# $N(1535)$ $1/2^-$

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

## N(1535) BREIT-WIGNER MASS

| VALUE (MeV) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **1525 to 1545 (≈ 1535) OUR ESTIMATE** | | | | |
| 1526 ± 2 | SHKLYAR | 13 | DPWA | Multichannel |
| 1519 ± 5 | ANISOVICH | 12A | DPWA | Multichannel |
| 1547.0 ± 0.7 | ARNDT | 06 | DPWA | $\pi N \rightarrow \pi N, \eta N$ |
| 1550 ± 40 | CUTKOSKY | 80 | IPWA | $\pi N \rightarrow \pi N$ |
| 1526 ± 7 | HOEHLER | 79 | IPWA | $\pi N \rightarrow \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 1538 ± 1 | SHRESTHA | 12A | DPWA | Multichannel |
| 1535 ± 20 | ANISOVICH | 10 | DPWA | Multichannel |
| 1553 ± 8 | BATINIC | 10 | DPWA | $\pi N \rightarrow N\pi, N\eta$ |
| 1548 ± 15 | THOMA | 08 | DPWA | Multichannel |
| 1546.7 ± 2.2 | ARNDT | 04 | DPWA | $\pi N \rightarrow \pi N, \eta N$ |
| 1526 ± 2 | PENNER | 02C | DPWA | Multichannel |
| 1530 ± 10 | BAI | 01B | BES | $J/\psi \rightarrow p\overline{p}\eta$ |
| 1522 ± 11 | THOMPSON | 01 | CLAS | $\gamma^* p \rightarrow p\eta$ |
| 1542 ± 3 | VRANA | 00 | DPWA | Multichannel |
| 1532 ± 5 | ARMSTRONG | 99B | DPWA | $\gamma^* p \rightarrow p\eta$ |
| 1549.0 ± 2.1 | ABAEV | 96 | DPWA | $\pi^- p \rightarrow \eta n$ |
| 1525 ± 10 | ARNDT | 96 | IPWA | $\gamma N \rightarrow \pi N$ |
| 1535 | ARNDT | 95 | DPWA | $\pi N \rightarrow N\pi$ |
| 1544 ± 13 | KRUSCHE | 95 | DPWA | $\gamma p \rightarrow p\eta$ |
| 1518 | LI | 93 | IPWA | $\gamma N \rightarrow \pi N$ |
| 1534 ± 7 | MANLEY | 92 | IPWA | $\pi N \rightarrow \pi N$ & $N\pi\pi$ |
| 1520 | [1] LONGACRE | 77 | IPWA | $\pi N \rightarrow N\pi\pi$ |
| 1510 | [2] LONGACRE | 75 | IPWA | $\pi N \rightarrow N\pi\pi$ |

## N(1535) BREIT-WIGNER WIDTH

| VALUE (MeV) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **125 to 175 (≈ 150) OUR ESTIMATE** | | | | |
| 131 ± 12 | SHKLYAR | 13 | DPWA | Multichannel |
| 128 ± 14 | ANISOVICH | 12A | DPWA | Multichannel |
| 188.4 ± 3.8 | ARNDT | 06 | DPWA | $\pi N \rightarrow \pi N, \eta N$ |
| 148.2 ± 8.1 | GREEN | 97 | DPWA | $\pi N \rightarrow \pi N, \eta N$ |
| 240 ± 80 | CUTKOSKY | 80 | IPWA | $\pi N \rightarrow \pi N$ |
| 120 ± 20 | HOEHLER | 79 | IPWA | $\pi N \rightarrow \pi N$ |

