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

$I(J^P) = \frac{1}{2}(\frac{3}{2}^-)$ 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, G **33** 1 (2006).

## *N*(1520) BREIT-WIGNER MASS

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **1515 to 1525 (≈ 1520) OUR ESTIMATE** | | | | |
| 1517 ± 3 | ANISOVICH | 12A | DPWA | Multichannel |
| 1514.5± 0.2 | 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. • • • | | | | |
| 1512.6± 0.5 | SHRESTHA | 12A | DPWA | Multichannel |
| 1524 ± 4 | ANISOVICH | 10 | DPWA | Multichannel |
| 1522 ± 8 | BATINIC | 10 | DPWA | $\pi N \to N\pi, N\eta$ |
| 1520 ±10 | THOMA | 08 | DPWA | Multichannel |
| 1516.3± 0.8 | ARNDT | 04 | DPWA | $\pi N \to \pi N, \eta N$ |
| 1509 ± 1 | PENNER | 02C | DPWA | Multichannel |
| 1518 ± 3 | VRANA | 00 | DPWA | Multichannel |
| 1516 ±10 | ARNDT | 96 | IPWA | $\gamma N \to \pi N$ |
| 1515 | ARNDT | 95 | DPWA | $\pi N \to N\pi$ |
| 1510 | LI | 93 | IPWA | $\gamma N \to \pi N$ |
| 1524 ± 4 | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |
| 1510 | [1] LONGACRE | 77 | IPWA | $\pi N \to N\pi\pi$ |
| 1520 | [2] LONGACRE | 75 | IPWA | $\pi N \to N\pi\pi$ |

## *N*(1520) BREIT-WIGNER WIDTH

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **100 to 125 (≈ 115) OUR ESTIMATE** | | | | |
| 114 ± 5 | ANISOVICH | 12A | DPWA | Multichannel |
| 103.6± 0.4 | 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. • • • | | | | |
| 117 ± 1 | SHRESTHA | 12A | DPWA | Multichannel |
| 117 ± 6 | ANISOVICH | 10 | DPWA | Multichannel |
| 132 ±11 | BATINIC | 10 | DPWA | $\pi N \to N\pi, N\eta$ |
| 125 ±15 | THOMA | 08 | DPWA | Multichannel |
| 98.6± 2.6 | ARNDT | 04 | DPWA | $\pi N \to \pi N, \eta N$ |
| 100 ± 2 | PENNER | 02C | DPWA | Multichannel |
| 124 ± 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

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **1505 to 1515 (≈ 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. • • • | | | | |
| 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

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **105 to 120 (≈ 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. • • • | | | | |
| 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 $|r|$

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **35±3 OUR ESTIMATE** | | | | |
| 36±3 | ANISOVICH | 12A | DPWA | Multichannel |
| 38 | ARNDT | 06 | DPWA | $\pi N \to \pi N$, $\eta N$ |
| 32 | HOEHLER | 93 | ARGD | $\pi N \to \pi N$ |
| 35±2 | CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 35 | BATINIC | 10 | DPWA | $\pi N \to N\pi$, $N\eta$ |
| 35 | ARNDT | 04 | DPWA | $\pi N \to \pi N$, $\eta N$ |
| 34 | ARNDT | 95 | DPWA | $\pi N \to N\pi$ |
| 33 | ARNDT | 91 | DPWA | $\pi N \to \pi N$ Soln SM90 |

### PHASE $\theta$

| *VALUE* (°) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **−10±5 OUR ESTIMATE** | | | | |
| −14±3 | ANISOVICH | 12A | DPWA | Multichannel |
| − 5 | ARNDT | 06 | DPWA | $\pi N \to \pi N$, $\eta N$ |
| − 8 | HOEHLER | 93 | ARGD | $\pi N \to \pi N$ |
| −12±5 | CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| − 7 | BATINIC | 10 | DPWA | $\pi N \to N\pi$, $N\eta$ |
| − 6 | ARNDT | 04 | DPWA | $\pi N \to \pi N$, $\eta N$ |
| 7 | ARNDT | 95 | DPWA | $\pi N \to N\pi$ |
| −10 | ARNDT | 91 | DPWA | $\pi N \to \pi N$ Soln SM90 |

