

$$\Delta(1900) \ 1/2^-$$

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

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

$\Delta(1900)$ POLE POSITION

REAL PART

| VALUE (MeV) | DOCUMENT ID | TECN | COMMENT |
|---|--------------------|------|--------------------------------|
| 1830 to 1900 (\approx 1865) OUR ESTIMATE | | | |
| 1845 \pm 20 | SOKHOYAN | 15A | DPWA Multichannel |
| 1865 \pm 35 \pm 19 | ¹ SVARC | 14 | L+P $\pi N \rightarrow \pi N$ |
| 1870 \pm 40 | CUTKOSKY | 80 | IPWA $\pi N \rightarrow \pi N$ |
| ● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ● | | | |
| 1957 | HUNT | 19 | DPWA Multichannel |
| 1845 \pm 20 | GUTZ | 14 | DPWA Multichannel |
| 1845 \pm 25 | ANISOVICH | 12A | DPWA Multichannel |
| 1795 | VRANA | 00 | DPWA Multichannel |
| 1780 | HOEHLER | 93 | SPED $\pi N \rightarrow \pi N$ |

¹Fit to the amplitudes of HOEHLER 79.

−2×IMAGINARY PART

| VALUE (MeV) | DOCUMENT ID | TECN | COMMENT |
|---|--------------------|------|--------------------------------|
| 180 to 300 (\approx 240) OUR ESTIMATE | | | |
| 295 \pm 35 | SOKHOYAN | 15A | DPWA Multichannel |
| 187 \pm 50 \pm 19 | ¹ SVARC | 14 | L+P $\pi N \rightarrow \pi N$ |
| 180 \pm 50 | CUTKOSKY | 80 | IPWA $\pi N \rightarrow \pi N$ |
| ● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ● | | | |
| 447 | HUNT | 19 | DPWA Multichannel |
| 295 \pm 35 | GUTZ | 14 | DPWA Multichannel |
| 300 \pm 45 | ANISOVICH | 12A | DPWA Multichannel |
| 58 | VRANA | 00 | DPWA Multichannel |

¹Fit to the amplitudes of HOEHLER 79.

$\Delta(1900)$ ELASTIC POLE RESIDUE

MODULUS $|r|$

| VALUE (MeV) | DOCUMENT ID | TECN | COMMENT |
|---|--------------------|------|--------------------------------|
| 8 to 14 (\approx 11) OUR ESTIMATE | | | |
| 11 \pm 2 | SOKHOYAN | 15A | DPWA Multichannel |
| 11 \pm 4 \pm 2 | ¹ SVARC | 14 | L+P $\pi N \rightarrow \pi N$ |
| 10 \pm 3 | CUTKOSKY | 80 | IPWA $\pi N \rightarrow \pi N$ |
| ● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ● | | | |
| 11 \pm 2 | GUTZ | 14 | DPWA Multichannel |
| 10 \pm 3 | ANISOVICH | 12A | DPWA Multichannel |

¹Fit to the amplitudes of HOEHLER 79.

PHASE θ

| <u>VALUE ($^\circ$)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|---|--------------------|-------------|--------------------------------|
| -115 ± 20 | SOKHOYAN | 15A | DPWA Multichannel |
| $20 \pm 27 \pm 19$ | ¹ SVARC | 14 | L+P $\pi N \rightarrow \pi N$ |
| $+ 20 \pm 40$ | CUTKOSKY | 80 | IPWA $\pi N \rightarrow \pi N$ |
| ● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ● | | | |
| -115 ± 20 | GUTZ | 14 | DPWA Multichannel |
| -125 ± 20 | ANISOVICH | 12A | DPWA Multichannel |
| ¹ Fit to the amplitudes of HOEHLER 79. | | | |

 $\Delta(1900)$ INELASTIC POLE RESIDUE

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

Normalized residue in $N\pi \rightarrow \Delta(1900) \rightarrow \Sigma K$

| <u>MODULUS</u> | <u>PHASE ($^\circ$)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|-----------------|------------------------------------|--------------------|-------------|-------------------|
| 0.07 ± 0.02 | -50 ± 30 | ANISOVICH | 12A | DPWA Multichannel |

Normalized residue in $N\pi \rightarrow \Delta(1900) \rightarrow \Delta\pi, D$ -wave

| <u>MODULUS</u> | <u>PHASE ($^\circ$)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|---|------------------------------------|--------------------|-------------|-------------------|
| 0.18 ± 0.10 | 105 ± 25 | SOKHOYAN | 15A | DPWA Multichannel |
| ● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ● | | | | |
| $0.12^{+0.08}_{-0.05}$ | 110 ± 20 | ANISOVICH | 12A | DPWA Multichannel |

Normalized residue in $N\pi \rightarrow \Delta(1900) \rightarrow \Delta(1232)\eta$

| <u>MODULUS</u> | <u>PHASE ($^\circ$)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|-------------------|------------------------------------|--------------------|-------------|-------------------|
| 0.013 ± 0.006 | undefined | GUTZ | 14 | DPWA Multichannel |

