

$N(1520) \ 3/2^-$ $I(J^P) = \frac{1}{2}(\frac{3}{2}^-)$ 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).

 $N(1520)$ BREIT-WIGNER MASS

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1510 to 1520 (\approx 1515) OUR ESTIMATE			
1505 \pm 4	SHKLYAR	13	DPWA Multichannel
1517 \pm 3	ANISOVICH	12A	DPWA Multichannel
1514.5 \pm 0.2	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1525 \pm 10	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
1519 \pm 4	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1512.6 \pm 0.5	SHRESTHA	12A	DPWA Multichannel
1524 \pm 4	ANISOVICH	10	DPWA Multichannel
1522 \pm 8	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
1520 \pm 10	THOMA	08	DPWA Multichannel
1516.3 \pm 0.8	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
1509 \pm 1	PENNER	02C	DPWA Multichannel
1518 \pm 3	VRANA	00	DPWA Multichannel
1516 \pm 10	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
1515	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
1510	LI	93	IPWA $\gamma N \rightarrow \pi N$
1524 \pm 4	MANLEY	92	IPWA $\pi N \rightarrow \pi N \ \& \ N\pi\pi$
1510	¹ LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$
1520	² LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$

 $N(1520)$ BREIT-WIGNER WIDTH

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
100 to 125 (\approx 115) OUR ESTIMATE			
100 \pm 2	SHKLYAR	13	DPWA Multichannel
114 \pm 5	ANISOVICH	12A	DPWA Multichannel
103.6 \pm 0.4	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
120 \pm 15	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
114 \pm 7	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
117 \pm 1	SHRESTHA	12A	DPWA Multichannel
117 \pm 6	ANISOVICH	10	DPWA Multichannel
132 \pm 11	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
125 \pm 15	THOMA	08	DPWA Multichannel
98.6 \pm 2.6	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
100 \pm 2	PENNER	02C	DPWA Multichannel
124 \pm 4	VRANA	00	DPWA Multichannel

106 ± 4	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
106	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
120	LI	93	IPWA	$\gamma N \rightarrow \pi N$
124 ± 8	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
110	¹ LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$
150	² LONGACRE	75	IPWA	$\pi N \rightarrow N\pi\pi$

***N*(1520) POLE POSITION**

REAL PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1505 to 1515 (\approx 1510) OUR ESTIMATE			
1507±3	ANISOVICH	12A	DPWA Multichannel
1515	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1510	³ HOEHLER	93	ARGD $\pi N \rightarrow \pi N$
1510±5	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1492	SHKLYAR	13	DPWA Multichannel
1501	SHRESTHA	12A	DPWA Multichannel
1512±3	ANISOVICH	10	DPWA Multichannel
1506±9	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
1509±7	THOMA	08	DPWA Multichannel
1514	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
1504	VRANA	00	DPWA Multichannel
1515	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
1511	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90
1514 or 1511	⁴ LONGACRE	78	IPWA $\pi N \rightarrow N\pi\pi$
1508 or 1505	¹ LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$

-2×IMAGINARY PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
105 to 120 (\approx 110) OUR ESTIMATE			
111± 5	ANISOVICH	12A	DPWA Multichannel
113	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
120	³ HOEHLER	93	ARGD $\pi N \rightarrow \pi N$
114±10	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
94	SHKLYAR	13	DPWA Multichannel
112	SHRESTHA	12A	DPWA Multichannel
110± 6	ANISOVICH	10	DPWA Multichannel
122± 9	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
113±12	THOMA	08	DPWA Multichannel
102	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
112	VRANA	00	DPWA Multichannel
110	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
108	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90
146 or 137	⁴ LONGACRE	78	IPWA $\pi N \rightarrow N\pi\pi$
109 or 107	¹ LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$