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

| | | | | |
|---|---|---|---|---|
| 141 ± 4 | SHRESTHA | 12A | DPWA | Multichannel |
| 170 ±35 | ANISOVICH | 10 | DPWA | Multichannel |
| 182 ±25 | BATINIC | 10 | DPWA | $\pi N \rightarrow N\pi$, $N\eta$ |
| 170 ±20 | THOMA | 08 | DPWA | Multichannel |
| 178.0±11.6 | ARNDT | 04 | DPWA | $\pi N \rightarrow \pi N$, $\eta N$ |
| 129 ± 8 | PENNER | 02C | DPWA | Multichannel |
| 95 ±25 | BAI | 01B | BES | $J/\psi \rightarrow p\overline{p}\eta$ |
| 143 ±18 | THOMPSON | 01 | CLAS | $\gamma^* p \rightarrow p\eta$ |
| 112 ±19 | VRANA | 00 | DPWA | Multichannel |
| 154 ±20 | ARMSTRONG | 99B | DPWA | $\gamma^* p \rightarrow p\eta$ |
| 212 ±20 | [3] KRUSCHE | 97 | DPWA | $\gamma N \rightarrow \eta N$ |
| 168.8±11.6 | ABAEV | 96 | DPWA | $\pi^- p \rightarrow \eta n$ |
| 103 ± 5 | ARNDT | 96 | IPWA | $\gamma N \rightarrow \pi N$ |
| 66 | ARNDT | 95 | DPWA | $\pi N \rightarrow N\pi$ |
| 200 ±40 | KRUSCHE | 95 | DPWA | $\gamma p \rightarrow p\eta$ |
| 84 | LI | 93 | IPWA | $\gamma N \rightarrow \pi N$ |
| 151 ±27 | MANLEY | 92 | IPWA | $\pi N \rightarrow \pi N$ & $N\pi\pi$ |
| 135 | [1] LONGACRE | 77 | IPWA | $\pi N \rightarrow N\pi\pi$ |
| 100 | [2] LONGACRE | 75 | IPWA | $\pi N \rightarrow N\pi\pi$ |

# N(1535) POLE POSITION

## REAL PART

| VALUE (MeV) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **1490 to 1530 (≈ 1510) OUR ESTIMATE** | | | | |
| 1501± 4 | ANISOVICH | 12A | DPWA | Multichannel |
| 1502 | ARNDT | 06 | DPWA | $\pi N \rightarrow \pi N$, $\eta N$ |
| 1487 | [4] HOEHLER | 93 | SPED | $\pi N \rightarrow \pi N$ |
| 1510±50 | CUTKOSKY | 80 | IPWA | $\pi N \rightarrow \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 1490 | SHKLYAR | 13 | DPWA | Multichannel |
| 1515 | SHRESTHA | 12A | DPWA | Multichannel |
| 1510±25 | ANISOVICH | 10 | DPWA | Multichannel |
| 1521±14 | BATINIC | 10 | DPWA | $\pi N \rightarrow N\pi$, $N\eta$ |
| $1508^{+10}_{-30}$ | THOMA | 08 | DPWA | Multichannel |
| 1526 | ARNDT | 04 | DPWA | $\pi N \rightarrow \pi N$, $\eta N$ |
| 1525 | VRANA | 00 | DPWA | Multichannel |
| 1510±10 | [5] ARNDT | 98 | DPWA | $\pi N \rightarrow \pi N$, $\eta N$ |
| 1501 | ARNDT | 95 | DPWA | $\pi N \rightarrow N\pi$ |
| 1499 | ARNDT | 91 | DPWA | $\pi N \rightarrow \pi N$ Soln SM90 |
| 1496 or 1499 | [6] LONGACRE | 78 | IPWA | $\pi N \rightarrow N\pi\pi$ |
| 1525 or 1527 | [1] LONGACRE | 77 | IPWA | $\pi N \rightarrow N\pi\pi$ |

## −2×IMAGINARY PART

| VALUE (MeV) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **90 to 250 (≈ 170) OUR ESTIMATE** | | | | |
| 134±11 | ANISOVICH | 12A | DPWA | Multichannel |
| 95 | ARNDT | 06 | DPWA | $\pi N \rightarrow \pi N$, $\eta N$ |
| 260±80 | CUTKOSKY | 80 | IPWA | $\pi N \rightarrow \pi N$ |