Normalized residue in $N\pi \rightarrow \Delta(1900) \rightarrow N(1440)\pi$

| <u>MODULUS</u> | <u>PHASE ($^\circ$)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|-----------------|------------------------------------|--------------------|-------------|-------------------|
| 0.11 ± 0.06 | 115 ± 30 | SOKHOYAN | 15A | DPWA Multichannel |

Normalized residue in $N\pi \rightarrow \Delta(1900) \rightarrow N(1520)\pi$

| <u>MODULUS</u> | <u>PHASE ($^\circ$)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|-----------------|------------------------------------|--------------------|-------------|-------------------|
| 0.06 ± 0.03 | undefined | SOKHOYAN | 15A | DPWA Multichannel |

 $\Delta(1900)$ BREIT-WIGNER MASS

| <u>VALUE (MeV)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|---|-----------------------|-------------|--------------------------------|
| 1840 to 1920 (≈ 1860) OUR ESTIMATE | | | |
| 1989 ± 22 | ¹ HUNT | 19 | DPWA Multichannel |
| 1840 ± 20 | SOKHOYAN | 15A | DPWA Multichannel |
| 1890 ± 50 | CUTKOSKY | 80 | IPWA $\pi N \rightarrow \pi N$ |
| 1908 ± 30 | HOEHLER | 79 | IPWA $\pi N \rightarrow \pi N$ |
| ● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ● | | | |
| 1840 ± 20 | GUTZ | 14 | DPWA Multichannel |
| 1840 ± 30 | ANISOVICH | 12A | DPWA Multichannel |
| 1868 ± 12 | ¹ SHRESTHA | 12A | DPWA Multichannel |
| 1802 ± 87 | VRANA | 00 | DPWA Multichannel |

¹Statistical error only.

$\Delta(1900)$ BREIT-WIGNER WIDTH

| VALUE (MeV) | DOCUMENT ID | TECN | COMMENT |
|---|-----------------------|------|--------------------------------|
| 180 to 320 (≈ 250) OUR ESTIMATE | | | |
| 457 ± 60 | ¹ HUNT | 19 | DPWA Multichannel |
| 295 ± 30 | SOKHOYAN | 15A | DPWA Multichannel |
| 170 ± 50 | CUTKOSKY | 80 | IPWA $\pi N \rightarrow \pi N$ |
| 140 ± 40 | HOEHLER | 79 | IPWA $\pi N \rightarrow \pi N$ |
| ● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ● | | | |
| 295 ± 30 | GUTZ | 14 | DPWA Multichannel |
| 300 ± 45 | ANISOVICH | 12A | DPWA Multichannel |
| 234 ± 27 | ¹ SHRESTHA | 12A | DPWA Multichannel |
| 48 ± 45 | VRANA | 00 | DPWA Multichannel |
| ¹ Statistical error only. | | | |

 $\Delta(1900)$ DECAY MODES

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

| Mode | Fraction (Γ_i/Γ) |
|--|--------------------------------|
| Γ_1 $N\pi$ | 4–12 % |
| Γ_2 ΣK | seen |
| Γ_3 $N\pi\pi$ | 45–85 % |
| Γ_4 $\Delta(1232)\pi$ | |
| Γ_5 $\Delta(1232)\pi$, D -wave | 30–70 % |
| Γ_6 $N\rho$ | |
| Γ_7 $N\rho$, $S=1/2$, S -wave | 8–16 % |
| Γ_8 $N\rho$, $S=3/2$, D -wave | 18–28 % |
| Γ_9 $N(1440)\pi$ | 8–32 % |
| Γ_{10} $N(1520)\pi$ | 2–10 % |
| Γ_{11} $\Delta(1232)\eta$ | 0–2 % |
| Γ_{12} $N\gamma$, helicity=1/2 | 0.06–0.43 % |

 $\Delta(1900)$ BRANCHING RATIOS

| $\Gamma(N\pi)/\Gamma_{\text{total}}$ | DOCUMENT ID | TECN | COMMENT | Γ_1/Γ |
|---|-----------------------|------|--------------------------------|-------------------|
| 4 to 12 (≈ 8) OUR ESTIMATE | | | | |
| 3.7 ± 0.8 | ¹ HUNT | 19 | DPWA Multichannel | |
| 7 ± 2 | SOKHOYAN | 15A | DPWA Multichannel | |
| 10 ± 3 | CUTKOSKY | 80 | IPWA $\pi N \rightarrow \pi N$ | |
| 8 ± 4 | HOEHLER | 79 | IPWA $\pi N \rightarrow \pi N$ | |
| ● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ● | | | | |
| 7 ± 2 | GUTZ | 14 | DPWA Multichannel | |
| 7 ± 3 | ANISOVICH | 12A | DPWA Multichannel | |
| 8 ± 1 | ¹ SHRESTHA | 12A | DPWA Multichannel | |
| 33 ± 10 | VRANA | 00 | DPWA Multichannel | |
| ¹ Statistical error only. | | | | |