## *N*(1520) INELASTIC POLE RESIDUE

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

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

| *MODULUS (%)* | *PHASE (°)* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|
| **33±5** | **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* |
|---|---|---|---|---|---|
| **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 ($\Gamma_i/\Gamma$) |
|---|---|---|
| $\Gamma_1$ | $N\pi$ | 55–65 % |
| $\Gamma_2$ | $N\eta$ | $(2.3\pm0.4)\times10^{-3}$ |
| $\Gamma_3$ | $N\pi\pi$ | 20–30 % |
| $\Gamma_4$ | $\Delta\pi$ | 15–25 % |
| $\Gamma_5$ | $\Delta(1232)\pi$, *S*-wave | 10–20 % |

| | | |
|---|---|---|
| $\Gamma_6$ | $\Delta(1232)\pi$, $D$-wave | 10–15 % |
| $\Gamma_7$ | $N\rho$ | 15–25 % |
| $\Gamma_8$ | $N\rho$, $S$=3/2, $S$-wave | (9.0±1.0) % |
| $\Gamma_9$ | $N(\pi\pi)^{I=0}_{S\text{-wave}}$ | <8 % |
| $\Gamma_{10}$ | $p\gamma$ | 0.31–0.52 % |
| $\Gamma_{11}$ | $p\gamma$, helicity=1/2 | 0.01–0.02 % |
| $\Gamma_{12}$ | $p\gamma$, helicity=3/2 | 0.30–0.50 % |
| $\Gamma_{13}$ | $n\gamma$ | 0.30–0.53 % |
| $\Gamma_{14}$ | $n\gamma$, helicity=1/2 | 0.04–0.10 % |
| $\Gamma_{15}$ | $n\gamma$, helicity=3/2 | 0.25–0.45 % |

## *N*(1520) BRANCHING RATIOS

### $\Gamma(N\pi)/\Gamma_{\text{total}}$ $\Gamma_1/\Gamma$

| *VALUE* (%) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **55 to 65 OUR ESTIMATE** | | | | |
| 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 | $\pi N \rightarrow \pi N$ & $N\pi\pi$ |

### $\Gamma(N\eta)/\Gamma_{\text{total}}$ $\Gamma_2/\Gamma$

| *VALUE* (%) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **0.23±0.04 OUR AVERAGE** | | | | |
| 0.23±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 $\Delta(1232)\pi$.

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1520) \to \Delta(1232)\pi$, S-wave $(\Gamma_1\Gamma_5)^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **−0.26 to −0.20 OUR ESTIMATE** | | | | |
| −0.26 | [1,5] LONGACRE | 77 | IPWA | $\pi N \to N\pi\pi$ |
| −0.24 | [2] LONGACRE | 75 | IPWA | $\pi N \to N\pi\pi$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| −0.18±0.05 | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |

### $\Gamma(\Delta(1232)\pi$, S-wave$)/\Gamma_{total}$ $\Gamma_5/\Gamma$

| VALUE (%) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **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 |

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

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **−0.28 to −0.24 OUR ESTIMATE** | | | | |
| −0.21 | [1,5] 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. • • • | | | | |
| −0.29±0.03 | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |

### $\Gamma(\Delta(1232)\pi$, D-wave$)/\Gamma_{total}$ $\Gamma_6/\Gamma$

| VALUE (%) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **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 |

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1520) \to N\rho$, S=3/2, S-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 | $\pi N \to N\pi\pi$ |
| −0.24 | [2] LONGACRE | 75 | IPWA | $\pi N \to N\pi\pi$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| −0.35±0.03 | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |

### $\Gamma(N\rho$, S=3/2, S-wave$)/\Gamma_{total}$ $\Gamma_8/\Gamma$

| VALUE (%) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **9 ±1** | VRANA | 00 | DPWA | Multichannel |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 20.9±0.7 | SHRESTHA | 12A | DPWA | Multichannel |

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

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **−0.22 to −0.06 OUR ESTIMATE** | | | | |
| −0.13 | [1,5] LONGACRE | 77 | IPWA | $\pi N \to N\pi\pi$ |
| −0.17 | [2] LONGACRE | 75 | IPWA | $\pi N \to N\pi\pi$ |

### $\Gamma(N(\pi\pi)^{I=0}_{S\text{-wave}})/\Gamma_{total}$ $\Gamma_9/\Gamma$

| 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 |
| <4 | THOMA | 08 | DPWA | Multichannel |

## N(1520) PHOTON DECAY AMPLITUDES

Papers on $\gamma N$ amplitudes predating 1981 may be found in our 2006 edition, Journal of Physics, G **33** 1 (2006).

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

| VALUE ($GeV^{-1/2}$) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **−0.024±0.009 OUR ESTIMATE** | | | | |
| −0.022±0.004 | ANISOVICH | 12A | DPWA | Multichannel |
| −0.019±0.002 | WORKMAN | 12A | DPWA | $\gamma N \to N\pi$ |
| −0.028±0.002 | DUGGER | 07 | DPWA | $\gamma N \to \pi N$ |
| −0.038±0.003 | AHRENS | 02 | DPWA | $\gamma N \to \pi N$ |
| −0.028±0.014 | CRAWFORD | 83 | IPWA | $\gamma N \to \pi N$ |
| −0.007±0.004 | AWAJI | 81 | DPWA | $\gamma N \to \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| −0.034±0.001 | SHRESTHA | 12A | DPWA | Multichannel |
| −0.032±0.006 | ANISOVICH | 10 | DPWA | Multichannel |
| −0.027 | DRECHSEL | 07 | DPWA | $\gamma N \to \pi N$ |
| −0.003 | PENNER | 02D | DPWA | Multichannel |
| −0.052±0.010±0.007 | [6] MUKHOPAD... | 98 | | $\gamma p \to \eta p$ |
| −0.020±0.007 | ARNDT | 96 | IPWA | $\gamma N \to \pi N$ |
| −0.020±0.002 | LI | 93 | IPWA | $\gamma N \to \pi N$ |
| −0.012 | WADA | 84 | DPWA | Compton scattering |

### N(1520) → pγ, helicity-3/2 amplitude $A_{3/2}$

| VALUE ($GeV^{-1/2}$) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **0.150±0.015 OUR ESTIMATE** | | | | |
| 0.131±0.010 | ANISOVICH | 12A | DPWA | Multichannel |
| 0.141±0.002 | WORKMAN | 12A | DPWA | $\gamma N \to N\pi$ |
| 0.143±0.002 | DUGGER | 07 | DPWA | $\gamma N \to \pi N$ |
| 0.147±0.010 | AHRENS | 02 | DPWA | $\gamma N \to \pi N$ |
| 0.156±0.022 | CRAWFORD | 83 | IPWA | $\gamma N \to \pi N$ |
| 0.168±0.013 | AWAJI | 81 | DPWA | $\gamma N \to \pi N$ |

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

| | | | | |
|---|---|---|---|---|
| 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 $A_{1/2}$

| VALUE ($GeV^{-1/2}$) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **−0.059±0.009 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 $A_{3/2}$

| VALUE ($GeV^{-1/2}$) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **−0.139±0.011 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 $\Delta$ resonances as determined from Argand diagrams of $\pi N$ 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 $\eta$ 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).


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|---|---|---|---|---|
| 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) |
| ANISOVICH | 10 | EPJ A44 203 | A.V. Anisovich *et al.* | (BONN, PNPI) |
| 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.* | (Jefferson Lab CLAS Collab.) |
| ARNDT | 06 | PR C74 045205 | R.A. Arndt *et al.* | (GWU) |
| PDG | 06 | JPG 33 1 | W.-M. Yao *et al.* | (PDG Collab.) |
| ARNDT | 05 | PR C72 045202 | R.A. Arndt *et al.* | (GWU, PNPI) |
| ARNDT | 04 | PR C69 035213 | R.A. Arndt *et al.* | (GWU, TRIU) |
| 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+) |
| TIATOR | 99 | PR C60 035210 | L. Tiator *et al.* | |
| MUKHOPAD... | 98 | PL B444 7 | N.C. Mukhopadhyay, N. Mathur | |
| 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) |
| HOEHLER | 93 | $\pi N$ 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 | (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 |
| WADA | 84 | NP B247 313 | Y. Wada *et al.* | (INUS) |
| CRAWFORD | 83 | NP B211 1 | R.L. Crawford, W.T. Morton | (GLAS) |
| PDG | 82 | PL 111B 1 | 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) |
| 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 |
| LONGACRE | 78 | PR D17 1795 | R.S. Longacre *et al.* | (LBL, SLAC) |
| LONGACRE | 77 | NP B122 493 | R.S. Longacre, J. Dolbeau | (SACL) IJP |
| Also | | NP B108 365 | J. Dolbeau *et al.* | (SACL) IJP |
| LONGACRE | 75 | PL 55B 415 | R.S. Longacre *et al.* | (LBL, SLAC) IJP |