$N(1680)\ F_{15}$

$I(J^P) = \frac{1}{2}(\frac{5}{2}^+)$ Status: ∗∗∗∗

Most of the results published before 1975 are now obsolete and have been omitted. They may be found in our 1982 edition, Physics Letters **111B** (1982).

N(1680) BREIT-WIGNER MASS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1680 to 1690 (≈ 1685) OUR ESTIMATE				
1683.2± 0.7	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$
1684 ± 4	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
1680 ±10	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
1684 ± 3	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1679 ± 3	VRANA	00	DPWA	Multichannel
1679 ± 5	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
1678	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
1674 ±12	BATINIC	95	DPWA	$\pi N \rightarrow N\pi, N\eta$
1682	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$
1680	BARBOUR	78	DPWA	$\gamma N \rightarrow \pi N$
1660	[1] LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$
1685	KNASEL	75	DPWA	$\pi^- p \rightarrow \Lambda K^0$
1670	[2] LONGACRE	75	IPWA	$\pi N \rightarrow N\pi\pi$

N(1680) BREIT-WIGNER WIDTH

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
120 to 140 (≈ 130) OUR ESTIMATE				
134.4± 3.8	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$
139 ± 8	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
120 ±10	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
128 ± 8	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
128 ± 9	VRANA	00	DPWA	Multichannel
124 ± 4	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
126	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
126 ±20	BATINIC	95	DPWA	$\pi N \rightarrow N\pi, N\eta$
121	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$
119	BARBOUR	78	DPWA	$\gamma N \rightarrow \pi N$
150	[1] LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$
155	KNASEL	75	DPWA	$\pi^- p \rightarrow \Lambda K^0$
130	[2] LONGACRE	75	IPWA	$\pi N \rightarrow N\pi\pi$

N(1680) POLE POSITION

REAL PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1665 to 1680 (≈ 1675) OUR ESTIMATE				
1678	[3] ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
1673	[4] HOEHLER	93	ARGD	$\pi N \to \pi N$
1667±5	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1667	VRANA	00	DPWA	Multichannel
1670	ARNDT	95	DPWA	$\pi N \to N\pi$
1670	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90
1668 or 1674	[5] LONGACRE	78	IPWA	$\pi N \to N\pi\pi$
1656 or 1653	[1] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

−2×IMAGINARY PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
110 to 135 (≈ 120) OUR ESTIMATE				
120	[3] ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
135	[4] HOEHLER	93	ARGD	$\pi N \to \pi N$
110±10	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
122	VRANA	00	DPWA	Multichannel
120	ARNDT	95	DPWA	$\pi N \to N\pi$
116	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90
132 or 137	[5] LONGACRE	78	IPWA	$\pi N \to N\pi\pi$
145 or 143	[1] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

N(1680) ELASTIC POLE RESIDUE

MODULUS $|r|$

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
43	[3] ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
44	HOEHLER	93	ARGD	$\pi N \to \pi N$
34±2	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
40	ARNDT	95	DPWA	$\pi N \to N\pi$
37	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90

PHASE θ

VALUE (°)	*DOCUMENT ID*		*TECN*	*COMMENT*
1	[3] ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
−17	HOEHLER	93	ARGD	$\pi N \to \pi N$
−25±5	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
+ 1	ARNDT	95	DPWA	$\pi N \to N\pi$
−14	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90

N(1680) DECAY MODES

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	0.65 to 0.70
Γ_2	$N\eta$	(0.0 ±1.0) %
Γ_3	ΛK	
Γ_4	ΣK	
Γ_5	$N\pi\pi$	30–40 %
Γ_6	$\Delta\pi$	5–15 %
Γ_7	$\Delta(1232)\pi$, *P*-wave	6–14 %
Γ_8	$\Delta(1232)\pi$, *F*-wave	<2 %
Γ_9	$N\rho$	3–15 %
Γ_{10}	$N\rho$, S=1/2, *F*-wave	
Γ_{11}	$N\rho$, S=3/2, *P*-wave	<12 %
Γ_{12}	$N\rho$, S=3/2, *F*-wave	1–5 %
Γ_{13}	$N(\pi\pi)^{I=0}_{S\text{-wave}}$	5–20 %
Γ_{14}	$p\gamma$	0.21–0.32 %
Γ_{15}	$p\gamma$, helicity=1/2	0.001–0.011 %
Γ_{16}	$p\gamma$, helicity=3/2	0.20–0.32 %
Γ_{17}	$n\gamma$	0.021–0.046 %
Γ_{18}	$n\gamma$, helicity=1/2	0.004–0.029 %
Γ_{19}	$n\gamma$, helicity=3/2	0.01–0.024 %

