$N(1520)\ 3/2^-$

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

Older and obsolete values are listed and referenced in the 2014 edition, Chinese Physics **C38** 070001 (2014).

N(1520) POLE POSITION

REAL PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1505 to 1515 (≈ 1510) OUR ESTIMATE				
1482±3	ROENCHEN	22	DPWA	Multichannel
1507±2	SOKHOYAN	15A	DPWA	Multichannel
1506±1±1	[1] SVARC	14	L+P	$\pi N \to \pi N$
1510±5	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1500	HUNT	19	DPWA	Multichannel
1512	ROENCHEN	15A	DPWA	Multichannel
1492	SHKLYAR	13	DPWA	Multichannel
1507±3	ANISOVICH	12A	DPWA	Multichannel
1506±9	BATINIC	10	DPWA	$\pi N \to N\pi,\ N\eta$
1515	ARNDT	06	DPWA	$\pi N \to \pi N,\ \eta N$
1504	VRANA	00	DPWA	Multichannel
1510	HOEHLER	93	ARGD	$\pi N \to \pi N$

[1] Fit to the amplitudes of HOEHLER 79.

−2×IMAGINARY PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
105 to 120 (≈ 110) OUR ESTIMATE				
126± 9	ROENCHEN	22	DPWA	Multichannel
111± 3	SOKHOYAN	15A	DPWA	Multichannel
115± 2±1	[1] SVARC	14	L+P	$\pi N \to \pi N$
114±10	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
117	HUNT	19	DPWA	Multichannel
89	ROENCHEN	15A	DPWA	Multichannel
94	SHKLYAR	13	DPWA	Multichannel
111± 5	ANISOVICH	12A	DPWA	Multichannel
122± 9	BATINIC	10	DPWA	$\pi N \to N\pi,\ N\eta$
113	ARNDT	06	DPWA	$\pi N \to \pi N,\ \eta N$
112	VRANA	00	DPWA	Multichannel
120	HOEHLER	93	ARGD	$\pi N \to \pi N$

[1] Fit to the amplitudes of HOEHLER 79.

N(1520) ELASTIC POLE RESIDUE

MODULUS $|r|$

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
32 to 38 (≈ 35) OUR ESTIMATE				
27±11	ROENCHEN	22	DPWA	Multichannel
36± 2	SOKHOYAN	15A	DPWA	Multichannel
33± 1±1	[1] SVARC	14	L+P	$\pi N \to \pi N$
35± 2	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
37	ROENCHEN	15A	DPWA	Multichannel
27	SHKLYAR	13	DPWA	Multichannel
36± 3	ANISOVICH	12A	DPWA	Multichannel
35	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
38	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
32	HOEHLER	93	ARGD	$\pi N \to \pi N$

[1] Fit to the amplitudes of HOEHLER 79.

PHASE θ

VALUE (°)	*DOCUMENT ID*		*TECN*	*COMMENT*
−15 to −5 (≈ − 10) OUR ESTIMATE				
−36±24	ROENCHEN	22	DPWA	Multichannel
−14± 3	SOKHOYAN	15A	DPWA	Multichannel
−15± 1±1	[1] SVARC	14	L+P	$\pi N \to \pi N$
−12± 5	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
− 6	ROENCHEN	15A	DPWA	Multichannel
−35	SHKLYAR	13	DPWA	Multichannel
−14± 3	ANISOVICH	12A	DPWA	Multichannel
− 7	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
− 5	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
− 8	HOEHLER	93	ARGD	$\pi N \to \pi N$

[1] Fit to the amplitudes of HOEHLER 79.

N(1520) INELASTIC POLE RESIDUE

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

Normalized residue in $N\pi \to N(1520) \to \Delta\pi$, *S*-wave

MODULUS	*PHASE* (°)	*DOCUMENT ID*		*TECN*	*COMMENT*
0.33±0.04	155 ± 15	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.33±0.05	150 ± 20	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \to N(1520) \to \Delta\pi$, *D*-wave

MODULUS	*PHASE* (°)	*DOCUMENT ID*		*TECN*	*COMMENT*
0.25±0.03	105 ± 18	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.25±0.03	100 ± 20	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \to N(1520) \to N\eta$

MODULUS	*PHASE (°)*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.021±0.009	34 ± 27	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.026	95	ROENCHEN	15A	DPWA	Multichannel

Normalized residue in $N\pi \to N(1520) \to \Lambda K$

MODULUS	*PHASE (°)*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.026±0.010	127 ± 24	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.069	158	ROENCHEN	15A	DPWA	Multichannel

