amplitude relative to the $\Delta I=1/2$ part. Both tests indicate the presence of $\Delta I=3/2$.

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Appendix II

A. SU(3) CLASSIFICATION OF BARYON RESONANCES

It is established that a symmetry higher than SU(3) is necessary to classify the known baryon resonances. However, many higher−symmetry schemes have been proposed, and even for SU(6) various versions exist (for a review see Dalitz[1]). Since it is not clear which one of these schemes best fits the data, we do not review them here, but we report once again fits of baryon states into SU(3) multiplets.

For the reader's convenience, we collect here the relevant formulae.

Exact SU(3) symmetry predicts that all the members of a multiplet should have the same mass and the same couplings for decays into other multiplets. It has been found, however, that the members of the octet of stable baryons lie within 20% of their mean mass; therefore a symmetry−breaking interaction has been introduced by Gell−Mann and Okubo independently.[2] In addition, for the isospin−0 vector mesons (ω and ϕ), an additional symmetry−breaking interaction has been introduced by Sakurai[3] to take care of octet−singlet mixing. The relevant formulae for masses and decay rates are given below.

Mass Formulae

Broken SU(3) gives:

Decuplet	$\Delta - \Sigma = \Sigma - \Xi^* = \Xi^* - \Omega$	GMO	(1)
Octet	$2(N + \Xi) = 3\Lambda + \Sigma$	GMO	(2)
Octet−Singlet mixing	$\sin^2\theta = \dfrac{\Lambda - M_8}{\Lambda - \Lambda'}$	Mixing angle[18]	(3)
	$M_8 = \dfrac{2(N + \Xi) - \Sigma}{3}$	GMO	(4)

Here GMO stands for the Gell−Mann−Okubo formula; the particle symbol indicates its mass. The formulae would be the same if squared masses were used. For the nonet case, Λ is the "mostly−octet" particle, Λ' is the "mostly−singlet" particle.

Decay Rates

In terms of a relativistically invariant matrix element T, the decay rate for two−body decay of a resonance of mass M_R is

$$\Gamma \propto \frac{|T|^2 R_2}{M_R} , \qquad (5)$$

where $R_2 = k/M_R$ is the two-body phase space factor. Since the numerator is an invariant, and since Γ must transform as $1/E$, we introduce the denominator M_R.[4]

For meson decays (see below) the rates are calculated according to Eq. (5); for baryon resonance decays into $1/2^+$ baryons and 0^- mesons, one next takes into account the fact that spin sums in $|T|^2$ introduce another factore M_R, cancelling the $1/M_R$. We are then left with

$$\Gamma = \frac{|T|^2 k}{M_R} M_N \text{ , for baryons} \qquad (5')$$

$$= \frac{|T|^2 k}{M_R^2} M_N^2 \text{ , for mesons.} \qquad (5'')$$

The powers of the nucleon mass M_N or M_N^2 have been introduced so that we can treat $|T|$ as dimensionless.

$|T|^2$ contains centrifugal barrier factors, which we call B_ℓ. We then have

Decuplet, Singlet: $$\Gamma = (cg)^2 B_\ell(k) \frac{M_N}{M_R} k \qquad (6)$$

Octet: $$\Gamma = (c_D g_D + c_F g_F)^2 B_\ell(k) \frac{M_N}{M_R} k \qquad (7)$$

Octet–Singlet mixing: $$\Lambda = G_8 \cos\theta + G_1 \sin\theta$$ $$\Lambda' = -G_8 \sin\theta + G_1 \cos\theta \qquad (8)$$

with $$G_8 = c_D g_D + c_F g_F$$ $$G_1 = c_1 g_1 . \qquad (9)$$

Here c_i are the SU(3) coefficients with the sign convention adopted in this article [see note in the Table of SU(3) Iscoscalar Factors and Fig. 2 in the text]. M_N is the nucleon mass, M_R is the resonance mass for which Γ is calculated, k is the center-of-mass momentum for the channel being considered, and g_i are the relevant couplings. For the case of singlet-octet mixing, formula (8) has to be used in conjuction with (6) and (7). G_8 and G_1 represent the couplings for the multiplet, and Λ and Λ' represent the couplings for the physical states.