***N*(1520) ELASTIC POLE RESIDUE**

MODULUS $|r|$

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
35±3 OUR ESTIMATE			
36±3	ANISOVICH	12A	DPWA Multichannel
38	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
32	HOEHLER	93	ARGD $\pi N \rightarrow \pi N$
35±2	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
27	SHKLYAR	13	DPWA Multichannel
35	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
35	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
34	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
33	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>
-10±5 OUR ESTIMATE			
-14±3	ANISOVICH	12A	DPWA Multichannel
- 5	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
- 8	HOEHLER	93	ARGD $\pi N \rightarrow \pi N$
-12±5	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
-35	SHKLYAR	13	DPWA Multichannel
- 7	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
- 6	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
7	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
-10	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

***N*(1520) INELASTIC POLE RESIDUE**

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

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

<u>MODULUS (%)</u>	<u>PHASE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
33±5	150 ± 20	ANISOVICH	12A	DPWA Multichannel

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

<u>MODULUS (%)</u>	<u>PHASE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
25±3	100 ± 20	ANISOVICH	12A	DPWA Multichannel

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 $N\eta$	$(2.3 \pm 0.4) \times 10^{-3}$
Γ_3 $N\pi\pi$	20–30 %
Γ_4 $\Delta\pi$	15–25 %
Γ_5 $\Delta(1232)\pi$, <i>S</i> -wave	10–20 %
Γ_6 $\Delta(1232)\pi$, <i>D</i> -wave	10–15 %
Γ_7 $N\rho$	15–25 %
Γ_8 $N\rho$, $S=3/2$, <i>S</i> -wave	(9.0 ± 1.0) %
Γ_9 $N(\pi\pi)_{S\text{-wave}}^{I=0}$	<8 %
Γ_{10} $p\gamma$	0.31–0.52 %
Γ_{11} $p\gamma$, helicity=1/2	0.01–0.02 %
Γ_{12} $p\gamma$, helicity=3/2	0.30–0.50 %
Γ_{13} $n\gamma$	0.30–0.53 %
Γ_{14} $n\gamma$, helicity=1/2	0.04–0.10 %
Γ_{15} $n\gamma$, 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 OUR ESTIMATE				
57 ± 2	SHKLYAR	13	DPWA	Multichannel
62 ± 3	ANISOVICH	12A	DPWA	Multichannel
63.2 ± 0.1	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
58 ± 3	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
54 ± 3	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
62.7 ± 0.5	SHRESTHA	12A	DPWA	Multichannel
57 ± 5	ANISOVICH	10	DPWA	Multichannel
55 ± 5	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
58 ± 8	THOMA	08	DPWA	Multichannel
64.0 ± 0.5	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$
56 ± 1	PENNER	02C	DPWA	Multichannel
63 ± 2	VRANA	00	DPWA	Multichannel
61	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
59 ± 3	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$
$\Gamma(N\eta)/\Gamma_{\text{total}}$				
VALUE (%)	DOCUMENT ID	TECN	COMMENT	Γ_2/Γ
0.23 \pm 0.04 OUR AVERAGE				
0 ± 1	SHKLYAR	13	DPWA	Multichannel
0.23 \pm 0.04	PENNER	02C	DPWA	Multichannel
0 ± 1	VRANA	00	DPWA	Multichannel

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

0.1 ±0.1	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
0.2 ±0.1	THOMA	08	DPWA	Multichannel
0.08 to 0.12	ARNDT	05	DPWA	Multichannel
0.08±0.01	TIATOR	99	DPWA	$\gamma p \rightarrow p\eta$

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 $N\pi \rightarrow N(1520) \rightarrow \Delta(1232)\pi$, S-wave **$(\Gamma_1\Gamma_5)^{1/2}/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
−0.26 to −0.20 OUR ESTIMATE			
−0.26	^{1,5} LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$
−0.24	² LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$

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

−0.18±0.05	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$
------------	--------	----	------	--------------------------------------

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
10 to 20 OUR ESTIMATE			
19 ±4	ANISOVICH	12A	DPWA Multichannel
15 ±2	VRANA	00	DPWA Multichannel

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

9.3±0.7	SHRESTHA	12A	DPWA Multichannel
12 ±4	THOMA	08	DPWA Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow N(1520) \rightarrow \Delta(1232)\pi$, D-wave **$(\Gamma_1\Gamma_6)^{1/2}/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
−0.28 to −0.24 OUR ESTIMATE			
−0.21	^{1,5} LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$
−0.30	² LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$

