

$N(1710) \ 1/2^+$ $I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$ Status: ***

Most of the results published before 1975 were last included in our 1982 edition, *Physics Letters* **111B** 1 (1982). Some further obsolete results published before 1984 were last included in our 2006 edition, *Journal of Physics* (generic for all A,B,E,G) **G33** 1 (2006).

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

 $N(1710)$ BREIT-WIGNER MASS

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1680 to 1740 (\approx 1710) OUR ESTIMATE			
1737 \pm 17	SHKLYAR	13	DPWA Multichannel
1710 \pm 20	ANISOVICH	12A	DPWA Multichannel
1700 \pm 50	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
1723 \pm 9	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1662 \pm 7	SHRESTHA	12A	DPWA Multichannel
1725 \pm 25	ANISOVICH	10	DPWA Multichannel
1729 \pm 16	¹ BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
1752 \pm 3	PENNER	02C	DPWA Multichannel
1699 \pm 65	VRANA	00	DPWA Multichannel
1720 \pm 10	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
1717 \pm 28	MANLEY	92	IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$
1706	CUTKOSKY	90	IPWA $\pi N \rightarrow \pi N$
1730	SAXON	80	DPWA $\pi^- p \rightarrow \Lambda K^0$
1720	² LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$
1710	³ LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$

 $N(1710)$ BREIT-WIGNER WIDTH

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
50 to 250 (\approx 100) OUR ESTIMATE			
368 \pm 120	SHKLYAR	13	DPWA Multichannel
200 \pm 18	ANISOVICH	12A	DPWA Multichannel
93 \pm 30	CUTKOSKY	90	IPWA $\pi N \rightarrow \pi N$
90 \pm 30	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
120 \pm 15	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
116 \pm 17	SHRESTHA	12A	DPWA Multichannel
200 \pm 35	ANISOVICH	10	DPWA Multichannel
180 \pm 17	¹ BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
386 \pm 59	PENNER	02C	DPWA Multichannel
143 \pm 100	VRANA	00	DPWA Multichannel
105 \pm 10	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$

480 ± 230	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \text{ \& } N\pi\pi$
540	BELL	83	DPWA	$\pi^- p \rightarrow \Lambda K^0$
550	SAXON	80	DPWA	$\pi^- p \rightarrow \Lambda K^0$
120	² LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$
75	³ LONGACRE	75	IPWA	$\pi N \rightarrow N\pi\pi$

N(1710) POLE POSITION

REAL PART

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1670 to 1770 (\approx 1720) OUR ESTIMATE			
1687 ± 17	ANISOVICH	12A	DPWA Multichannel
1690	⁴ HOEHLER	93	SPED $\pi N \rightarrow \pi N$
1698	CUTKOSKY	90	IPWA $\pi N \rightarrow \pi N$
1690 ± 20	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1670	SHKLYAR	13	DPWA Multichannel
1644	SHRESTHA	12A	DPWA Multichannel
1708 ± 18	ANISOVICH	10	DPWA Multichannel
1711 ± 15	¹ BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
1679	VRANA	00	DPWA Multichannel
1770	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
1636	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90
1708 or 1712	⁵ LONGACRE	78	IPWA $\pi N \rightarrow N\pi\pi$
1720 or 1711	² LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$

−2×IMAGINARY PART

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
80 to 380 (\approx 230) OUR ESTIMATE			
200 ± 25	ANISOVICH	12A	DPWA Multichannel
200	⁴ HOEHLER	93	SPED $\pi N \rightarrow \pi N$
88	CUTKOSKY	90	IPWA $\pi N \rightarrow \pi N$
80 ± 20	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
159	SHKLYAR	13	DPWA Multichannel
104	SHRESTHA	12A	DPWA Multichannel
200 ± 20	ANISOVICH	10	DPWA Multichannel
174 ± 16	¹ BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
132	VRANA	00	DPWA Multichannel
378	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
544	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90
17 or 22	⁵ LONGACRE	78	IPWA $\pi N \rightarrow N\pi\pi$
123 or 115	² LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$

N(1710) ELASTIC POLE RESIDUE

MODULUS $|r|$

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
6 ± 4	ANISOVICH	12A DPWA	Multichannel
15	HOEHLER	93 SPED	$\pi N \rightarrow \pi N$
9	CUTKOSKY	90 IPWA	$\pi N \rightarrow \pi N$
8 ± 2	CUTKOSKY	80 IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
11	SHKLYAR	13 DPWA	Multichannel
24	¹ BATINIC	10 DPWA	$\pi N \rightarrow N\pi, N\eta$
37	ARNDT	95 DPWA	$\pi N \rightarrow N\pi$
149	ARNDT	91 DPWA	$\pi N \rightarrow \pi N$ Soln SM90