The relation between g_D, g_F, and the parameter α is

$$\alpha = \left[1 + \frac{\sqrt{5}}{3} \frac{g_F}{g_D} \right]^{-1} . \qquad (10)$$

Exact SU(3) predicts that the couplings g_i for all the members of a multiplet are the same; however, since the symmetry is broken for the masses, it is probably broken for the widths. In the case of the $3/2^+$ decuplet, for broken SU(3) a sum rule has been derived by Becchi[5] and by Gupta[6] independently. It relates the g_i for the members of the decuplet by the relation

$$2(\Delta + \Xi) = 3\Sigma^*(\Lambda\pi) + \Sigma^*(\Sigma\pi), \qquad (11)$$

where $\Sigma^*(\Lambda\pi)$ is the coupling for the $\Sigma(1385) \rightarrow \Lambda\pi$ decay and $\Sigma^*(\Sigma\pi)$ is the coupling for the decay $\Sigma(1385) \rightarrow \Sigma\pi$.

As mentioned in the text (Sec. IV B) the determination of the relative signs of resonant amplitudes can be useful in making an SU(3) assignment of resonances. In fact the resonant amplitude $T \propto \sqrt{x_e x_i} \propto G_e G_i$, where the subscript e refers to the elastic channel and the G_e, G_i are the couplings of Eqs. (6) through (9). Assuming that all g_i are positive, the sign of the G_i are dependent upon the sign of the Clebsh–Gordon coefficients c_i. Once a sign convention is adopted (we use the Levi–Setti[7] convention, see Fig. 2 in the text) and the signs for a Σ state (I=1) and a Λ state (I=0) of known SU(3) assignment have been chosen for reference, the signs of all the other amplitudes can be useful in determining multiplet assignments. For exact SU(3) all the decays of members of a decuplet have the same sign. For octets the relative sign depends upon the value of g_D/g_F and the mixing angle, as seen from Eqs.(7) through (9).

Fits to the Data

Fits of baryon decay rates within SU(3) can be found in, among others, papers by Tripp,[8,9] Levi–Setti,[7] Samios,[10] and Plane.[11] The most recent fits were made by Barbaro–Galtieri[12] and Samios.[13]

In fitting the data a choice for B_ℓ has to be made. Plane[11] tried two forms for B_ℓ:

(a) The form $B_\ell = (kr)^{2\ell} D_\ell(kr)$, r being the radius of interaction and D_ℓ the polynomials in kr given by Blatt and Weisskopf.[14] Usually r is taken to be 1 fermi.[8]

(b) The form $B_\ell = k^{2\ell}$.

However, for final results form (b) was chosen. A discussion of the differences among these two forms has been given by Barbaro–Galtieri.[15] It turns out that not only the values of the couplings, g_i, depend upon the form used for B_ℓ, but also the value obtained for the mixing angle. For the $3/2^-$ singlet, Λ(1520), and the isospin–0 member of the octet, Λ(1690), the mixing angles obtained in the two cases are

$$\theta_a = (-16.1^{+1.4}_{-1.3})^\circ \ , \ \theta_b = (-27.5^{+3.6}_{-3.4})^\circ \ ,$$

in disagreement by a few standard deviations. It turns out that if a radius of interaction of r = 0.15 fermi is used for form (a), the two values of θ agree. This value of r does not fit resonance shapes when used in the Breit–Wigner resonant form.

Samios[13] used form (b) for B_ℓ.

Table I is a summary of the fits made by us (update of Barbaro–Galtieri[12]) using the barrier factor form (a) and exact SU(3). A few comments follow.

$1/2^-$ Nonet (Baryon–Eta Resonances)

For this nonet Eq. (7) was multiplied by the factor

$$\left[\frac{M_R - M_B}{\overline{M}_R - \overline{M}_B}\right]^2 ,$$

where M_B is the decay baryon and $\overline{M}_R-\overline{M}_B$=564 MeV is the difference of the mean $1/2^-$ and $1/2^+$ baryon octet masses. This kinematic factor comes from PCAC arguments (i.e., the assumption that the axial vector current remains an octet in the presence of symmetry breaking) and it was advocated by Graham.[16] For the $1/2^-$ nonet it was used in this form first by Gell–Mann.[17]

$3/2^+$ Decuplet

The agreement among the coupling constants obtained for the four rates in this decuplet is very bad. The fit made using form (b) for B_ℓ has χ^2=50 for 3 degrees of freedom; the one made with form (a) for B_ℓ has χ^2/DF=24/3. The broken SU(3) relation (11), however, is very well satisified.

B. SU(3) CLASSIFICATION OF MESON RESONANCES

All of the discussion above applies, except that for bosons the GMO formula is usually applied to the square of the masses, as opposed to the first power for fermions. Thus for example, Eq. (2) becomes

$$4\hat{K} = 3\hat{\eta} + \hat{\pi}. \qquad (2')$$

The symbol $\hat{K}$ was introduced by Glashow and Socolow[18] for the square of the K mass, etc.