Normalized residue in $N\pi \to N(1520) \to \Sigma K$

MODULUS	*PHASE (°)*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.010±0.006	94 ± 34	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.049	−41	ROENCHEN	15A	DPWA	Multichannel

Normalized residue in $N\pi \to N(1520) \to N\sigma$

MODULUS	*PHASE (°)*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.08±0.03	−45 ± 25	SOKHOYAN	15A	DPWA	Multichannel

$N(1520)$ BREIT-WIGNER MASS

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1510 to 1520 (≈ 1515) OUR ESTIMATE				
1512.0± 1.5	[1] HUNT	19	DPWA	Multichannel
1516 ± 2	SOKHOYAN	15A	DPWA	Multichannel
1505 ± 4	[1] SHKLYAR	13	DPWA	Multichannel
1514.5± 0.2	[1] ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
1525 ±10	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1519 ± 4	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1517 ± 3	ANISOVICH	12A	DPWA	Multichannel
1512.6± 0.5	[1] SHRESTHA	12A	DPWA	Multichannel
1522 ± 8	BATINIC	10	DPWA	$\pi N \to N\pi, N\eta$
1509 ± 1	PENNER	02C	DPWA	Multichannel
1518 ± 3	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

$N(1520)$ BREIT-WIGNER WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
100 to 120 (≈ 110) OUR ESTIMATE				
121 ± 3	[1] HUNT	19	DPWA	Multichannel
113 ± 4	SOKHOYAN	15A	DPWA	Multichannel
100 ± 2	[1] SHKLYAR	13	DPWA	Multichannel
103.6± 0.4	[1] ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
120 ±15	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
114 ± 7	HOEHLER	79	IPWA	$\pi N \to \pi N$

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

114 ± 5	ANISOVICH	12A	DPWA	Multichannel
117 ± 1	[1] SHRESTHA	12A	DPWA	Multichannel
132 ±11	BATINIC	10	DPWA	$\pi N \to N\pi, N\eta$
100 ± 2	PENNER	02C	DPWA	Multichannel
124 ± 4	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

$N(1520)$ DECAY MODES

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	55–65 %
Γ_2	$N\eta$	0.07–0.09 %
Γ_3	$N\pi\pi$	25–35 %
Γ_4	$\Delta(1232)\pi$	22–34 %
Γ_5	$\Delta(1232)\pi$, S-wave	15–23 %
Γ_6	$\Delta(1232)\pi$, D-wave	7–11 %
Γ_7	$N\rho$	10–16 %
Γ_8	$N\rho$, S=3/2 , S-wave	10–16 %
Γ_9	$N\rho$, S=1/2 , D-wave	0.2–0.4 %
Γ_{10}	$N\sigma$	<10 %
Γ_{11}	$p\gamma$	0.31–0.52 %
Γ_{12}	$p\gamma$, helicity=1/2	0.01–0.02 %
Γ_{13}	$p\gamma$, helicity=3/2	0.30–0.50 %
Γ_{14}	$n\gamma$	0.30–0.53 %
Γ_{15}	$n\gamma$, helicity=1/2	0.04–0.10 %
Γ_{16}	$n\gamma$, helicity=3/2	0.25–0.45 %

$N(1520)$ BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
55 to 65 (≈ 60) OUR ESTIMATE				
58.3±1.5	[1] HUNT	19	DPWA	Multichannel
61 ±2	SOKHOYAN	15A	DPWA	Multichannel
57 ±2	[1] SHKLYAR	13	DPWA	Multichannel
63.2±0.1	[1] ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
58 ±3	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
54 ±3	HOEHLER	79	IPWA	$\pi N \to \pi N$

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

62 ±3	ANISOVICH	12A	DPWA	Multichannel
62.7±0.5	[1] SHRESTHA	12A	DPWA	Multichannel
55 ±5	BATINIC	10	DPWA	$\pi N \to N\pi, N\eta$
56 ±1	PENNER	02C	DPWA	Multichannel
63 ±2	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

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

VALUE (%)	DOCUMENT ID		TECN	COMMENT
<0.1	MUELLER	20	DPWA	Multichannel
0.03 ± 0.01	[1] HUNT	19	DPWA	Multichannel
0.08 ± 0.01	TIATOR	99	DPWA	$\gamma p \to p\eta$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<1	SHKLYAR	13	DPWA	Multichannel
$0.1\ \pm0.1$	BATINIC	10	DPWA	$\pi N \to N\pi,\ N\eta$
$0.2\ \pm0.1$	THOMA	08	DPWA	Multichannel
0.08 to 0.12	ARNDT	05	DPWA	Multichannel
0.23 ± 0.04	PENNER	02C	DPWA	Multichannel
$0\quad\pm1$	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