N(1680) BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{total}$ — Γ_1/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.65 to 0.70 OUR ESTIMATE				
0.670±0.004	ARNDT	04	DPWA	$\pi N \to \pi N$, ηN
0.70 ±0.03	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
0.62 ±0.05	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
0.65 ±0.02	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.69 ±0.02	VRANA	00	DPWA	Multichannel
0.68	ARNDT	95	DPWA	$\pi N \to N\pi$
0.69 ±0.04	BATINIC	95	DPWA	$\pi N \to N\pi$, $N\eta$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1680) \to N\eta$ — $(\Gamma_1\Gamma_2)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
not seen	BAKER	79	DPWA	$\pi^- p \to n\eta$

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.00 ±0.01	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$0.0015^{+0.0035}_{-0.0010}$	TIATOR	99	DPWA	$\gamma p \to p\eta$
0.01 ±0.004	BATINIC	95	DPWA	$\pi N \to N\pi$, $N\eta$
0.0005 or 0.001	[6] CARRERAS	70	MPWA	t pole + resonance
0.0004	[6] BOTKE	69	MPWA	t pole + resonance
0.003 ±0.002	[6] DEANS	69	MPWA	t pole + resonance

$\Gamma(N\eta)/\Gamma(N\pi)$ — Γ_2/Γ_1

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<0.027	HEUSCH	66	RVUE	π^0, η photoproduction

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1680) \to \Lambda K$ — $(\Gamma_1\Gamma_3)^{1/2}/\Gamma$

Coupling to ΛK not required in the analyses of BAKER 77, SAXON 80, or BELL 83.

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.01	KNASEL	75	DPWA	$\pi^- p \to \Lambda K^0$
−0.009±0.009	DEVENISH	74B		Fixed-t dispersion rel.

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1680) \to \Sigma K$ — $(\Gamma_1\Gamma_4)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<0.001	[7] DEANS	75	DPWA	$\pi N \to \Sigma K$

Note: Signs of couplings from $\pi N \to N\pi\pi$ 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 $\Delta(1232)\pi$.

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1680) \to \Delta(1232)\pi$, P-wave — $(\Gamma_1\Gamma_7)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
−0.31 to −0.21 OUR ESTIMATE				
−0.26±0.04	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
−0.27	[1,8] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
−0.25	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.38	[9] NOVOSELLER	78	IPWA	$\pi N \to N\pi\pi$

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.14±0.03	VRANA	00	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1680) \to \Delta(1232)\pi$, F-wave $(\Gamma_1\Gamma_8)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
+0.03 to +0.11 OUR ESTIMATE				
+0.07±0.03	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
+0.07	[1,8] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
+0.08	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
+0.05	[9] NOVOSELLER	78	IPWA	$\pi N \to N\pi\pi$

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.01±0.01	VRANA	00	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1680) \to N\rho$, S=3/2, P-wave $(\Gamma_1\Gamma_{11})^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
−0.30 to −0.10 OUR ESTIMATE				
−0.20±0.05	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
−0.23	[1,8] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
−0.30	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.34	[9] NOVOSELLER	78	IPWA	$\pi N \to N\pi\pi$

$\Gamma(N\rho$, S=3/2, P-wave$)/\Gamma_{total}$ Γ_{11}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.05±0.01	VRANA	00	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1680) \to N\rho$, S=3/2, F-wave $(\Gamma_1\Gamma_{12})^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
−0.18 to −0.10 OUR ESTIMATE				
−0.13±0.03	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
−0.15	[1,8] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