Because of the difference between Eqs. (5') and (5"), there is also an extra factor of (M_N/M_R) in Eqs. (6) and (7). The three established nonets (0^-, 1^-, 2^+) and their mixing angles are listed at the bottom of the Meson Table.

Table I. SU(3) baryon multiplets with two or more known members. Values of θ and α [defined by Eqs. (8) and (10)] are the result of fits made to all the measured two–body decay rates of each mutiplet.

J^P	Octet members[a]				Singlet	θ(deg)[b]	α
$1/2^-$	N(1535)	Λ(1670)	Σ(1750)	[Ξ(1825)]	Λ(1405)	3±5	0.93±.11
$3/2^-$	N(1520)	Λ(1690)	Σ(1670)	[Ξ(1815)]	Λ(1520)	−23±4	0.31±.05
$5/2^-$	N(1670)	Λ(1830)	Σ(1765)				1.17±.04
$5/2^+$	N(1688)	Λ(1815)	Σ(1915)				0.65±.03
	Decuplet members[c]				g_{10}		
$3/2^+$	Δ(1232)	Σ(1385)	Ξ(1530)	Ω^-	1.78–2.29	χ^2/DF=50/3	
$7/2^+$	Δ(1950)	Σ(2030)					

[a]Masses in parentheses are the nominal masses used in the Baryon Table. The Ξ members have masses as calculated by using formulae (1) and (2) with the mixing angle θ derived from the decay widths.
[b]See text for a discussion of the $3/2^-$ mixing angle.
[c]Coupling constants from Ref. 12.

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Appendix III

TEST OF $\Delta I=1/2$ RULE FOR HYPERON DECAYS

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1. Nonleptonic decay Amplitudes

In this edition we again use the new convention for the amplitudes A and B adopted in 1973. Some theorists have suggested that dimensionless amplitudes are more useful to them than the ones appearing in the literature. Berge[1] used a convention with A and B in units of $\sec^{-1/2}$. Samios[2] used a convention which gave A and B in units of $(\text{MeV-sec})^{-1/2}$. Following is the convention suggested by Jackson[3], which gives dimensionless A and B.

The effective Lagrangian density for nonleptonic hyperon decays ($B_1 \to B_2 + \pi$) can be written

$$\mathcal{L}_{\text{eff}} = G\mu_c^2[\bar{\psi}_2(A+B\gamma_5)\psi_1]\phi_\pi,$$

where $G=10^{-5}m_p^{-2}$ is a coupling constant characteristic of first-order weak decays, μ_c is the charged pion mass, and A and B are dimensionless complex numbers giving the relative amplitudes of the parity-violating and parity-conserving decays, respectively. The matrix γ_5 is to be taken in the Pauli form, $\gamma_5=\begin{pmatrix}0 & -I\\ -I & 0\end{pmatrix}$. The invariant amplitude for the decay is

$$\mathcal{M} = G\mu_c^2[\bar{u}(p)(A+B\gamma_5)u(P)],$$

where P is the 4-momentum of the decaying hyperon of mass M, and p is the 4-momentum of the baryon decay product of mass m. With the normalization convention, $\bar{u}_i u_i = 2m_i$, the Pauli form of the matrix element in the rest frame of the decaying hyperon is

$$\mathcal{M} = G\mu_c^2\langle\chi_2|\sqrt{2M(E+m)}A + \sqrt{2M(E-m)}\,B\vec{\sigma}\cdot\hat{q}|\chi_1\rangle,$$

where E is the total energy of the final baryon and $\hat{q}$ is a unit vector in the direction of motion of the final baryon. Comparison with Sec. VI D of the text shows that the amplitudes s and p defined there are proportional to A and B:

$$\frac{p}{s} = \left(\frac{E-m}{E+m}\right)^{1/2}\frac{B}{A} = \left[\frac{(M-m)^2-\mu^2}{(M+m)^2-\mu^2}\right]^{1/2}\frac{B}{A}.$$

Here μ is the mass of the pion entering the decay. The parameters α, β, and γ can therefore be expressed in terms of A and B, rather than s and p, if desired.