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

| | | | | |
|---|---|---|---|---|
| 100 | SHKLYAR | 13 | DPWA | Multichannel |
| 123 | SHRESTHA | 12A | DPWA | Multichannel |
| 140±30 | ANISOVICH | 10 | DPWA | Multichannel |
| 190±28 | BATINIC | 10 | DPWA | $\pi N \rightarrow N\pi$, $N\eta$ |
| 165±15 | THOMA | 08 | DPWA | Multichannel |
| 130 | ARNDT | 04 | DPWA | $\pi N \rightarrow \pi N$, $\eta N$ |
| 102 | VRANA | 00 | DPWA | Multichannel |
| 170±30 | [5] ARNDT | 98 | DPWA | $\pi N \rightarrow \pi N$, $\eta N$ |
| 124 | ARNDT | 95 | DPWA | $\pi N \rightarrow N\pi$ |
| 110 | ARNDT | 91 | DPWA | $\pi N \rightarrow \pi N$ Soln SM90 |
| 103 or 105 | [6] LONGACRE | 78 | IPWA | $\pi N \rightarrow N\pi\pi$ |
| 135 or 123 | [1] LONGACRE | 77 | IPWA | $\pi N \rightarrow N\pi\pi$ |

## N(1535) ELASTIC POLE RESIDUE

### MODULUS |r|

| VALUE (MeV) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **50±20 OUR ESTIMATE** | | | | |
| 31± 4 | ANISOVICH | 12A | DPWA | Multichannel |
| 16 | ARNDT | 06 | DPWA | $\pi N \rightarrow \pi N$, $\eta N$ |
| 120±40 | CUTKOSKY | 80 | IPWA | $\pi N \rightarrow \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 15 | SHKLYAR | 13 | DPWA | Multichannel |
| 68 | BATINIC | 10 | DPWA | $\pi N \rightarrow N\pi$, $N\eta$ |
| 33 | ARNDT | 04 | DPWA | $\pi N \rightarrow \pi N$, $\eta N$ |
| 31 | ARNDT | 95 | DPWA | $\pi N \rightarrow N\pi$ |
| 23 | ARNDT | 91 | DPWA | $\pi N \rightarrow \pi N$ Soln SM90 |

### PHASE $\theta$

| VALUE (°) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **−15±15 OUR ESTIMATE** | | | | |
| −29± 5 | ANISOVICH | 12A | DPWA | Multichannel |
| −16 | ARNDT | 06 | DPWA | $\pi N \rightarrow \pi N$, $\eta N$ |
| +15±45 | CUTKOSKY | 80 | IPWA | $\pi N \rightarrow \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| −51 | SHKLYAR | 13 | DPWA | Multichannel |
| 12 | BATINIC | 10 | DPWA | $\pi N \rightarrow N\pi$, $N\eta$ |
| 14 | ARNDT | 04 | DPWA | $\pi N \rightarrow \pi N$, $\eta N$ |
| −12 | ARNDT | 95 | DPWA | $\pi N \rightarrow N\pi$ |
| −13 | ARNDT | 91 | DPWA | $\pi N \rightarrow \pi N$ Soln SM90 |

## N(1535) INELASTIC POLE RESIDUE

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

### Normalized residue in $N\pi \rightarrow N(1535) \rightarrow N\eta$

| MODULUS (%) | PHASE (°) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **43±3** | **−76 ± 5** | ANISOVICH | 12A | DPWA | Multichannel |

### Normalized residue in $N\pi \rightarrow N(1535) \rightarrow \Delta\pi$, D-wave

| MODULUS (%) | PHASE (°) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **12±3** | **145 ± 17** | ANISOVICH | 12A | DPWA | Multichannel |