$\Gamma(N\rho$, S=3/2, F-wave$)/\Gamma_{total}$ Γ_{12}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.03±0.01	VRANA	00	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1680) \to N(\pi\pi)^{I=0}_{S\text{-wave}}$ $(\Gamma_1\Gamma_{13})^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
+0.25 to +0.35 OUR ESTIMATE				
+0.29±0.04	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
+0.31	[1,8] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
+0.30	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
+0.42	[9] NOVOSELLER	78	IPWA	$\pi N \to N\pi\pi$

$\Gamma(N(\pi\pi)^{I=0}_{S\text{-wave}})/\Gamma_{total}$ Γ_{13}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.09±0.01	VRANA	00	DPWA	Multichannel

N(1680) PHOTON DECAY AMPLITUDES

N(1680) → $p\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.015±0.006 OUR ESTIMATE				
−0.010±0.004	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
−0.017±0.018	CRAWFORD	83	IPWA	$\gamma N \rightarrow \pi N$
−0.009±0.006	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
−0.028±0.003	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 1)
−0.026±0.003	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 2)
−0.018±0.014	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.006±0.002	LI	93	IPWA	$\gamma N \rightarrow \pi N$
−0.005±0.015	BARBOUR	78	DPWA	$\gamma N \rightarrow \pi N$
−0.009±0.002	FELLER	76	DPWA	$\gamma N \rightarrow \pi N$

N(1680) → $p\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
+0.133±0.012 OUR ESTIMATE				
0.145±0.005	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
0.132±0.010	CRAWFORD	83	IPWA	$\gamma N \rightarrow \pi N$
0.115±0.008	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
0.115±0.003	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 1)
0.122±0.003	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 2)
0.141±0.014	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.154±0.002	LI	93	IPWA	$\gamma N \rightarrow \pi N$
+0.138±0.021	BARBOUR	78	DPWA	$\gamma N \rightarrow \pi N$
+0.121±0.010	FELLER	76	DPWA	$\gamma N \rightarrow \pi N$

N(1680) → $n\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
+0.029±0.010 OUR ESTIMATE				
0.030±0.005	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
0.017±0.014	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
0.032±0.003	FUJII	81	DPWA	$\gamma N \rightarrow \pi N$
0.026±0.005	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 1)
0.028±0.014	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 2)
0.044±0.012	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$
0.025±0.010	TAKEDA	80	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.022±0.002	LI	93	IPWA	$\gamma N \rightarrow \pi N$
+0.037±0.010	BARBOUR	78	DPWA	$\gamma N \rightarrow \pi N$

$N(1680) \to n\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.033±0.009 OUR ESTIMATE				
−0.040±0.015	ARNDT	96	IPWA	$\gamma N \to \pi N$
−0.033±0.013	AWAJI	81	DPWA	$\gamma N \to \pi N$
−0.023±0.005	FUJII	81	DPWA	$\gamma N \to \pi N$
−0.024±0.009	ARAI	80	DPWA	$\gamma N \to \pi N$ (fit 1)
−0.029±0.017	ARAI	80	DPWA	$\gamma N \to \pi N$ (fit 2)
−0.033±0.015	CRAWFORD	80	DPWA	$\gamma N \to \pi N$
−0.035±0.012	TAKEDA	80	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.048±0.002	LI	93	IPWA	$\gamma N \to \pi N$
−0.038±0.018	BARBOUR	78	DPWA	$\gamma N \to \pi N$

N(1680) FOOTNOTES

[1] LONGACRE 77 pole positions are from a search for poles in the unitarized T-matrix; the first (second) value uses, in addition to $\pi N \to N\pi\pi$ 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.

[2] From method II of LONGACRE 75: eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.

[3] ARNDT 04 also finds another pole in the F15 wave with real part = 1779 MeV, $-2 \times$ imaginary part = 248 MeV, and residue with modulus 47 MeV and phase = -61°.

