

$\Lambda(1520) \ 3/2^-$  $I(J^P) = 0(\frac{3}{2}^-)$  Status: \*\*\*\*

Discovered by FERRO-LUZZI 62; the elaboration in WATSON 63 is the classic paper on the Breit-Wigner analysis of a multichannel resonance.

The measurements of the mass, width, and elasticity published before 1975 are now obsolete and have been omitted. They were last listed in our 1982 edition Physics Letters **111B** 1 (1982).

Production and formation experiments agree quite well, so they are listed together here.

### $\Lambda(1520)$ POLE POSITION

#### REAL PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>1517 to 1518 (<math>\approx 1517.5</math>) OUR ESTIMATE</b>			
<b>1517.5<math>\pm</math>0.4 OUR AVERAGE</b>			
1517.5 $\pm$ 0.4	SARANTSEV 19	DPWA	$\bar{K}N$ multichannel
1517 $\begin{smallmatrix} +4 \\ -4 \end{smallmatrix}$	<sup>1</sup> KAMANO 15	DPWA	$\bar{K}N$ multichannel
••• We do not use the following data for averages, fits, limits, etc. •••			
1518	ZHANG 13A	DPWA	$\bar{K}N$ multichannel
1518.8	QIANG 10	SPEC	$e p \rightarrow e' K^+ X$ (fit to X)
<sup>1</sup> From the preferred solution A in KAMANO 15.			

#### –2×IMAGINARY PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>14 to 18 (<math>\approx 16</math>) OUR ESTIMATE</b>			
<b>15.3<math>\pm</math> 0.9 OUR AVERAGE</b>			
15.3 $\pm$ 0.9	SARANTSEV 19	DPWA	$\bar{K}N$ multichannel
15 $\begin{smallmatrix} +10 \\ -8 \end{smallmatrix}$	<sup>1</sup> KAMANO 15	DPWA	$\bar{K}N$ multichannel
••• We do not use the following data for averages, fits, limits, etc. •••			
16	ZHANG 13A	DPWA	$\bar{K}N$ multichannel
17.2	QIANG 10	SPEC	$e p \rightarrow e' K^+ X$ (fit to X)
<sup>1</sup> From the preferred solution A in KAMANO 15.			

### $\Lambda(1520)$ POLE RESIDUES

The normalized residue is the residue divided by  $\Gamma_{pole}/2$ .

#### Normalized residue in $N\bar{K} \rightarrow \Lambda(1520) \rightarrow N\bar{K}$

<u>MODULUS</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.45 <math>\pm</math> 0.01</b>	<b>–10 <math>\pm</math> 3</b>	SARANTSEV 19	DPWA	$\bar{K}N$ multichannel
••• We do not use the following data for averages, fits, limits, etc. •••				
0.431	–11	<sup>1</sup> KAMANO 15	DPWA	$\bar{K}N$ multichannel
<sup>1</sup> From the preferred solution A in KAMANO 15.				

### Normalized residue in $N\bar{K} \rightarrow \Lambda(1520) \rightarrow \Sigma\pi$

<u>MODULUS</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.44 ± 0.01</b>	<b>-15 ± 3</b>	SARANTSEV 19	DPWA	$\bar{K}N$ multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.435	-10	<sup>1</sup> KAMANO 15	DPWA	$\bar{K}N$ multichannel

<sup>1</sup>From the preferred solution A in KAMANO 15.

### Normalized residue in $N\bar{K} \rightarrow \Lambda(1520) \rightarrow \Lambda\eta$

<u>MODULUS</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.013 ± 0.003</b>	<b>116 ± 3</b>	SARANTSEV 19	DPWA	$\bar{K}N$ multichannel

### Normalized residue in $N\bar{K} \rightarrow \Lambda(1520) \rightarrow \Sigma(1385)\pi$ , S-wave

<u>MODULUS</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.431	-123	<sup>1</sup> KAMANO 15	DPWA	$\bar{K}N$ multichannel

<sup>1</sup>From the preferred solution A in KAMANO 15.

### Normalized residue in $N\bar{K} \rightarrow \Lambda(1520) \rightarrow \Sigma(1385)\pi$ , D-wave

<u>MODULUS</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.0141	122	<sup>1</sup> KAMANO 15	DPWA	$\bar{K}N$ multichannel

<sup>1</sup>From the preferred solution A in KAMANO 15.