PHASE θ

<u>VALUE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
120 ± 70	ANISOVICH	12A DPWA	Multichannel
-167	CUTKOSKY	90 IPWA	$\pi N \rightarrow \pi N$
175 ± 35	CUTKOSKY	80 IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
9	SHKLYAR	13 DPWA	Multichannel
20	¹ BATINIC	10 DPWA	$\pi N \rightarrow N\pi, N\eta$
-167	ARNDT	95 DPWA	$\pi N \rightarrow N\pi$
149	ARNDT	91 DPWA	$\pi N \rightarrow \pi N$ Soln SM90

N(1710) INELASTIC POLE RESIDUE

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

Normalized residue in $N\pi \rightarrow N(1710) \rightarrow N\eta$

<u>MODULUS (%)</u>	<u>PHASE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
12 ± 4	0 ± 45	ANISOVICH	12A DPWA	Multichannel

Normalized residue in $N\pi \rightarrow N(1710) \rightarrow \Lambda K$

<u>MODULUS (%)</u>	<u>PHASE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
17 ± 6	-110 ± 20	ANISOVICH	12A DPWA	Multichannel

N(1710) DECAY MODES

The following branching fractions are our estimates, not fits or averages.

Mode	Fraction (Γ_i/Γ)	Scale factor
Γ_1 $N\pi$	5–20 %	
Γ_2 $N\eta$	10–30 %	
Γ_3 $N\omega$	(8 ± 5) %	3.5
Γ_4 ΛK	5–25 %	
Γ_5 ΣK		
Γ_6 $N\pi\pi$	40–90 %	
Γ_7 $\Delta\pi$	15–40 %	

Γ_8	$\Delta(1232)\pi$, <i>P</i> -wave	
Γ_9	$N\rho$	5–25 %
Γ_{10}	$N\rho$, $S=1/2$, <i>P</i> -wave	
Γ_{11}	$N\rho$, $S=3/2$, <i>P</i> -wave	
Γ_{12}	$N(\pi\pi)_{S\text{-wave}}^{I=0}$	10–40 %
Γ_{13}	$p\gamma$	0.002–0.08 %
Γ_{14}	$p\gamma$, helicity=1/2	0.002–0.08 %
Γ_{15}	$n\gamma$	0.0–0.02%
Γ_{16}	$n\gamma$, helicity=1/2	0.0–0.02%

$N(1710)$ BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{\text{total}}$				Γ_1/Γ
<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	

5 to 20 OUR ESTIMATE

2 ± 2	SHKLYAR	13	PWA	Multichannel	
5 ± 4	ANISOVICH	12A	DPWA	Multichannel	
20 ± 4	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$	
12 ± 4	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
15 ± 4	SHRESTHA	12A	DPWA	Multichannel	
12 ± 6	ANISOVICH	10	DPWA	Multichannel	
22 ± 24	¹ BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$	
14 ± 8	PENNER	02C	DPWA	Multichannel	
27 ± 13	VRANA	00	DPWA	Multichannel	
9 ± 4	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \text{ \& } N\pi\pi$	

$\Gamma(N\eta)/\Gamma_{\text{total}}$				Γ_2/Γ
<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	

10 to 30 OUR ESTIMATE

45 ± 4	SHKLYAR	13	DPWA	Multichannel	
17 ± 10	ANISOVICH	12A	DPWA	Multichannel	
36 ± 11	PENNER	02C	DPWA	Multichannel	
6 ± 1	VRANA	00	DPWA	Multichannel	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
11 ± 7	SHRESTHA	12A	DPWA	Multichannel	
6 ± 8	¹ BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$	

$\Gamma(N\omega)/\Gamma_{\text{total}}$				Γ_3/Γ
<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	

8 ± 5 OUR AVERAGE Error includes scale factor of 3.5.