[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 $\pi N \to N\pi\pi$ data, elastic amplitudes from a Saclay (CERN) partial-wave analysis.

[6] The parametrization used may be double counting.

[7] The range given is from 3 of 4 best solutions; not present in solution 1. DEANS 75 disagrees with $\pi^+ p \to \Sigma^+ K^+$ data of WINNIK 77 around 1920 MeV.

[8] LONGACRE 77 considers this coupling to be well determined.

[9] A Breit-Wigner fit to the HERNDON 75 IPWA.

N(1680) REFERENCES

For early references, see Physics Letters **111B** 70 (1982). For very early references, see Reviews of Modern Physics **37** 633 (1965).

ARNDT	04	PR C69 035213	R.A. Arndt *et al.*	(GWU, TRIU)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman,, T.-S.H. Lee	(PITT+)
TIATOR	99	PR C60 035210	L. Tiator *et al.*	
ARNDT	96	PR C53 430	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI)
ARNDT	95	PR C52 2120	R.A. Arndt *et al.*	(VPI, BRCO)
BATINIC	95	PR C51 2310	M. Batinic *et al.*	(BOSK, UCLA)
Also		PR C57 1004 (erratum)	M. Batinic *et al.*	
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)
LI	93	PR C47 2759	Z.J. Li *et al.*	(VPI)
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KENT) IJP
Also		PR D30 904	D.M. Manley *et al.*	(VPI)
ARNDT	91	PR D43 2131	R.A. Arndt *et al.*	(VPI, TELE) IJP
BELL	83	NP B222 389	K.W. Bell *et al.*	(RL) IJP
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)
PDG	82	PL 111B	M. Roos *et al.*	(HELS, CIT, CERN)

AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)
Also		NP B197 365	K. Fujii *et al.*	(NAGO)
FUJII	81	NP B187 53	K. Fujii *et al.*	(NAGO, OSAK)
ARAI	80	Toronto Conf. 93	I. Arai	(INUS)
Also		NP B194 251	I. Arai, H. Fujii	(INUS)
CRAWFORD	80	Toronto Conf. 107	R.L. Crawford	(GLAS)
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
TAKEDA	80	NP B168 17	H. Takeda *et al.*	(TOKY, INUS)
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
BARBOUR	78	NP B141 253	I.M. Barbour, R.L. Crawford, N.H. Parsons	(GLAS)
LONGACRE	78	PR D17 1795	R.S. Longacre *et al.*	(LBL, SLAC)
NOVOSELLER	78	NP B137 509	D.E. Novoseller	(CIT) IJP
Also		NP B137 445	D.E. Novoseller	(CIT) IJP
BAKER	77	NP B126 365	R.D. Baker *et al.*	(RHEL) IJP
LONGACRE	77	NP B122 493	R.S. Longacre, J. Dolbeau	(SACL) IJP
Also		NP B108 365	J. Dolbeau *et al.*	(SACL) IJP
WINNIK	77	NP B128 66	M. Winnik *et al.*	(HAIF) I
FELLER	76	NP B104 219	P. Feller *et al.*	(NAGO, OSAK) IJP
DEANS	75	NP B96 90	S.R. Deans *et al.*	(SFLA, ALAH) IJP
HERNDON	75	PR D11 3183	D. Herndon *et al.*	(LBL, SLAC)
KNASEL	75	PR D11 1	T.M. Knasel *et al.*	(CHIC, WUSL, OSU+) IJP
LONGACRE	75	PL 55B 415	R.S. Longacre *et al.*	(LBL, SLAC) IJP
DEVENISH	74B	NP B81 330	R.C.E. Devenish, C.D. Froggatt, B.R. Martin	(DESY+)
CARRERAS	70	NP B16 35	B. Carreras, A. Donnachie	(DARE, MCHS)
BOTKE	69	PR 180 1417	J.C. Botke	(UCSB)
DEANS	69	PR 185 1797	S.R. Deans, J.W. Wooten	(SFLA)
HEUSCH	66	PRL 17 1019	C.A. Heusch, C.Y. Prescott, R.F. Dashen	(CIT)