## $\Lambda(1520)$ MASS

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>1518 to 1520 (<math>\approx</math> 1519) OUR ESTIMATE</b>				
<b>1519.42 ± 0.19 OUR AVERAGE</b> Error includes scale factor of 1.1.				
1518.5 ± 0.5		SARANTSEV 19	DPWA	$\bar{K}N$ multichannel
1519.6 ± 0.5		ZHANG 13A	DPWA	$\bar{K}N$ multichannel
1520.4 ± 0.6 ± 1.5		QIANG 10	SPEC	$e p \rightarrow e' K^+ X$ (fit to X)
1517.3 ± 1.5	300	BARBER 80D	SPEC	$\gamma p \rightarrow \Lambda(1520) K^+$
1517.8 ± 1.2	5k	BARLAG 79	HBC	$K^- p$ 4.2 GeV/c
1520.0 ± 0.5		ALSTON-... 78	DPWA	$\bar{K}N \rightarrow \bar{K}N$
1519.7 ± 0.3	4k	CAMERON 77	HBC	$K^- p$ 0.96–1.36 GeV/c
1519 ± 1		GOPAL 77	DPWA	$\bar{K}N$ multichannel
1519.4 ± 0.3	2000	CORDEN 75	DBC	$K^- d$ 1.4–1.8 GeV/c

## $\Lambda(1520)$ WIDTH

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>15 to 17 (<math>\approx</math> 16) OUR ESTIMATE</b>				
<b>15.73 ± 0.26 OUR AVERAGE</b>				
15.7 ± 1.0		SARANTSEV 19	DPWA	$\bar{K}N$ multichannel
17 ± 1		ZHANG 13A	DPWA	$\bar{K}N$ multichannel
18.6 ± 1.9 ± 1.0		QIANG 10	SPEC	$e p \rightarrow e' K^+ X$ (fit to X)
16.3 ± 3.3	300	BARBER 80D	SPEC	$\gamma p \rightarrow \Lambda(1520) K^+$
16 ± 1		GOPAL 80	DPWA	$\bar{K}N \rightarrow \bar{K}N$

14 ±3	677	<sup>1</sup> BARLAG	79	HBC	$K^- p$ 4.2 GeV/c
15.4 ±0.5		ALSTON-...	78	DPWA	$\bar{K} N \rightarrow \bar{K} N$
16.3 ±0.5	4k	CAMERON	77	HBC	$K^- p$ 0.96–1.36 GeV/c
15.0 ±0.5		GOPAL	77	DPWA	$\bar{K} N$ multichannel
15.5 ±1.6	2000	CORDEN	75	DBC	$K^- d$ 1.4–1.8 GeV/c

<sup>1</sup>From the best-resolution sample of  $\Lambda\pi\pi$  events only.

### $\Lambda(1520)$ DECAY MODES

Mode	Fraction ( $\Gamma_i/\Gamma$ )
$\Gamma_1$ $N\bar{K}$	(45 ±1 ) %
$\Gamma_2$ $\Sigma\pi$	(42 ±1 ) %
$\Gamma_3$ $\Lambda\pi\pi$	(10 ±1 ) %
$\Gamma_4$ $\Sigma(1385)\pi$ , S-wave	
$\Gamma_5$ $\Sigma(1385)\pi$ , D-wave	
$\Gamma_6$ $\Sigma(1385)\pi$	
$\Gamma_7$ $\Sigma(1385)\pi (\rightarrow \Lambda\pi\pi)$	
$\Gamma_8$ $\Lambda(\pi\pi)$ S-wave	
$\Gamma_9$ $\Sigma\pi\pi$	( 0.9 ±0.1 ) %
$\Gamma_{10}$ $\Lambda\gamma$	( 0.85±0.15 ) %
$\Gamma_{11}$ $\Sigma^0\gamma$	

### $\Lambda(1520)$ BRANCHING RATIOS

See “Sign conventions for resonance couplings” in the Note on  $\Lambda$  and  $\Sigma$  Resonances.