## N(1535) DECAY MODES

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

| | Mode | Fraction ($\Gamma_i/\Gamma$) |
|---|---|---|
| $\Gamma_1$ | $N\pi$ | 35–55 % |
| $\Gamma_2$ | $N\eta$ | (42 ±10 ) % |
| $\Gamma_3$ | $N\pi\pi$ | 1–10 % |
| $\Gamma_4$ | $\Delta\pi$ | <1 % |
| $\Gamma_5$ | $\Delta(1232)\pi$, D-wave | 0–4 % |
| $\Gamma_6$ | $N\rho$ | <4 % |
| $\Gamma_7$ | $N\rho$, S=1/2, S-wave | ( 2.0± 1.0) % |
| $\Gamma_8$ | $N\rho$, S=3/2, D-wave | ( 0.0± 1.0) % |
| $\Gamma_9$ | $N(\pi\pi)^{I=0}_{S\text{-wave}}$ | ( 2 ± 1 ) % |
| $\Gamma_{10}$ | $N(1440)\pi$ | ( 8 ± 3 ) % |
| $\Gamma_{11}$ | $p\gamma$ | 0.15–0.30 % |
| $\Gamma_{12}$ | $p\gamma$, helicity=1/2 | 0.15–0.30 % |
| $\Gamma_{13}$ | $n\gamma$ | 0.01–0.25 % |
| $\Gamma_{14}$ | $n\gamma$, helicity=1/2 | 0.01–0.25 % |

## N(1535) BRANCHING RATIOS

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

| VALUE (%) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **35 to 55 OUR ESTIMATE** | | | | |
| 35 ± 3 | SHKLYAR | 13 | DPWA | Multichannel |
| 54 ± 5 | ANISOVICH | 12A | DPWA | Multichannel |
| 35.5± 0.2 | ARNDT | 06 | DPWA | $\pi N \rightarrow \pi N$, $\eta N$ |
| 39.4± 0.9 | GREEN | 97 | DPWA | $\pi N \rightarrow \pi N$, $\eta N$ |
| 50 ±10 | CUTKOSKY | 80 | IPWA | $\pi N \rightarrow \pi N$ |
| 38 ± 4 | HOEHLER | 79 | IPWA | $\pi N \rightarrow \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 37 ± 1 | SHRESTHA | 12A | DPWA | Multichannel |
| 35 ±15 | ANISOVICH | 10 | DPWA | Multichannel |
| 46 ± 7 | BATINIC | 10 | DPWA | $\pi N \rightarrow N\pi$, $N\eta$ |
| 37 ± 9 | THOMA | 08 | DPWA | Multichannel |
| 36.0± 0.9 | ARNDT | 04 | DPWA | $\pi N \rightarrow \pi N$, $\eta N$ |
| 36 ± 1 | PENNER | 02C | DPWA | Multichannel |
| 35 ± 8 | VRANA | 00 | DPWA | Multichannel |
| 33.0± 1.1 | ABAEV | 96 | DPWA | $\pi^- p \rightarrow \eta n$ |
| 31 | ARNDT | 95 | DPWA | $\pi N \rightarrow N\pi$ |
| 51 ± 5 | MANLEY | 92 | IPWA | $\pi N \rightarrow \pi N$ & $N\pi\pi$ |

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

| VALUE (%) | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **42 ±10 OUR ESTIMATE** | | | | | |
| 58 ± 4 | | SHKLYAR | 13 | DPWA | Multichannel |
| 33 ± 5 | | ANISOVICH | 12A | DPWA | Multichannel |
| 53 ± 1 | | PENNER | 02C | DPWA | Multichannel |
| 51 ± 5 | | VRANA | 00 | DPWA | Multichannel |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 41 ± 2 | | SHRESTHA | 12A | DPWA | Multichannel |
| 50 ± 7 | | BATINIC | 10 | DPWA | $\pi N \to N\pi$, $N\eta$ |
| 40 ±10 | | THOMA | 08 | DPWA | Multichannel |
| >45 | 95 | [7] ARMSTRONG | 99B | DPWA | $p\,(e,e'p)\,\eta$ |
| 56.8± 1.1 | | GREEN | 97 | DPWA | $\pi N \to \pi N$, $\eta N$ |
| 59.1± 1.7 | | ABAEV | 96 | DPWA | $\pi^- p \to \eta n$ |

## $\Gamma(N\eta)/\Gamma(N\pi)$ — $\Gamma_2/\Gamma_1$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 0.95±0.03 | AZNAURYAN | 09 | CLAS | $\pi$, $\eta$ electroproduction |