$\Gamma(\Delta(1232)\pi, S\text{-wave})/\Gamma_{\text{total}}$ Γ_5/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
12.1 ± 2.1	ADAMCZEW...	20	DPWA	Multichannel
$21\ \pm2$	[1] HUNT	19	DPWA	Multichannel
$19\ \pm4$	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$19\ \pm4$	ANISOVICH	12A	DPWA	Multichannel
9.3 ± 0.7	[1] SHRESTHA	12A	DPWA	Multichannel
$15\ \pm2$	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

$\Gamma(\Delta(1232)\pi, D\text{-wave})/\Gamma_{\text{total}}$ Γ_6/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
$6\ \pm2$	ADAMCZEW...	20	DPWA	Multichannel
$6\ \pm1$	[1] HUNT	19	DPWA	Multichannel
$9\ \pm2$	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$9\ \pm2$	ANISOVICH	12A	DPWA	Multichannel
6.3 ± 0.5	[1] SHRESTHA	12A	DPWA	Multichannel
$11\ \pm2$	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

$\Gamma(N\rho, S{=}3/2, S\text{-wave})/\Gamma_{\text{total}}$ Γ_8/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
10–16 % OUR EVALUATION				
11.8 ± 1.9	ADAMCZEW...	20	DPWA	Multichannel
14.1 ± 1.5	[1] HUNT	19	DPWA	Multichannel

[1] Statistical error only

$\Gamma(N\rho, S{=}1/2, D\text{-wave})/\Gamma_{\text{total}}$ Γ_9/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
0.2–0.4 % OUR EVALUATION				
0.4 ± 0.2	ADAMCZEW...	20	DPWA	Multichannel

$\Gamma(N\sigma)/\Gamma_{total}$ Γ_{10}/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
<10 % OUR ESTIMATE				
7 ±3	ADAMCZEW...	20	DPWA	Multichannel
<0.7	[1] HUNT	19	DPWA	Multichannel
<2	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<1	[1] SHRESTHA	12A	DPWA	Multichannel
<4	THOMA	08	DPWA	Multichannel
1 ±1	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

N(1520) PHOTON DECAY AMPLITUDES AT THE POLE

$N(1520) \to p\gamma$, helicity-1/2 amplitude $A_{1/2}$

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
−0.043±0.013	−47 ± 10	ROENCHEN	22	DPWA	Multichannel
−0.023±0.004	−6 ± 5	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
−0.031	−17	ROENCHEN	15A	DPWA	Multichannel

$N(1520) \to p\gamma$, helicity-3/2 amplitude $A_{3/2}$

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.112±0.032	1.8 ± 19	ROENCHEN	22	DPWA	Multichannel
0.131±0.006	4 ± 4	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.075	1.7	ROENCHEN	15A	DPWA	Multichannel

$N(1520) \to n\gamma$, helicity-1/2 amplitude $A_{1/2}$

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
−0.045±0.005	−5 ± 4	ANISOVICH	17E	DPWA	Multichannel

$N(1520) \to n\gamma$, helicity-3/2 amplitude $A_{3/2}$

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
−0.119±0.005	5 ± 4	ANISOVICH	17E	DPWA	Multichannel

N(1520) BREIT-WIGNER PHOTON DECAY AMPLITUDES

$N(1520) \to p\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.030 to −0.015 (≈ −0.025) OUR ESTIMATE				
−0.034±0.003	[1] HUNT	19	DPWA	Multichannel
−0.024±0.004	SOKHOYAN	15A	DPWA	Multichannel
−0.015±0.001	[1] SHKLYAR	13	DPWA	Multichannel
−0.019±0.002	[1] WORKMAN	12A	DPWA	$\gamma N \to N\pi$
−0.028±0.002	[1] DUGGER	07	DPWA	$\gamma N \to \pi N$
−0.038±0.003	[1] AHRENS	02	DPWA	$\gamma N \to \pi N$

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

−0.022±0.004	ANISOVICH	12A	DPWA	Multichannel
−0.034±0.001	[1] SHRESTHA	12A	DPWA	Multichannel
−0.027	DRECHSEL	07	DPWA	$\gamma N \to \pi N$
−0.003	PENNER	02D	DPWA	Multichannel
−0.052±0.010±0.007	[1] MUKHOPAD...	98		$\gamma p \to \eta p$

[1] Statistical error only.