3 ± 2	SHKLYAR	13	DPWA	Multichannel	
13 ± 2	PENNER	02C	DPWA	Multichannel	

$(\Gamma_i \Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow N(1710) \rightarrow \Lambda K$				$(\Gamma_1 \Gamma_4)^{1/2}/\Gamma$
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	

+0.12 to +0.18 OUR ESTIMATE

+0.16	BELL	83	DPWA	$\pi^- p \rightarrow \Lambda K^0$
+0.14	SAXON	80	DPWA	$\pi^- p \rightarrow \Lambda K^0$

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
5 to 25 OUR ESTIMATE			
23 ± 7	ANISOVICH	12A	DPWA Multichannel
5 ± 3	SHKLYAR	05	DPWA Multichannel
5 ± 2	PENNER	02C	DPWA Multichannel
10 ± 10	VRANA	00	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
8 ± 4	SHRESTHA	12A	DPWA Multichannel

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
• • • We do not use the following data for averages, fits, limits, etc. • • •			
7 ± 7	PENNER	02C	DPWA Multichannel

$(\Gamma_i \Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow N(1710) \rightarrow \Sigma K$ $(\Gamma_1 \Gamma_5)^{1/2}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
• • • We do not use the following data for averages, fits, limits, etc. • • •			
-0.034	LIVANOS	80	DPWA $\pi p \rightarrow \Sigma K$

Note: Signs of couplings from $\pi N \rightarrow N\pi\pi$ analyses were changed in the 1986 edition to agree with the baryon-first convention; the overall phase ambiguity is resolved by choosing a negative sign for the $\Delta(1620) S_{31}$ coupling to $\Delta(1232)\pi$.

$(\Gamma_i \Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow N(1710) \rightarrow \Delta(1232)\pi, P\text{-wave}$ $(\Gamma_1 \Gamma_8)^{1/2}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
±0.16 to ±0.22 OUR ESTIMATE			
-0.17	² LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$
+0.20	³ LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
-0.21 ± 0.04	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
39 ± 8	VRANA	00	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
6 ± 3	SHRESTHA	12A	DPWA Multichannel

$(\Gamma_i \Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow N(1710) \rightarrow N\rho, S=1/2, P\text{-wave}$ $(\Gamma_1 \Gamma_{10})^{1/2}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
±0.09 to ±0.19 OUR ESTIMATE			
+0.19	² LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$
-0.20	³ LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
+0.05 ± 0.06	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$

$\Gamma(N\rho, S=1/2, P\text{-wave})/\Gamma_{\text{total}}$ Γ_{10}/Γ

VALUE (%)	DOCUMENT ID	TECN	COMMENT
17 ± 1	VRANA	00	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
17 ± 6	SHRESTHA	12A	DPWA Multichannel

$(\Gamma_i \Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow N(1710) \rightarrow N\rho, S=3/2, P\text{-wave}$ $(\Gamma_1 \Gamma_{11})^{1/2}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
+0.31	² LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$

$(\Gamma_i \Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow N(1710) \rightarrow N(\pi\pi)_{S\text{-wave}}^{I=0}$ $(\Gamma_1 \Gamma_{12})^{1/2}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
±0.14 to ±0.22 OUR ESTIMATE			
−0.26	² LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$
−0.28	³ LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
+0.04 ± 0.05	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$

$\Gamma(N(\pi\pi)_{S\text{-wave}}^{I=0})/\Gamma_{\text{total}}$ Γ_{12}/Γ

VALUE (%)	DOCUMENT ID	TECN	COMMENT
1 ± 1	VRANA	00	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
<1	SHRESTHA	12A	DPWA Multichannel

N(1710) PHOTON DECAY AMPLITUDES

Papers on γN amplitudes predating 1981 may be found in our 2006 edition, *Journal of Physics* (generic for all A,B,E,G) **G33** 1 (2006).

$N(1710) \rightarrow p\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE (GeV ^{-1/2})	DOCUMENT ID	TECN	COMMENT
0.040 ± 0.020 OUR ESTIMATE			
0.052 ± 0.015	ANISOVICH	12A	DPWA Multichannel
0.007 ± 0.015	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
0.006 ± 0.018	CRAWFORD	83	IPWA $\gamma N \rightarrow \pi N$
0.028 ± 0.009	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
−0.050 ± 0.001	SHKLYAR	13	DPWA Multichannel
−0.008 ± 0.003	SHRESTHA	12A	DPWA Multichannel
0.025 ± 0.010	ANISOVICH	10	DPWA Multichannel
0.044	PENNER	02D	DPWA Multichannel
−0.037 ± 0.002	LI	93	IPWA $\gamma N \rightarrow \pi N$

$N(1710) \rightarrow n\gamma$, helicity-1/2 amplitude $A_{1/2}$

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.040±0.020 OUR ESTIMATE			
-0.002±0.015	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
0.000±0.018	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
-0.001±0.003	FUJII	81	DPWA $\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.017±0.003	SHRESTHA	12A	DPWA Multichannel
-0.024	PENNER	02D	DPWA Multichannel
0.052±0.003	LI	93	IPWA $\gamma N \rightarrow \pi N$

$N(1710) \quad \gamma p \rightarrow \Lambda K^+$ AMPLITUDES

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $p\gamma \rightarrow N(1710) \rightarrow \Lambda K^+$ (M_{1-} amplitude)