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

| <u>VALUE (%)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|---|-----------------------|-------------|-------------------|
| 42 ± 8 | ¹ HUNT | 19 | DPWA Multichannel |
| 50 ± 20 | SOKHOYAN | 15A | DPWA Multichannel |
| ● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ● | | | |
| 15^{+50}_{-10} | ANISOVICH | 12A | DPWA Multichannel |
| 56 ± 6 | ¹ SHRESTHA | 12A | DPWA Multichannel |
| 28 ± 1 | VRANA | 00 | DPWA Multichannel |

¹Statistical error only. $\Gamma(N\rho, S=1/2, S\text{-wave})/\Gamma_{\text{total}}$ Γ_7/Γ

| <u>VALUE (%)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|---|-----------------------|-------------|-------------------|
| 23 ± 12 | ¹ HUNT | 19 | DPWA Multichannel |
| ● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ● | | | |
| 12 ± 4 | ¹ SHRESTHA | 12A | DPWA Multichannel |
| 30 ± 2 | VRANA | 00 | DPWA Multichannel |

¹Statistical error only. $\Gamma(N\rho, S=3/2, D\text{-wave})/\Gamma_{\text{total}}$ Γ_8/Γ

| <u>VALUE (%)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|---|-----------------------|-------------|-------------------|
| 18 ± 7 | ¹ HUNT | 19 | DPWA Multichannel |
| ● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ● | | | |
| 23 ± 5 | ¹ SHRESTHA | 12A | DPWA Multichannel |
| 5 ± 1 | VRANA | 00 | DPWA Multichannel |

¹Statistical error only. $\Gamma(N(1440)\pi)/\Gamma_{\text{total}}$ Γ_9/Γ

| <u>VALUE (%)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|---|-----------------------|-------------|-------------------|
| 12 ± 9 | ¹ HUNT | 19 | DPWA Multichannel |
| 20 ± 12 | SOKHOYAN | 15A | DPWA Multichannel |
| ● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ● | | | |
| < 1 | ¹ SHRESTHA | 12A | DPWA Multichannel |
| 4 ± 1 | VRANA | 00 | DPWA Multichannel |

¹Statistical error only. $\Gamma(N(1520)\pi)/\Gamma_{\text{total}}$ Γ_{10}/Γ

| <u>VALUE (%)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|------------------|--------------------|-------------|-------------------|
| 6 ± 4 | SOKHOYAN | 15A | DPWA Multichannel |

 $\Gamma(\Delta(1232)\eta)/\Gamma_{\text{total}}$ Γ_{11}/Γ

| <u>VALUE (%)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|------------------|--------------------|-------------|-------------------|
| 1 ± 1 | GUTZ | 14 | DPWA Multichannel |

$\Delta(1900)$ PHOTON DECAY AMPLITUDES AT THE POLE **$\Delta(1900) \rightarrow N\gamma$, helicity-1/2 amplitude $A_{1/2}$**

| <u>MODULUS ($\text{GeV}^{-1/2}$)</u> | <u>PHASE ($^\circ$)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|---|------------------------------------|--------------------|-------------|-------------------|
| 0.064 ± 0.015 | 60 ± 20 | SOKHOYAN | 15A | DPWA Multichannel |

 $\Delta(1900)$ BREIT-WIGNER PHOTON DECAY AMPLITUDES **$\Delta(1900) \rightarrow N\gamma$, helicity-1/2 amplitude $A_{1/2}$**

| <u>VALUE ($\text{GeV}^{-1/2}$)</u> | <u>DOCUMENT ID</u> | <u>TECN</u> | <u>COMMENT</u> |
|---|-----------------------|-------------|-------------------|
| 0.212 ± 0.029 | ¹ HUNT | 19 | DPWA Multichannel |
| 0.065 ± 0.015 | SOKHOYAN | 15A | DPWA Multichannel |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | |
| 0.057 ± 0.014 | GUTZ | 14 | DPWA Multichannel |
| -0.082 ± 0.009 | ¹ SHRESTHA | 12A | DPWA Multichannel |

¹Statistical error only. **$\Delta(1900)$ REFERENCES**For early references, see Physics Letters **111B** 1 (1982).

| | | | | |
|-----------|-----|------------------------|--------------------------------------|-------------------------|
| HUNT | 19 | PR C99 055205 | B.C. Hunt, D.M. Manley | |
| SOKHOYAN | 15A | EPJ A51 95 | V. Sokhoyan <i>et al.</i> | (CBELSA/TAPS Collab.) |
| GUTZ | 14 | EPJ A50 74 | E. Gutz <i>et al.</i> | (CBELSA/TAPS Collab.) |
| PDG | 14 | CP C38 070001 | K. Olive <i>et al.</i> | (PDG Collab.) |
| SVARC | 14 | PR C89 045205 | A. Svarc <i>et al.</i> | (RBI Zagreb, UNI Tuzla) |
| ANISOVICH | 12A | EPJ A48 15 | A.V. Anisovich <i>et al.</i> | (BONN, PNPI) |
| SHRESTHA | 12A | PR C86 055203 | M. Shrestha, D.M. Manley | (KSU) |
| VRANA | 00 | PRPL 328 181 | T.P. Vrana, S.A. Dytman, T.-S.H. Lee | (PITT, ANL) |
| HOEHLER | 93 | πN Newsletter 9 1 | G. Hohler | (KARL) |
| 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 |