$\Gamma(N\bar{K})/\Gamma_{\text{total}}$				$\Gamma_1/\Gamma$
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>0.45 to 0.47 OUR ESTIMATE</b>				
0.45 ±0.01	SARANTSEV 19	DPWA	$\bar{K} N$ multichannel	
0.47 ±0.04	ZHANG 13A	DPWA	$\bar{K} N$ multichannel	
0.47 ±0.02	GOPAL 80	DPWA	$\bar{K} N \rightarrow \bar{K} N$	
0.45 ±0.03	ALSTON-... 78	DPWA	$\bar{K} N \rightarrow \bar{K} N$	
0.448±0.014	CORDEN 75	DBC	$K^- d$ 1.4–1.8 GeV/c	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
0.43	<sup>1</sup> KAMANO 15	DPWA	$\bar{K} N$ multichannel	
0.47 ±0.01	GOPAL 77	DPWA	See GOPAL 80	
0.42	MAST 76	HBC	$K^- p \rightarrow \bar{K}^0 n$	

<sup>1</sup>From the preferred solution A in KAMANO 15.

$\Gamma(\Sigma\pi)/\Gamma_{\text{total}}$   $\Gamma_2/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.42 to 0.46 OUR ESTIMATE</b>			
0.43 ± 0.01	SARANTSEV 19	DPWA	$\bar{K}N$ multichannel
0.47 ± 0.05	ZHANG 13A	DPWA	$\bar{K}N$ multichannel
0.426 ± 0.014	CORDEN 75	DBC	$K^- d$ 1.4–1.8 GeV/c
0.418 ± 0.017	BARBARO-...	69B HBC	$K^- p$ 0.28–0.45 GeV/c
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.446	<sup>1</sup> KAMANO 15	DPWA	$\bar{K}N$ multichannel
0.46	KIM 71	DPWA	K-matrix analysis

<sup>1</sup> From the preferred solution A in KAMANO 15.

$\Gamma(\Sigma\pi)/\Gamma(N\bar{K})$   $\Gamma_2/\Gamma_1$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.9 to 1.0 OUR ESTIMATE</b>			
0.98 ± 0.03	<sup>1</sup> GOPAL 77	DPWA	$\bar{K}N$ multichannel
0.82 ± 0.08	BURKHARDT 69	HBC	$K^- p$ 0.8–1.2 GeV/c
1.06 ± 0.14	SCHEUER 68	DBC	$K^- N$ 3 GeV/c
0.96 ± 0.20	DAHL 67	HBC	$\pi^- p$ 1.6–4 GeV/c
0.73 ± 0.11	DAUBER 67	HBC	$K^- p$ 2 GeV/c
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1.06 ± 0.12	BERTHON 74	HBC	Quasi-2-body $\sigma$
1.72 ± 0.78	MUSGRAVE 65	HBC	

<sup>1</sup> The  $\bar{K}N \rightarrow \Sigma\pi$  amplitude at resonance is  $+0.46 \pm 0.01$ .

$\Gamma(\Lambda\pi\pi)/\Gamma_{\text{total}}$   $\Gamma_3/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.09 to 0.11 OUR ESTIMATE</b>			
0.091 ± 0.006	CORDEN 75	DBC	$K^- d$ 1.4–1.8 GeV/c
0.11 ± 0.01	<sup>1</sup> MAST 73B	IPWA	$K^- p \rightarrow \Lambda\pi\pi$

<sup>1</sup> Assumes  $\Gamma(N\bar{K})/\Gamma_{\text{total}} = 0.46 \pm 0.02$ .

$\Gamma(\Lambda\pi\pi)/\Gamma(N\bar{K})$   $\Gamma_3/\Gamma_1$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.18 to 0.22 OUR ESTIMATE</b>			
0.22 ± 0.03	BURKHARDT 69	HBC	$K^- p$ 0.8–1.2 GeV/c
0.19 ± 0.04	SCHEUER 68	DBC	$K^- N$ 3 GeV/c
0.17 ± 0.05	DAHL 67	HBC	$\pi^- p$ 1.6–4 GeV/c
0.21 ± 0.18	DAUBER 67	HBC	$K^- p$ 2 GeV/c
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.27 ± 0.13	BERTHON 74	HBC	Quasi-2-body $\sigma$
0.2	KIM 71	DPWA	K-matrix analysis

$\Gamma(\Sigma\pi)/\Gamma(\Lambda\pi\pi)$   $\Gamma_2/\Gamma_3$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>3.4 to 4.4 OUR ESTIMATE</b>			
3.9 ± 1.0	UHLIG 67	HBC	$K^- p$ 0.9–1.0 GeV/c
3.3 ± 1.1	BIRMINGHAM 66	HBC	$K^- p$ 3.5 GeV/c
4.5 ± 1.0	ARMENTEROS65C	HBC	

$\Gamma(\Sigma(1385)\pi, S\text{-wave})/\Gamma_{\text{total}}$   $\Gamma_4/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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• • • We do not use the following data for averages, fits, limits, etc. • • •

0.121	<sup>1</sup> KAMANO	15	DPWA $\bar{K}N$ multichannel
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<sup>1</sup> From the preferred solution A in KAMANO 15.

$\Gamma(\Sigma(1385)\pi, D\text{-wave})/\Gamma_{\text{total}}$   $\Gamma_5/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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• • • We do not use the following data for averages, fits, limits, etc. • • •

0.003	<sup>1</sup> KAMANO	15	DPWA Multichannel
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<sup>1</sup> From the preferred solution A in KAMANO 15.

$\Gamma(\Sigma(1385)\pi)/\Gamma_{\text{total}}$   $\Gamma_6/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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<b>0.041 ± 0.005</b>	CHAN	72	HBC $K^- p \rightarrow \Lambda\pi\pi$
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$\Gamma(\Sigma(1385)\pi(\rightarrow \Lambda\pi\pi))/\Gamma(\Lambda\pi\pi)$   $\Gamma_7/\Gamma_3$

The  $\Lambda\pi\pi$  mode is largely due to  $\Sigma(1385)\pi$ . Only the values of  $(\Sigma(1385)\pi) / (\Lambda\pi\pi)$  given by MAST 73B and CORDEN 75 are based on real 3-body partial-wave analyses. The discrepancy between the two results is essentially due to the different hypotheses made concerning the shape of the  $(\pi\pi)_{S\text{-wave}}$  state.

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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0.58 ± 0.22		CORDEN	75	DBC $K^- d$ 1.4–1.8 GeV/c
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0.82 ± 0.10		<sup>1</sup> MAST	73B	IPWA $K^- p \rightarrow \Lambda\pi\pi$
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• • • We do not use the following data for averages, fits, limits, etc. • • •

$<0.44$	90	WIELAND	11	SPHR $\gamma p \rightarrow K^+ \Lambda(1520)$
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0.39 ± 0.10		<sup>2</sup> BURKHARDT	71	HBC $K^- p \rightarrow (\Lambda\pi\pi)\pi$
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<sup>1</sup> Both  $\Sigma(1385)\pi DS_{03}$  and  $\Sigma(\pi\pi) DP_{03}$  contribute.

<sup>2</sup> The central bin (1514–1524 MeV) gives  $0.74 \pm 0.10$ ; other bins are lower by 2-to-5 standard deviations.

$\Gamma(\Lambda(\pi\pi)_{S\text{-wave}})/\Gamma(\Lambda\pi\pi)$   $\Gamma_8/\Gamma_3$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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<b>0.20 ± 0.08</b>	CORDEN	75	DBC $K^- d$ 1.4–1.8 GeV/c
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$\Gamma(\Sigma\pi\pi)/\Gamma_{\text{total}}$   $\Gamma_9/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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**0.007 to 0.011 OUR ESTIMATE**

0.007 ± 0.002	<sup>1</sup> CORDEN	75	DBC $K^- d$ 1.4–1.8 GeV/c
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0.0085 ± 0.0006	<sup>2</sup> MAST	73	MPWA $K^- p \rightarrow \Sigma\pi\pi$
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0.010 ± 0.0015	BARBARO-...	69B	HBC $K^- p$ 0.28–0.45 GeV/c
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<sup>1</sup> Much of the  $\Sigma\pi\pi$  decay proceeds via  $\Sigma(1385)\pi$ .

<sup>2</sup> Assumes  $\Gamma(N\bar{K})/\Gamma_{\text{total}} = 0.46$ .

$\Gamma(\Lambda\gamma)/\Gamma_{\text{total}}$					$\Gamma_{10}/\Gamma$
VALUE (units $10^{-3}$ )	EVTS	DOCUMENT ID	TECN	COMMENT	
<b>7 to 11 OUR ESTIMATE</b>					
$10.7 \pm 2.9^{+1.5}_{-0.4}$	32	TAYLOR	05 CLAS	$\gamma p \rightarrow K^+ \Lambda\gamma$	
$10.2 \pm 2.1 \pm 1.5$	290	ANTIPOV	04A SPNX	$p N(C) \rightarrow \Lambda(1520) K^+ N(C)$	
$8.0 \pm 1.4$	238	MAST	68B HBC	Using $\Gamma(N\bar{K})/\Gamma_{\text{total}} = 0.45$	

$\Gamma(\Sigma^0\gamma)/\Gamma_{\text{total}}$					$\Gamma_{11}/\Gamma$
VALUE		DOCUMENT ID	TECN	COMMENT	
<b><math>0.02 \pm 0.0035</math></b>		<sup>1</sup> MAST	68B HBC	Not measured; see note	

<sup>1</sup> Calculated from  $\Gamma(\Lambda\gamma)/\Gamma_{\text{total}}$ , assuming SU(3). Needed to constrain the sum of all the branching ratios to be unity.

### $\Lambda(1520)$ REFERENCES

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KAMANO	15	PR C92 025205	H. Kamano <i>et al.</i>	(ANL, OSAK)
ZHANG	13A	PR C88 035205	H. Zhang <i>et al.</i>	(KSU)
WIELAND	11	EPJ A47 47	F. Wieland <i>et al.</i>	(ELSA SAPHIR Collab.)
QIANG	10	PL B694 123	Y. Qiang <i>et al.</i>	(DUKE, JEFF, PNPI, GWU+)
TAYLOR	05	PR C71 054609	S. Taylor <i>et al.</i>	(JLab CLAS Collab.)
Also		PR C72 039902 (errat.)	S. Taylor <i>et al.</i>	(JLab CLAS Collab.)
ANTIPOV	04A	PL B604 22	Yu.M. Antipov <i>et al.</i>	(IHEP SPHINX Collab.)
PDG	82	PL 111B 1	M. Roos <i>et al.</i>	(HELS, CIT, CERN)
BARBER	80D	ZPHY C7 17	D.P. Barber <i>et al.</i>	(DARE, LANC, SHEF)
GOPAL	80	Toronto Conf. 159	G.P. Gopal	(RHEL) IJP
BARLAG	79	NP B149 220	S.J.M. Barlag <i>et al.</i>	(AMST, CERN, NIJM+)
ALSTON-...	78	PR D18 182	M. Alston-Garnjost <i>et al.</i>	(LBL, MTHO+) IJP
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GOPAL	77	NP B119 362	G.P. Gopal <i>et al.</i>	(LOIC, RHEL) IJP
MAST	76	PR D14 13	T.S. Mast <i>et al.</i>	(LBL)
CORDEN	75	NP B84 306	M.J. Corden <i>et al.</i>	(BIRM)
BERTHON	74	NC 21A 146	A. Berthon <i>et al.</i>	(CDEF, RHEL, SACL+)
MAST	73	PR D7 3212	T.S. Mast <i>et al.</i>	(LBL) IJP
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CHAN	72	PRL 28 256	S.B. Chan <i>et al.</i>	(MASA, YALE)
BURKHARDT	71	NP B27 64	E. Burkhardt <i>et al.</i>	(HEID, CERN, SACL)
KIM	71	PRL 27 356	J.K. Kim	(HARV) IJP
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BARBARO-...	69B	Lund Conf. 352	A. Barbaro-Galtieri <i>et al.</i>	(LRL)
Also		Duke Conf. 95	R.D. Tripp	(LRL)
Hyperon Resonances 1970				
BURKHARDT	69	NP B14 106	E. Burkhardt <i>et al.</i>	(HEID, EFI, CERN+)
MAST	68B	PRL 21 1715	T.S. Mast <i>et al.</i>	(LRL)
SCHEUER	68	NP B8 503	J.C. Scheuer <i>et al.</i>	(SABRE Collab.)
DAHL	67	PR 163 1377	O.I. Dahl <i>et al.</i>	(LRL)
DAUBER	67	PL 24B 525	P.M. Dauber <i>et al.</i>	(UCLA)
UHLIG	67	PR 155 1448	R.P. Uhlig <i>et al.</i>	(UMD, NRL)
BIRMINGHAM	66	PR 152 1148	M. Haque <i>et al.</i>	(BIRM, GLAS, LOIC, OXF+)
ARMENTEROS	65C	PL 19 338	R. Armenteros <i>et al.</i>	(CERN, HEID, SACL)
MUSGRAVE	65	NC 35 735	B. Musgrave <i>et al.</i>	(BIRM, CERN, EPOL+)
WATSON	63	PR 131 2248	M.B. Watson, M. Ferro-Luzzi, R.D. Tripp	(LRL) IJP
FERRO-LUZZI	62	PRL 8 28	M. Ferro-Luzzi, R.D. Tripp, M.B. Watson	(LRL) IJP