<u>VALUE (units 10⁻³)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
• • • We do not use the following data for averages, fits, limits, etc. • • •		
-10.6 ±0.4	WORKMAN	90 DPWA
- 7.21	TANABE	89 DPWA

$p\gamma \rightarrow N(1710) \rightarrow \Lambda K^+$ phase angle θ (M_{1-} amplitude)

<u>VALUE (degrees)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
• • • We do not use the following data for averages, fits, limits, etc. • • •		
215 ±3	WORKMAN	90 DPWA
176.3	TANABE	89 DPWA

$N(1710)$ FOOTNOTES

- ¹ BATINIC 10 finds evidence for a second P_{11} state with all parameters except for the phase of the pole residue very similar to the parameters we give here.
- ² LONGACRE 77 pole positions are from a search for poles in the unitarized T-matrix; the first (second) value uses, in addition to $\pi N \rightarrow N\pi\pi$ data, elastic amplitudes from a Saclay (CERN) partial-wave analysis. The other LONGACRE 77 values are from eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.
- ³ From method II of LONGACRE 75: eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.
- ⁴ See HOEHLER 93 for a detailed discussion of the evidence for and the pole parameters of N and Δ resonances as determined from Argand diagrams of πN elastic partial-wave amplitudes and from plots of the speeds with which the amplitudes traverse the diagrams.
- ⁵ LONGACRE 78 values are from a search for poles in the unitarized T-matrix. The first (second) value uses, in addition to $\pi N \rightarrow N\pi\pi$ data, elastic amplitudes from a Saclay (CERN) partial-wave analysis.

N(1710) REFERENCESFor early references, see *Physics Letters* **111B** 1 (1982).

SHKLYAR	13	PR C87 015201	V. Shklyar, H. Lenske, U. Mosel	(GIES)
ANISOVICH	12A	EPJ A48 15	A.V. Anisovich <i>et al.</i>	(BONN, PNPI)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
ANISOVICH	10	EPJ A44 203	A.V. Anisovich <i>et al.</i>	(BONN, PNPI)
BATINIC	10	PR C82 038203	M. Batinic <i>et al.</i>	(ZAGR)
ARNDT	06	PR C74 045205	R.A. Arndt <i>et al.</i>	(GWU)
PDG	06	JP G33 1	W.-M. Yao <i>et al.</i>	(PDG Collab.)
SHKLYAR	05	PR C72 015210	V. Shklyar, H. Lenske, U. Mosel	(GIES)
PENNER	02C	PR C66 055211	G. Penner, U. Mosel	(GIES)
PENNER	02D	PR C66 055212	G. Penner, U. Mosel	(GIES)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman,, T.-S.H. Lee	(PITT+)
ARNDT	96	PR C53 430	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI)
ARNDT	95	PR C52 2120	R.A. Arndt <i>et al.</i>	(VPI, BRCO)
HOEHLER	93	π N Newsletter 9 1	G. Hohler	(KARL)
LI	93	PR C47 2759	Z.J. Li <i>et al.</i>	(VPI)
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KSA) IJP
Also		PR D30 904	D.M. Manley <i>et al.</i>	(VPI)
ARNDT	91	PR D43 2131	R.A. Arndt <i>et al.</i>	(VPI, TELE) IJP
CUTKOSKY	90	PR D42 235	R.E. Cutkosky, S. Wang	(CMU)
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 <i>et al.</i>	(RL) IJP
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)
PDG	82	PL 111B 1	M. Roos <i>et al.</i>	(HELS, CIT, CERN)
AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)
Also		NP B197 365	K. Fujii <i>et al.</i>	(NAGO)
FUJII	81	NP B187 53	K. Fujii <i>et al.</i>	(NAGO, OSAK)
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
Also		PR D20 2839	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
LIVANOS	80	Toronto Conf. 35	P. Livanos <i>et al.</i>	(SACL) IJP
SAXON	80	NP B162 522	D.H. Saxon <i>et al.</i>	(RHEL, BRIS) IJP
HOEHLER	79	PDAT 12-1	G. Hohler <i>et al.</i>	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP
LONGACRE	78	PR D17 1795	R.S. Longacre <i>et al.</i>	(LBL, SLAC)
LONGACRE	77	NP B122 493	R.S. Longacre, J. Dolbeau	(SACL) IJP
Also		NP B108 365	J. Dolbeau <i>et al.</i>	(SACL) IJP
LONGACRE	75	PL 55B 415	R.S. Longacre <i>et al.</i>	(LBL, SLAC) IJP