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

−0.29±0.03	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$
------------	--------	----	------	--------------------------------------

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
10 to 15 OUR ESTIMATE			
9 ±2	ANISOVICH	12A	DPWA Multichannel
11 ±2	VRANA	00	DPWA Multichannel

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

6.3±0.5	SHRESTHA	12A	DPWA Multichannel
14 ±5	THOMA	08	DPWA Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(1520) \rightarrow N\rho, S=3/2, S\text{-wave}$ $(\Gamma_1 \Gamma_8)^{1/2} / \Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
–0.35 to –0.31 OUR ESTIMATE			
–0.35	^{1,5} LONGACRE 77	IPWA	$\pi N \rightarrow N\pi\pi$
–0.24	² LONGACRE 75	IPWA	$\pi N \rightarrow N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
–0.35 ± 0.03	MANLEY 92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$

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

VALUE (%)	DOCUMENT ID	TECN	COMMENT
9 ± 1			
• • • We do not use the following data for averages, fits, limits, etc. • • •			
20.9 ± 0.7	SHRESTHA 12A	DPWA	Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(1520) \rightarrow N(\pi\pi)_{S\text{-wave}}^{I=0}$ $(\Gamma_1 \Gamma_9)^{1/2} / \Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
–0.22 to –0.06 OUR ESTIMATE			
–0.13	^{1,5} LONGACRE 77	IPWA	$\pi N \rightarrow N\pi\pi$
–0.17	² LONGACRE 75	IPWA	$\pi N \rightarrow N\pi\pi$

$\Gamma(N(\pi\pi)_{S\text{-wave}}^{I=0}) / \Gamma_{\text{total}}$ Γ_9 / Γ

VALUE (%)	DOCUMENT ID	TECN	COMMENT
1 ± 1			
• • • We do not use the following data for averages, fits, limits, etc. • • •			
<1	SHRESTHA 12A	DPWA	Multichannel
<4	THOMA 08	DPWA	Multichannel

N(1520) 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(1520) → pγ, helicity-1/2 amplitude A_{1/2}

VALUE (GeV ^{–1/2})	DOCUMENT ID	TECN	COMMENT
–0.020 ± 0.005 OUR ESTIMATE			
–0.022 ± 0.004	ANISOVICH 12A	DPWA	Multichannel
–0.019 ± 0.002	WORKMAN 12A	DPWA	$\gamma N \rightarrow N\pi$
–0.028 ± 0.002	DUGGER 07	DPWA	$\gamma N \rightarrow \pi N$
–0.038 ± 0.003	AHRENS 02	DPWA	$\gamma N \rightarrow \pi N$
–0.028 ± 0.014	CRAWFORD 83	IPWA	$\gamma N \rightarrow \pi N$
–0.007 ± 0.004	AWAJI 81	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
–0.015 ± 0.001	SHKLYAR 13	DPWA	Multichannel
–0.034 ± 0.001	SHRESTHA 12A	DPWA	Multichannel
–0.032 ± 0.006	ANISOVICH 10	DPWA	Multichannel
–0.027	DRECHSEL 07	DPWA	$\gamma N \rightarrow \pi N$
–0.003	PENNER 02D	DPWA	Multichannel
–0.052 ± 0.010 ± 0.007	⁶ MUKHOPAD... 98		$\gamma p \rightarrow \eta p$
–0.020 ± 0.007	ARNDT 96	IPWA	$\gamma N \rightarrow \pi N$
–0.020 ± 0.002	LI 93	IPWA	$\gamma N \rightarrow \pi N$
–0.012	WADA 84	DPWA	Compton scattering