$N(1520) \to p\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
0.135 to 0.145 (≈ 0.140) OUR ESTIMATE				
0.142±0.003	[1] HUNT	19	DPWA	Multichannel
0.130±0.006	SOKHOYAN	15A	DPWA	Multichannel
0.146±0.001	[1] SHKLYAR	13	DPWA	Multichannel
0.141±0.002	[1] WORKMAN	12A	DPWA	$\gamma N \to N\pi$
0.143±0.002	[1] DUGGER	07	DPWA	$\gamma N \to \pi N$
0.147±0.010	[1] AHRENS	02	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.131±0.010	ANISOVICH	12A	DPWA	Multichannel
0.127±0.003	[1] SHRESTHA	12A	DPWA	Multichannel
0.161	DRECHSEL	07	DPWA	$\gamma N \to \pi N$
0.151	PENNER	02D	DPWA	Multichannel
0.130±0.020±0.015	[1] MUKHOPAD...	98		$\gamma p \to \eta p$

[1] Statistical error only.

$N(1520) \to n\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.055 to −0.040 (≈ −0.050) OUR ESTIMATE				
−0.072±0.003	[1] HUNT	19	DPWA	Multichannel
−0.046±0.005	ANISOVICH	17E	DPWA	Multichannel
−0.046±0.006	[1] CHEN	12A	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.049±0.008	ANISOVICH	13B	DPWA	Multichannel
−0.038±0.003	[1] SHRESTHA	12A	DPWA	Multichannel
−0.077	DRECHSEL	07	DPWA	$\gamma N \to \pi N$
−0.084	PENNER	02D	DPWA	Multichannel

[1] Statistical error only.

$N(1520) \to n\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.120 to −0.100 (≈ −0.115) OUR ESTIMATE				
−0.123±0.006	[1] HUNT	19	DPWA	Multichannel
−0.118±0.005	ANISOVICH	17E	DPWA	Multichannel
−0.115±0.005	[1] CHEN	12A	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.113±0.012	ANISOVICH	13B	DPWA	Multichannel
−0.101±0.004	[1] SHRESTHA	12A	DPWA	Multichannel
−0.154	DRECHSEL	07	DPWA	$\gamma N \to \pi N$
−0.159	PENNER	02D	DPWA	Multichannel

[1] Statistical error only.

N(1520) REFERENCES

For early references, see Physics Letters **111B** 1 (1982). For very early references, see Reviews of Modern Physics **37** 633 (1965).

ROENCHEN	22	EPJ A58 229	D. Roenchen *et al.*	(JULI, GWU, BONN+)
ADAMCZEW...	20	PR C102 024001	J. Adamczewski-Musch *et al.*	(HADES Collab.)
MUELLER	20	PL B803 135323	J. Mueller *et al.*	(CBELSA/TAPS Collab.)
HUNT	19	PR C99 055205	B.C. Hunt, D.M. Manley	
ANISOVICH	17E	PR C96 055202	A.V. Anisovich *et al.*	(BONN, PNPI, JLAB+)
ROENCHEN	15A	EPJ A51 70	D. Roenchen *et al.*	
SOKHOYAN	15A	EPJ A51 95	V. Sokhoyan *et al.*	(CBELSA/TAPS Collab.)
PDG	14	CP C38 070001	K. Olive *et al.*	(PDG Collab.)
SVARC	14	PR C89 045205	A. Svarc *et al.*	(RBI Zagreb, UNI Tuzla)
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)
CHEN	12A	PR C86 015206	W. Chen *et al.*	(DUKE, GWU, MSST, ITEP+)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
WORKMAN	12A	PR C86 015202	R. Workman *et al.*	(GWU)
BATINIC	10	PR C82 038203	M. Batinic *et al.*	(ZAGR)
THOMA	08	PL B659 87	U. Thoma *et al.*	(CB-ELSA Collab.)
DRECHSEL	07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)
DUGGER	07	PR C76 025211	M. Dugger *et al.*	(JLab CLAS Collab.)
ARNDT	06	PR C74 045205	R.A. Arndt *et al.*	(GWU)
ARNDT	05	PR C72 045202	R.A. Arndt *et al.*	(GWU, PNPI)
AHRENS	02	PRL 88 232002	J. Ahrens *et al.*	(Mainz MAMI GDH/A2 Collab.)
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, ANL)
TIATOR	99	PR C60 035210	L. Tiator *et al.*	
MUKHOPAD...	98	PL B444 7	N.C. Mukhopadhyay, N. Mathur	
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)
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
HOEHLER	79	PDAT 12-1	G. Hohler *et al.*	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP