$N(1875)\ 3/2^-$

$I(J^P) = \frac{1}{2}(\frac{3}{2}^-)$ Status: ∗∗∗

Before the 2012 *Review*, all the evidence for a $J^P = 3/2^-$ state with a mass above 1800 MeV was filed under a two-star $N(2080)$. There is now evidence from ANISOVICH 12A for two $3/2^-$ states in this region, so we have split the older data (according to mass) between a three-star $N(1875)$ and a two-star $N(2120)$.

The latest GWU analysis (ARNDT 06) finds no evidence for this resonance.

$N(1875)$ BREIT-WIGNER MASS

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1820 to 1920 (≈ 1875) OUR ESTIMATE				
1934± 10	SHKLYAR	13	DPWA	Multichannel
1880± 20	ANISOVICH	12A	DPWA	Multichannel
1920	BELL	83	DPWA	$\pi^- p \rightarrow \Lambda K^0$
1880±100	[1] CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
1900	SAXON	80	DPWA	$\pi^- p \rightarrow \Lambda K^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1951± 27	SHRESTHA	12A	DPWA	Multichannel
2048± 65	BATINIC	10	DPWA	$\pi N \rightarrow N\pi$, $N\eta$
1946± 1	PENNER	02C	DPWA	Multichannel
1895	MART	00	DPWA	$\gamma p \rightarrow \Lambda K^+$
2003± 18	VRANA	00	DPWA	Multichannel
1804± 55	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
1880	BAKER	79	DPWA	$\pi^- p \rightarrow n\eta$

$N(1875)$ BREIT-WIGNER WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
250± 70 OUR ESTIMATE				
857±100	SHKLYAR	13	DPWA	Multichannel
200± 25	ANISOVICH	12A	DPWA	Multichannel
320	BELL	83	DPWA	$\pi^- p \rightarrow \Lambda K^0$
180± 60	[1] CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$ (lower m)
240	SAXON	80	DPWA	$\pi^- p \rightarrow \Lambda K^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
500± 45	SHRESTHA	12A	DPWA	Multichannel
529±128	BATINIC	10	DPWA	$\pi N \rightarrow N\pi$, $N\eta$
859± 7	PENNER	02C	DPWA	Multichannel
372	MART	00	DPWA	$\gamma p \rightarrow \Lambda K^+$
1070±858	VRANA	00	DPWA	Multichannel
450±185	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
87	BAKER	79	DPWA	$\pi^- p \rightarrow n\eta$

N(1875) POLE POSITION

REAL PART

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1800 to 1950 OUR ESTIMATE				
2094± 7±11	[2] SVARC	14	MLS	$\pi N \rightarrow \pi N$
1860± 25	ANISOVICH	12A	DPWA	Multichannel
1880±100	[1] CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$ (lower m)
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1810	SHKLYAR	13	DPWA	Multichannel
1975	SHRESTHA	12A	DPWA	Multichannel
1957± 49	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
1824	VRANA	00	DPWA	Multichannel
not seen	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

−2×IMAGINARY PART

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
150 to 250 OUR ESTIMATE				
296± 15±4	[2] SVARC	14	MLS	$\pi N \rightarrow \pi N$
200± 20	ANISOVICH	12A	DPWA	Multichannel
160± 80	[1] CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$ (lower m)
• • • We do not use the following data for averages, fits, limits, etc. • • •				
98	SHKLYAR	13	DPWA	Multichannel
495	SHRESTHA	12A	DPWA	Multichannel
467±106	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
614	VRANA	00	DPWA	Multichannel
not seen	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

N(1875) ELASTIC POLE RESIDUE

MODULUS |r|

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
2 to 10 OUR ESTIMATE				
13 ±1 ±1	[2] SVARC	14	MLS	$\pi N \rightarrow \pi N$
2.5±1.0	ANISOVICH	12A	DPWA	Multichannel
10 ±5	[1] CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$ (lower m)
• • • We do not use the following data for averages, fits, limits, etc. • • •				
3	SHKLYAR	13	DPWA	Multichannel
53	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$

PHASE θ

VALUE (°)	DOCUMENT ID		TECN	COMMENT
− 2± 4±9	[2] SVARC	14	MLS	$\pi N \rightarrow \pi N$
100±80	[1] CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$ (lower m)
• • • We do not use the following data for averages, fits, limits, etc. • • •				
− 76	SHKLYAR	13	DPWA	Multichannel
− 65	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$

$N(1875)$ INELASTIC POLE RESIDUE

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

Normalized residue in $N\pi \to N(1875) \to \Lambda K$

MODULUS (%)	DOCUMENT ID		TECN	COMMENT
1.5±0.5	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \to N(1875) \to \Sigma K$

MODULUS (%)	DOCUMENT ID		TECN	COMMENT
4±2	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \to N(1875) \to N\sigma$

MODULUS (%)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
8±3	**−170 ± 65**	ANISOVICH	12A	DPWA	Multichannel

$N(1875)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Scale factor
Γ_1	$N\pi$	(7 ± 6) %	
Γ_2	$N\eta$	(1.2± 1.8) %	2.3
Γ_3	$N\omega$	(20 ± 4) %	
Γ_4	ΛK		
Γ_5	ΣK	(7 ± 4) $\times 10^{-3}$	
Γ_6	$N\pi\pi$		
Γ_7	$\Delta(1232)\pi$, S-wave	(40 ±10) %	
Γ_8	$\Delta(1232)\pi$, D-wave	(17 ±10) %	
Γ_9	$N\rho$, S=3/2, S-wave	(6 ± 6) %	
Γ_{10}	$N(\pi\pi)^{I=0}_{S\text{-wave}}$	(24 ±24) %	
Γ_{11}	$n\gamma$, helicity=1/2		
Γ_{12}	$n\gamma$, helicity=3/2		
Γ_{13}	$p\gamma$	0.008–0.016 %	
Γ_{14}	$p\gamma$, helicity=1/2	0.006–0.010 %	
Γ_{15}	$p\gamma$, helicity=3/2	0.002–0.006 %	

$N(1875)$ BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{total}$ — Γ_1/Γ

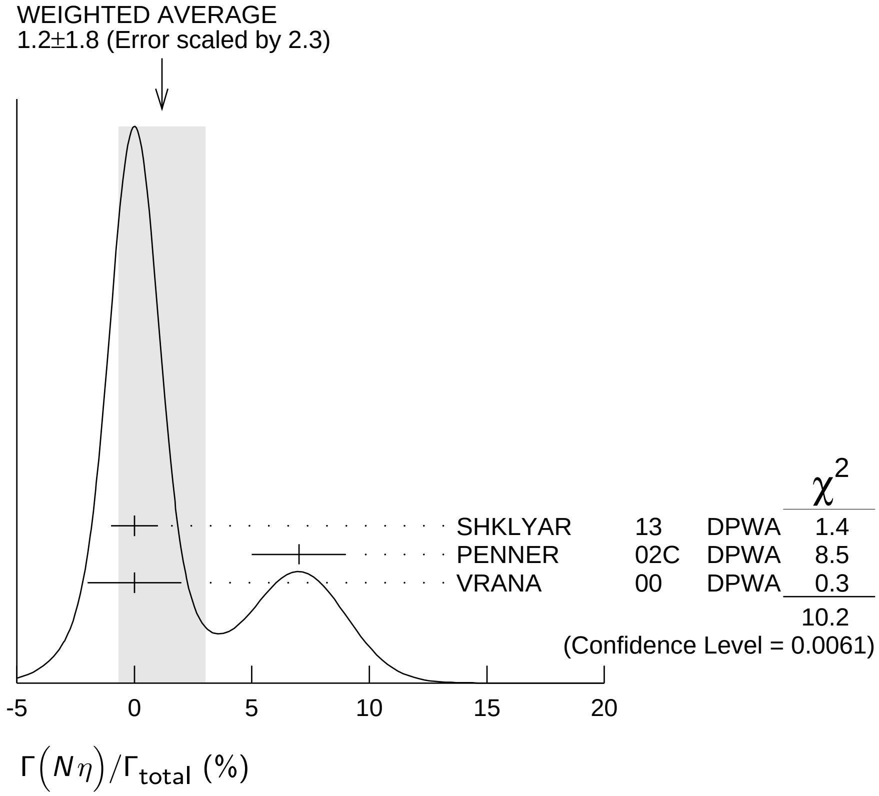
VALUE (%)	DOCUMENT ID		TECN	COMMENT
7±6 OUR ESTIMATE				
11±1	SHKLYAR	13	DPWA	Multichannel
3±2	ANISOVICH	12A	DPWA	Multichannel
10±4	[1] CUTKOSKY	80	IPWA	$\pi N \to \pi N$ (lower m)

• • • We do not use the following data for averages, fits, limits, etc. • • •

7±2	SHRESTHA	12A	DPWA	Multichannel
17±7	BATINIC	10	DPWA	$\pi N \rightarrow N\pi$, $N\eta$
12±2	PENNER	02C	DPWA	Multichannel
13±3	VRANA	00	DPWA	Multichannel
23±3	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$

$\Gamma(N\eta)/\Gamma_{total}$ — Γ_2/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
1.2±1.8 OUR AVERAGE	Error includes scale factor of 2.3. See the ideogram below.			
0 ±1	SHKLYAR	13	DPWA	Multichannel
7 ±2	PENNER	02C	DPWA	Multichannel
0 ±2	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
8 ±3	BATINIC	10	DPWA	$\pi N \rightarrow N\pi$, $N\eta$



$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \rightarrow N(1875) \rightarrow N\eta$ — $(\Gamma_1\Gamma_2)^{1/2}/\Gamma$

VALUE (%)	DOCUMENT ID		TECN	COMMENT
6 ±4 OUR ESTIMATE				
5 ±2	ANISOVICH	12A	DPWA	Multichannel
6.5	BAKER	79	DPWA	$\pi^- p \rightarrow n\eta$

$\Gamma(N\omega)/\Gamma_{total}$ — Γ_3/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
20±4 OUR AVERAGE				
20±5	SHKLYAR	13	DPWA	Multichannel
21±7	PENNER	02C	DPWA	Multichannel

$\Gamma(\Lambda K)/\Gamma_{total}$ — Γ_4/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.2±0.2	PENNER	02C	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \rightarrow N(1875) \rightarrow \Lambda K$ — $(\Gamma_1\Gamma_4)^{1/2}/\Gamma$

VALUE (%)	DOCUMENT ID		TECN	COMMENT
4±2 OUR ESTIMATE				
4±2	ANISOVICH	12A	DPWA	Multichannel
4	BELL	83	DPWA	$\pi^- p \rightarrow \Lambda K^0$
3	SAXON	80	DPWA	$\pi^- p \rightarrow \Lambda K^0$

$\Gamma(\Sigma K)/\Gamma_{total}$ — Γ_5/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
0.7±0.4	PENNER	02C	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \rightarrow N(1875) \rightarrow \Sigma K$ — $(\Gamma_1\Gamma_5)^{1/2}/\Gamma$

VALUE (%)	DOCUMENT ID		TECN	COMMENT
1 to 10 OUR ESTIMATE				
15 ±8	ANISOVICH	12A	DPWA	Multichannel
1.4 to 3.7	[3] DEANS	75	DPWA	$\pi N \rightarrow \Sigma K$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \rightarrow N(1875) \rightarrow \Delta(1232)\pi$, S-wave — $(\Gamma_1\Gamma_7)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.09±0.09	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$

$\Gamma(\Delta(1232)\pi$, S-wave$)/\Gamma_{total}$ — Γ_7/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
40±10	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
87± 3	SHRESTHA	12A	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \rightarrow N(1875) \rightarrow \Delta(1232)\pi$, D-wave — $(\Gamma_1\Gamma_8)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
+0.22±0.07	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$

$\Gamma(\Delta(1232)\pi, D\text{-wave})/\Gamma_{total}$ Γ_8/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
17±10	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
< 6	SHRESTHA	12A	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1875) \to N\rho$, S=3/2, S-wave $(\Gamma_1\Gamma_9)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.24±0.06	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

$\Gamma(N\rho, S=3/2, S\text{-wave})/\Gamma_{total}$ Γ_9/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
6±6	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<5	SHRESTHA	12A	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1875) \to N(\pi\pi)^{I=0}_{S\text{-wave}}$ $(\Gamma_1\Gamma_{10})^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
+0.25±0.06	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

$\Gamma(N(\pi\pi)^{I=0}_{S\text{-wave}})/\Gamma_{total}$ Γ_{10}/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
24±24	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
< 4	SHRESTHA	12A	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $p\gamma \to N(1875) \to N\eta$ $(\Gamma_{13}\Gamma_2)^{1/2}/\Gamma$

VALUE (%)	DOCUMENT ID		TECN	COMMENT
60 ±12	ANISOVICH	12A	DPWA	Multichannel
0.37	HICKS	73	MPWA	$\gamma p \to p\eta$

N(1875) PHOTON DECAY AMPLITUDES

Papers on γN amplitudes predating 1981 may be found in our 2006 edition, Journal of Physics **G33** 1 (2006).

$N(1875) \to p\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
0.018±0.010	ANISOVICH	12A	DPWA	Multichannel
−0.020±0.008	AWAJI	81	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.011±0.001	SHKLYAR	13	DPWA	Multichannel
0.007±0.008	SHRESTHA	12A	DPWA	Multichannel
0.012	PENNER	02D	DPWA	Multichannel
0.026±0.052	DEVENISH	74	DPWA	$\gamma N \to \pi N$

$N(1875) \to p\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
-0.009 ± 0.005	ANISOVICH	12A	DPWA	Multichannel
0.017 ± 0.011	AWAJI	81	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.026 ± 0.001	SHKLYAR	13	DPWA	Multichannel
0.043 ± 0.022	SHRESTHA	12A	DPWA	Multichannel
-0.010	PENNER	02D	DPWA	Multichannel
0.128 ± 0.057	DEVENISH	74	DPWA	$\gamma N \to \pi N$

$N(1875) \to n\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
0.010 ± 0.010 OUR ESTIMATE				
0.010 ± 0.006	ANISOVICH	13B	DPWA	Multichannel
0.007 ± 0.013	AWAJI	81	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.055 ± 0.021	SHRESTHA	12A	DPWA	Multichannel
0.023	PENNER	02D	DPWA	Multichannel
0.053 ± 0.083	DEVENISH	74	DPWA	$\gamma N \to \pi N$

$N(1875) \to n\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
-0.020 ± 0.015 OUR ESTIMATE				
-0.020 ± 0.015	ANISOVICH	13B	DPWA	Multichannel
-0.053 ± 0.034	AWAJI	81	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-0.085 ± 0.031	SHRESTHA	12A	DPWA	Multichannel
-0.009	PENNER	02D	DPWA	Multichannel
0.100 ± 0.141	DEVENISH	74	DPWA	$\gamma N \to \pi N$

$N(1875)$ $\gamma p \to \Lambda K^+$ AMPLITUDES

$(\Gamma_i \Gamma_f)^{1/2}/\Gamma_{total}$ in $p\gamma \to N(1875) \to \Lambda K^+$ (E_{2-} amplitude)

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$2.29^{+0.7}_{-0.2}$	MART	00	DPWA	$\gamma p \to \Lambda K^+$
5.5 ± 0.3	WORKMAN	90	DPWA	
4.09	TANABE	89	DPWA	

$p\gamma \to N(1875) \to \Lambda K^+$ phase angle θ (E_{2-} amplitude)

VALUE (degrees)	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •			
-48 ± 5	WORKMAN	90	DPWA
-35.9	TANABE	89	DPWA

$(\Gamma_i \Gamma_f)^{1/2}/\Gamma_{total}$ in $p\gamma \to N(1875) \to \Lambda K^+$ (M_{2-} amplitude)

VALUE (units 10^{-3})	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •			
-6.7 ± 0.2	WORKMAN	90	DPWA
-4.09	TANABE	89	DPWA

N(1875) FOOTNOTES

[1] CUTKOSKY 80 finds a lower mass D_{13} resonance, as well as one in this region. Both are listed here.
[2] Fit to the amplitudes of HOEHLER 79.
[3] The range given for DEANS 75 is from the four best solutions. Disagrees with $\pi^+ p \to \Sigma^+ K^+$ data of WINNIK 77 around 1920 MeV.

N(1875) REFERENCES

For early references, see Physics Letters **111B** 1 (1982).

SVARC	14	PR C89 045205	A. Svarc *et al.*	
ANISOVICH	13B	EPJ A49 67	A.V. Anisovich *et al.*	
SHKLYAR	13	PR C87 015201	V. Shklyar, H. Lenske, U. Mosel	(GIES)
ANISOVICH	12A	EPJ A48 15	A.V. Anisovich *et al.*	(BONN, PNPI)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
BATINIC	10	PR C82 038203	M. Batinic *et al.*	(ZAGR)
ARNDT	06	PR C74 045205	R.A. Arndt *et al.*	(GWU)
PDG	06	JP G33 1	W.-M. Yao *et al.*	(PDG Collab.)
PENNER	02C	PR C66 055211	G. Penner, U. Mosel	(GIES)
PENNER	02D	PR C66 055212	G. Penner, U. Mosel	(GIES)
MART	00	PR C61 012201	T. Mart, C. Bennhold	
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman,, T.-S.H. Lee	(PITT+)
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KSA) IJP
Also		PR D30 904	D.M. Manley *et al.*	(VPI)
ARNDT	91	PR D43 2131	R.A. Arndt *et al.*	(VPI, TELE) IJP
WORKMAN	90	PR C42 781	R.L. Workman	(VPI)
TANABE	89	PR C39 741	H. Tanabe, M. Kohno, C. Bennhold	(MANZ)
Also		NC 102A 193	M. Kohno, H. Tanabe, C. Bennhold	(MANZ)
BELL	83	NP B222 389	K.W. Bell *et al.*	(RL) IJP
AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)
Also		NP B197 365	K. Fujii *et al.*	(NAGO)
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky *et al.*	(CMU, LBL) IJP
Also		PR D20 2839	R.E. Cutkosky *et al.*	(CMU, LBL) IJP
SAXON	80	NP B162 522	D.H. Saxon *et al.*	(RHEL, BRIS) IJP
BAKER	79	NP B156 93	R.D. Baker *et al.*	(RHEL) IJP
HOEHLER	79	PDAT 12-1	G. Hohler *et al.*	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP
WINNIK	77	NP B128 66	M. Winnik *et al.*	(HAIF) I
DEANS	75	NP B96 90	S.R. Deans *et al.*	(SFLA, ALAH) IJP
DEVENISH	74	PL 52B 227	R.C.E. Devenish, D.H. Lyth, W.A. Rankin	(DESY+) IJP
HICKS	73	PR D7 2614	H.R. Hicks *et al.*	(CMU, ORNL, SFLA) IJP