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

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.140±0.010 OUR ESTIMATE			
0.131±0.010	ANISOVICH	12A	DPWA Multichannel
0.141±0.002	WORKMAN	12A	DPWA $\gamma N \rightarrow N\pi$
0.143±0.002	DUGGER	07	DPWA $\gamma N \rightarrow \pi N$
0.147±0.010	AHRENS	02	DPWA $\gamma N \rightarrow \pi N$
0.156±0.022	CRAWFORD	83	IPWA $\gamma N \rightarrow \pi N$
0.168±0.013	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.146±0.001	SHKLYAR	13	DPWA Multichannel
0.127±0.003	SHRESTHA	12A	DPWA Multichannel
0.138±0.008	ANISOVICH	10	DPWA Multichannel
0.161	DRECHSEL	07	DPWA $\gamma N \rightarrow \pi N$
0.151	PENNER	02D	DPWA Multichannel
0.130±0.020±0.015	⁶ MUKHOPAD...	98	$\gamma p \rightarrow \eta p$
0.167±0.005	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
0.167±0.002	LI	93	IPWA $\gamma N \rightarrow \pi N$
0.168	WADA	84	DPWA Compton scattering

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

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.050±0.010 OUR ESTIMATE			
-0.046±0.006	CHEN	12A	DPWA $\gamma N \rightarrow \pi N$
-0.066±0.013	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
-0.067±0.004	FUJII	81	DPWA $\gamma N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
-0.038±0.003	SHRESTHA	12A	DPWA Multichannel
-0.077	DRECHSEL	07	DPWA $\gamma N \rightarrow \pi N$
-0.084	PENNER	02D	DPWA Multichannel
-0.048±0.008	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
-0.058±0.003	LI	93	IPWA $\gamma N \rightarrow \pi N$

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

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.115±0.010 OUR ESTIMATE			
-0.115±0.005	CHEN	12A	DPWA $\gamma N \rightarrow \pi N$
-0.124±0.009	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
-0.158±0.003	FUJII	81	DPWA $\gamma N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
-0.101±0.004	SHRESTHA	12A	DPWA Multichannel
-0.154	DRECHSEL	07	DPWA $\gamma N \rightarrow \pi N$
-0.159	PENNER	02D	DPWA Multichannel
-0.140±0.010	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
-0.131±0.003	LI	93	IPWA $\gamma N \rightarrow \pi N$

N(1520) 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 $\pi N \rightarrow N\pi\pi$ 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.
- ² From method II of LONGACRE 75: eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.
- ³ 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.
- ⁴ 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.
- ⁵ LONGACRE 77 considers this coupling to be well determined.
- ⁶ MUKHOPADHYAY 98 uses an effective Lagrangian approach to analyze η photoproduction data. The *ratio* of the $A_{3/2}$ and $A_{1/2}$ amplitudes is determined, with less model dependence than the amplitudes themselves, to be $A_{3/2}/A_{1/2} = -2.5 \pm 0.5 \pm 0.4$.

N(1520) REFERENCES

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

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)
CHEN	12A	PR C86 015206	W. Chen <i>et al.</i>	(DUKE, GWU, MSST, ITEP+)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
WORKMAN	12A	PR C86 015202	R. Workman <i>et al.</i>	(GWU)
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)
THOMA	08	PL B659 87	U. Thoma <i>et al.</i>	(CB-ELSA Collab.)
DRECHSEL	07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)
DUGGER	07	PR C76 025211	M. Dugger <i>et al.</i>	(Jefferson Lab CLAS Collab.)
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.)
ARNDT	05	PR C72 045202	R.A. Arndt <i>et al.</i>	(GWU, PNPI)
ARNDT	04	PR C69 035213	R.A. Arndt <i>et al.</i>	(GWU, TRIU)
AHRENS	02	PRL 88 232002	J. Ahrens <i>et al.</i>	(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+)
TIATOR	99	PR C60 035210	L. Tiator <i>et al.</i>	
MUKHOPAD...	98	PL B444 7	N.C. Mukhopadhyay, N. Mathur	(VPI)
ARNDT	96	PR C53 430	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI, BRCO)
ARNDT	95	PR C52 2120	R.A. Arndt <i>et al.</i>	(VPI, BRCO)
HOEHLER	93	πN 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
WADA	84	NP B247 313	Y. Wada <i>et al.</i>	(INUS)
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)
PDG	82	PL 111B 1	M. Roos <i>et al.</i>	(HELSE, 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
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