The decay rate for $B_1 \to B_2 + \pi$ is

$$\Gamma=\frac{G^2\mu_c^4}{8\pi}q\left\{\left[\frac{(M+m)^2-\mu^2}{M^2}\right]|A|^2+\left[\frac{(M-m)^2-\mu^2}{M^2}\right]|B|^2\right\},$$

where q is the c.m. momentum of the decay products. For reference, the dimensionless constant in this expression has the value $(G^2\mu_c^4/8\pi) = 1.9488\times10^{-15}$.

Table I summarizes the amplitudes A and B for the nonleptonic decays of the Λ, Σ, and Ξ hyperons. These amplitudes have been calculated by using the experimental data for mean lives, branching ratios, and the decay asymmetry α given in the Stable Particle Table of this Review. Time-reversal invariance is assumed and final-state interactions are neglected, so A and B are taken to be relatively real. The subscript on the hyperon refers to the sign of the decaying pion. The statistical correlation coefficient

$$C_{AB} = \frac{\langle\Delta A\Delta B\rangle}{\sqrt{\langle\Delta A^2\rangle\langle\Delta B^2\rangle}}$$

is also given. The absolute signs of A and B have been assigned, using the following convention. Taking $A(\Lambda^0_-)$ as positive, the other S-wave decay amplitudes are chosen to give an approximate fit to the triangular relationships

$$\sqrt{2}A(\Sigma^+_0) + A(\Sigma^+_+) = A(\Sigma^-_-) \text{ and } \sqrt{3}A(\Sigma^+_0) + A(\Lambda^0_-) = 2A(\Xi^-_-).$$

The signs of the B amplitudes relative to those of the corresponding A amplitudes are determined by the sign of the appropriate α decay parameter.

Table I

$M \to m + \mu$	A	B	C_{AB}
$\Lambda^0_- \to p + \pi^-$	1.48±0.01	10.17±0.24	−0.272
$\Lambda^0_0 \to n + \pi^0$	−1.08±0.02	−7.28±0.59	−0.747
$\Sigma^+_+ \to n + \pi^+$	0.06±0.02	19.06±0.16	0.003
$\Sigma^+_0 \to p + \pi^0$	1.48±0.05	−12.04±0.59	0.918
$\Sigma^-_- \to n + \pi^-$	1.93±0.01	−0.65±0.08	−0.024
$\Xi^0_0 \to \Lambda + \pi^0$	1.53±0.03	−5.90±1.11	0.347
$\Xi^-_- \to \Lambda + \pi^-$	2.04±0.02	−6.71±0.38	0.198

2. Tests of the ΔI=1/2 Rule

(a) Λ Decay

For Λ decay the ΔI=1/2 rule predicts that $\Gamma_0/\Gamma_- = 0.50$ and $\alpha_0 = \alpha_-$. In order to determine the magnitude of possible ΔI=3/2 amplitudes present we write the linear expressions[4] for the ΔI=3/2 A- and B-wave amplitudes in terms of $\Delta\alpha$, where $\Delta\alpha$ is the measured value of α_0/α_- minus the predicted value, and in terms of $\Delta\Gamma$ similarly defined. Evaluating these we find

$$\Delta\alpha = -1.53\,(A_3/A_1) + 1.60\,(B_3/B_1),$$
$$\Delta\Gamma = 1.83\,(A_3/A_1) + 0.26\,(B_3/B_1).$$

Here the ΔI=3/2 amplitudes are expressed relative to the ΔI=1/2 amplitudes. The numerical values of the coefficients depend on the ratio B/A. The uncertainties in the coefficients are small compared to the uncertainties in $\Delta\alpha$ and $\Delta\Gamma$. Final-state πN interactions have been included in these relations but have a very small effect. From the Stable Particle Table,

$$\Delta\alpha = 0.006\pm0.066, \quad \Delta\Gamma = 0.058\pm0.012,$$

and hence

$$(A_3/A_1) = 0.027\pm0.008$$

and

$$(B_3/B_1) = 0.030\pm0.037.$$

The possible 3% ΔI=3/2 A-wave amplitude is due to the disagreement of decay rates with prediction. At this level the results are sensitive to electromagnetic corrections. However, in Λ decay the phase space correction and the other radiative corrections appear to be about equal in magnitude and have opposite signs,[5,6] and hence cancel each other in the correction to the decay rates.

(b) Ξ Decay

The analysis for Ξ decay is very similar to that for Λ decay. If the ΔI=1/2 rule is valid, $\Gamma_0(\Xi^0)/\Gamma_-(\Xi^-) = 0.50$ and $\alpha_0 = \alpha_-$. For this case the expressions linear in ΔI=3/2 A- and B-wave amplitudes are[4]

$$\Delta\alpha = 1.38\,(A_3/A_1) - 1.38\,(B_3/B_1),$$
$$\Delta\Gamma = -1.44\,(A_3/A_1) - 0.06\,(B_3/B_1).$$

From the Stable Particle Table,

$$\Delta\alpha = 0.12\pm0.21, \quad \Delta\Gamma = 0.058\pm0.024,$$

and we find

$$(A_3/A_1) = -0.035\pm0.017$$

and

$$(B_3/B_1) = -0.13\pm0.15.$$

(c) Σ Decay

The traditional test of the ΔI=1/2 rule in Σ decay is that the amplitudes satisfy the relationship

$$\sqrt{2}\,\Sigma^+_0 + \Sigma^+_+ - \Sigma^-_- = 0\ .$$

Graphically this is equivalent to closing the Σ triangle when the amplitudes are plotted on A, B axes. Including ΔI≥3/2 amplitudes in Σ decay analysis, the "Σ triangle" relationship becomes

$$\sqrt{2}\,A_0 + A_+ - A_- = -3\sqrt{2/5}\,A_3 + \frac{2}{\sqrt{15}}\,A_5\ ,$$

where A_3 and A_5 are ΔI=3/2 and ΔI=5/2 amplitudes, respectively. There is a similar equation for the B amplitudes. From Table I,

$$\sqrt{2}A_0 + A_+ - A_- = 0.22\pm0.09$$

and

$$\sqrt{2}B_0 + B_+ - B_- = 2.7 \pm 1.1 \ .$$

If we neglect the $\Delta I=5/2$ amplitudes and assume all amplitudes to be real we can solve for possible $\Delta I=3/2$ amplitudes. The result is

$$\frac{A_3}{A_-} = -0.060 \pm 0.026$$

and

$$\frac{B_3}{B_+} = -0.074 \pm 0.030 \ .$$

Thus for hyperon decay, present experimental data limit $\Delta I=3/2$ amplitudes to less than about 5%.

3. The Lee–Sugawara Relation

From Table I the Lee–Sugawara relation,[7,8] $\sqrt{3}\Sigma_0^+ + \Lambda_-^0 - 2\Xi_-^- = 0$, is satisfied to -0.05 ± 0.12 for the A amplitudes, and to 2.7 ± 2.0 for the B amplitudes.

References

1. J. P. Berge, in Proceedings of the 13th International Conference on High-Energy Physics, Berkeley, (1966) (University of California Press, Berkeley, 1967), p. 46.
2. N. P. Samios, International Conference on Weak Interactions, Argonne, (1965), p. 189.
3. J. D. Jackson, private communication (1973).
4. See O. E. Overseth and S. Pakvasa, Phys. Rev. 184, 1663 (1969). The expression for Γ_0/Γ_- for Λ decay should read

$$\frac{\Gamma_0}{\Gamma_-} \approx \frac{1}{2}\left\{1+3\sqrt{2} \times \left[\frac{S_{11}S_{33}\cos(\delta_1-\delta_3)+P_{11}P_{33}\cos(\delta_{11}-\delta_{31})}{S_{11}^2+P_{11}^2}\right]\right\} .$$

5. See A. A. Belavin and I. M. Narodetsky, Yadern. Fiz. 8, 978 (1968) [Soviet J. Nucl. Phys. 8, 568 (1969)].
6. G. W. Intemann, private communication (1973).
7. See B. W. Lee, Phys. Rev. Lett. 12, 83 (1964).
8. See H. Sugawara, Prog. Theor. Phys. 31, 213 (1964).

Appendix IV

GROWTH OF INFORMATION

From time to time we have presented figures demonstrating the amount of experimental work which has gone into spectroscopy, and the amount of new information available as a result. The 1976 versions of these figures are shown as Figs. 1, 2, and 3.

Figure 1 is a simple count of the number of meson resonances listed in the Tables, categorized as those "understood" -- i.e., all quantum numbers are believed known -- and those simply "listed". For the 1976 edition, there is an increase in both of these categories because of the discovery of the J/ψ and related particles.

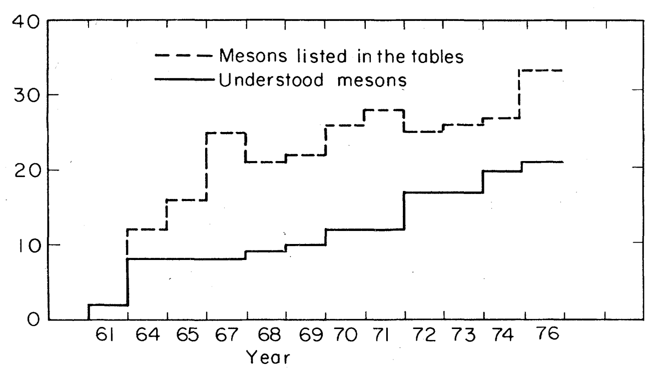

Fig. 1. Number of meson resonances listed in the Tables (dashed line) and those for which all quantum numbers are known (solid line), as a function of year of publication of the Review of Particle Properties. Note abscissa omits years in which no publication occurred.

In Figure 2 we present similar information for the baryon resonances, but concentrating here on the "growth of understanding". That is, the number of known baryons (we include for this figure only those with known J^P) has grown only very slowly with time (dashed line); the real progress has been in the measurement of the properties of those baryons. Therefore we show as the solid curve a count of the number of baryonic properties -- mass, width, and branching ratios. Most of these results are from partial-wave analyses.

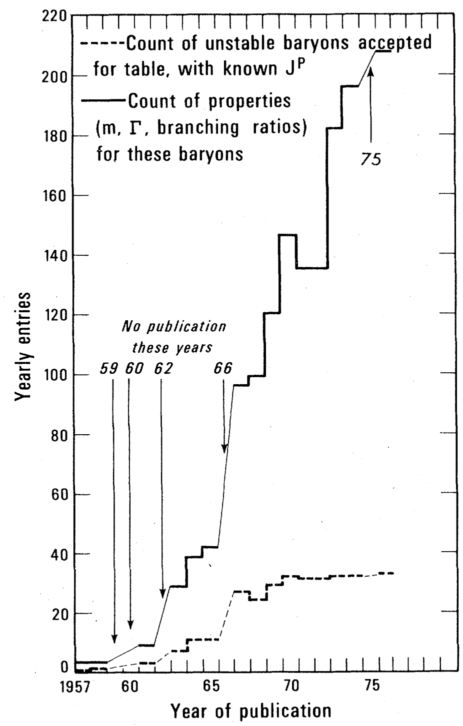

Fig. 2. Total amount of information (mass + width + branching ratios) on baryon resonances listed in the Tables, restricted to those with well-established J^P (solid line). Dashed line shows numbers of such resonances listed. Abscissa shows year of publication of Review of Particle Properties.

Finally, in Figure 3 we show a count of the number of new results put in the Listings each year, shown according to the type of detector that was used in obtaining the result, and according to the type of particle. N^* and Z^* particles have been omitted from this figure, because for these we use mainly the results of partial-wave analyses, rather than the primary data.

The fall in productivity in recent years doubtless reflects the tight budget situation and the declining emphasis on spectroscopy. Intense activity on the J/ψ and related particles is evident in the curve for meson resonances.

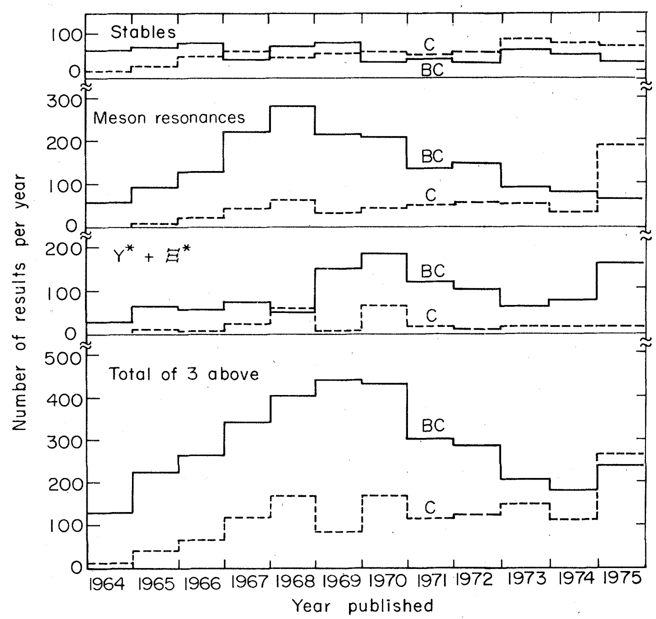

Fig. 3. The rate of production of data on particle properties, as a function of year of publication of the original result, based on data cards added to the Listings. Solid line shows bubble chamber results, dashed line counter or other electronic systems results.