## $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1535) \to N\eta$ — $(\Gamma_1\Gamma_2)^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **+0.44 to +0.50 OUR ESTIMATE** | | | | |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| +0.47±0.02 | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |

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 $N\pi \to N(1535) \to \Delta(1232)\pi$, D-wave — $(\Gamma_1\Gamma_5)^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **−0.04 to +0.06 OUR ESTIMATE** | | | | |
| 0.00 | [1] LONGACRE | 77 | IPWA | $\pi N \to N\pi\pi$ |
| +0.06 | [2] LONGACRE | 75 | IPWA | $\pi N \to N\pi\pi$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| +0.00±0.04 | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |

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

| VALUE (%) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **0 to 4 OUR ESTIMATE** | | | | |
| 2.5±1.5 | ANISOVICH | 12A | DPWA | Multichannel |
| 1 ±1 | VRANA | 00 | DPWA | Multichannel |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 1.8±0.8 | SHRESTHA | 12A | DPWA | Multichannel |
| 23 ±8 | THOMA | 08 | DPWA | Multichannel |

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1535) \to N\rho$, $S$=1/2, $S$-wave — $(\Gamma_1\Gamma_7)^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **−0.14 to −0.06 OUR ESTIMATE** | | | | |
| −0.10 | [1] LONGACRE | 77 | IPWA | $\pi N \to N\pi\pi$ |
| −0.09 | [2] LONGACRE | 75 | IPWA | $\pi N \to N\pi\pi$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| −0.10±0.03 | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |

### $\Gamma(N\rho$, $S$=1/2, $S$-wave$)/\Gamma_{total}$ — $\Gamma_7/\Gamma$

| VALUE (%) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **2±1** | VRANA | 00 | DPWA | Multichannel |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 10±1 | SHRESTHA | 12A | DPWA | Multichannel |

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

| VALUE (%) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **0±1** | VRANA | 00 | DPWA | Multichannel |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 8±1 | SHRESTHA | 12A | DPWA | Multichannel |

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1535) \to N(\pi\pi)^{I=0}_{S\text{-wave}}$ — $(\Gamma_1\Gamma_9)^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **+0.03 to +0.13 OUR ESTIMATE** | | | | |
| +0.08 | [1] LONGACRE | 77 | IPWA | $\pi N \to N\pi\pi$ |
| +0.09 | [2] LONGACRE | 75 | IPWA | $\pi N \to N\pi\pi$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| +0.07±0.04 | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |

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

| VALUE (%) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **2 ±1** | VRANA | 00 | DPWA | Multichannel |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 1.5±0.5 | SHRESTHA | 12A | DPWA | Multichannel |

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1535) \to N(1440)\pi$ — $(\Gamma_1\Gamma_{10})^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| +0.10±0.05 | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |

### $\Gamma(N(1440)\pi)/\Gamma_{total}$ — $\Gamma_{10}/\Gamma$

| VALUE (%) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **8±3 OUR ESTIMATE** | | | | |
| 8±2 | [8] STAROSTIN | 03 | | $\pi^- p \to n 3\pi^0$ |
| 10±9 | VRANA | 00 | DPWA | Multichannel |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| < 1 | SHRESTHA | 12A | DPWA | Multichannel |

# N(1535) PHOTON DECAY AMPLITUDES

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

## $N(1535) \rightarrow p\gamma$, helicity-1/2 amplitude $A_{1/2}$

| VALUE (GeV$^{-1/2}$) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **+0.115±0.015 OUR ESTIMATE** | | | | |
| 0.105±0.010 | ANISOVICH | 12A | DPWA | Multichannel |
| 0.128±0.004 | WORKMAN | 12A | DPWA | $\gamma N \rightarrow N\pi$ |
| 0.091±0.002 | DUGGER | 07 | DPWA | $\gamma N \rightarrow \pi N$ |
| 0.120±0.011±0.015 | [3] KRUSCHE | 97 | DPWA | $\gamma N \rightarrow \eta N$ |
| 0.097±0.006 | BENMERROU... | 95 | DPWA | $\gamma N \rightarrow N\eta$ |
| 0.095±0.011 | [9] BENMERROU... | 91 | | $\gamma p \rightarrow p\eta$ |
| 0.053±0.015 | CRAWFORD | 83 | IPWA | $\gamma N \rightarrow \pi N$ |
| 0.077±0.021 | AWAJI | 81 | DPWA | $\gamma N \rightarrow \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 0.091±0.004 | SHKLYAR | 13 | DPWA | Multichannel |
| 0.059±0.003 | SHRESTHA | 12A | DPWA | Multichannel |
| 0.090±0.015 | ANISOVICH | 10 | DPWA | Multichannel |
| 0.090±0.025 | [10] ANISOVICH | 09A | DPWA | $\gamma d \rightarrow \eta N(N)$ |
| 0.066 | DRECHSEL | 07 | DPWA | $\gamma N \rightarrow \pi N$ |
| 0.090 | PENNER | 02D | DPWA | Multichannel |
| 0.060±0.015 | ARNDT | 96 | IPWA | $\gamma N \rightarrow \pi N$ |
| 0.110 to 0.140 | KRUSCHE | 95 | DPWA | $\gamma p \rightarrow p\eta$ |
| 0.125±0.025 | KRUSCHE | 95C | IPWA | $\gamma d \rightarrow \eta N(N)$ |
| 0.061±0.003 | LI | 93 | IPWA | $\gamma N \rightarrow \pi N$ |
| 0.055 | WADA | 84 | DPWA | Compton scattering |

## $N(1535) \rightarrow n\gamma$, helicity-1/2 amplitude $A_{1/2}$

| VALUE (GeV$^{-1/2}$) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **−0.075±0.020 OUR ESTIMATE** | | | | |
| −0.058±0.006 | CHEN | 12A | DPWA | $\gamma N \rightarrow \pi N$ |
| −0.080±0.020 | [11] ANISOVICH | 09A | DPWA | $\gamma d \rightarrow \eta N(N)$ |
| 0.035±0.014 | AWAJI | 81 | DPWA | $\gamma N \rightarrow \pi N$ |
| −0.062±0.003 | FUJII | 81 | DPWA | $\gamma N \rightarrow \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| −0.049±0.003 | SHRESTHA | 12A | DPWA | Multichannel |
| −0.051 | DRECHSEL | 07 | DPWA | $\gamma N \rightarrow \pi N$ |
| −0.024 | PENNER | 02D | DPWA | Multichannel |
| −0.020±0.035 | ARNDT | 96 | IPWA | $\gamma N \rightarrow \pi N$ |
| −0.100±0.030 | KRUSCHE | 95C | IPWA | $\gamma d \rightarrow \eta N(N)$ |
| −0.046±0.005 | LI | 93 | IPWA | $\gamma N \rightarrow \pi N$ |

## $N(1535) \rightarrow N\gamma$, ratio $A^n_{1/2}/A^p_{1/2}$

| VALUE (GeV$^{-1/2}$) | DOCUMENT ID | | TECN |
|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | |
| −0.84±0.15 | MUKHOPAD... | 95B | IPWA |

## *N*(1535) 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] KRUSCHE 97 fits with the mass fixed at 1544 MeV.

[4] 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.

[5] ARNDT 98 also lists pole residues, which display more model dependence than do the associated pole positions.

[6] 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.

[7] The best value ARMSTRONG 99B obtains is $\simeq 0.55$; this assumes $S_{11}$ dominance in the reaction $p(e,\, e' p)\, \eta$ at $Q^2 = 4$ (GeV$/c)^2$.

[8] This STAROSTIN 03 value is an estimate made using simplest assumptions.

[9] BENMERROUCHE 91 uses an effective Lagrangian approach to analyze $\eta$ photoproduction data.

[10] This ANISOVICH 09A amplitude is evaluated at the pole position; the phase is $(20 \pm 15)^\circ$.

[11] This ANISOVICH 09A amplitude is evaluated at the pole position; the phase is $(20 \pm 20)^\circ$.

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