

$\Delta(1900) 1/2^-$ $I(J^P) = \frac{3}{2}(\frac{1}{2}^-)$ Status: **

OMITTED FROM SUMMARY TABLE

Some obsolete results published before 1980 were last included in our 2006 edition, Journal of Physics, G **33** 1 (2006). Some further obsolete results published before 1984 were last included in our 2006 edition, Journal of Physics, G **33** 1 (2006).

The latest GWU analysis (ARNDT 06) finds no evidence for this resonance.

 $\Delta(1900)$ BREIT-WIGNER MASS

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1840 to 1920 (\approx 1860) OUR ESTIMATE			
1840 \pm 30	ANISOVICH	12A DPWA	Multichannel
1890 \pm 50	CUTKOSKY	80 IPWA	$\pi N \rightarrow \pi N$
1908 \pm 30	HOEHLER	79 IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
1868 \pm 12	SHRESTHA	12A DPWA	Multichannel
1802 \pm 87	VRANA	00 DPWA	Multichannel
1920 \pm 24	MANLEY	92 IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
1918.5 \pm 23.0	CHEW	80 BPWA	$\pi^+ p \rightarrow \pi^+ p$

 $\Delta(1900)$ BREIT-WIGNER WIDTH

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
300 \pm 45	ANISOVICH	12A DPWA	Multichannel
170 \pm 50	CUTKOSKY	80 IPWA	$\pi N \rightarrow \pi N$
140 \pm 40	HOEHLER	79 IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
234 \pm 27	SHRESTHA	12A DPWA	Multichannel
48 \pm 45	VRANA	00 DPWA	Multichannel
263 \pm 39	MANLEY	92 IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
93.5 \pm 54.0	CHEW	80 BPWA	$\pi^+ p \rightarrow \pi^+ p$

 $\Delta(1900)$ POLE POSITION**REAL PART**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1845 \pm 25	ANISOVICH	12A DPWA	Multichannel
1780	¹ HOEHLER	93 SPED	$\pi N \rightarrow \pi N$
1870 \pm 40	CUTKOSKY	80 IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
1844	SHRESTHA	12A DPWA	Multichannel
1795	VRANA	00 DPWA	Multichannel
not seen	ARNDT	91 DPWA	$\pi N \rightarrow \pi N$ Soln SM90
2029 or 2025	² LONGACRE	78 IPWA	$\pi N \rightarrow N\pi\pi$

– 2×IMAGINARY PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
300 ± 45	ANISOVICH 12A	DPWA	Multichannel
180 ± 50	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
223	SHRESTHA 12A	DPWA	Multichannel
58	VRANA 00	DPWA	Multichannel
not seen	ARNDT 91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90
164 or 163	² LONGACRE 78	IPWA	$\pi N \rightarrow N\pi\pi$

$\Delta(1900)$ ELASTIC POLE RESIDUE

MODULUS $|r|$

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
10 ± 3	ANISOVICH 12A	DPWA	Multichannel
10 ± 3	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$

PHASE θ

<u>VALUE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
– 125 ± 20	ANISOVICH 12A	DPWA	Multichannel
+ 20 ± 40	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$

$\Delta(1900)$ 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 (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
7 ± 2	– 50 ± 30	ANISOVICH 12A	DPWA	Multichannel

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

<u>MODULUS (%)</u>	<u>PHASE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
12 ⁺⁸ _{–5}	110 ± 20	ANISOVICH 12A	DPWA	Multichannel

$\Delta(1900)$ DECAY MODES

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

Mode	Fraction (Γ_i/Γ)
Γ_1 $N\pi$	10–30 %
Γ_2 ΣK	
Γ_3 $N\pi\pi$	
Γ_4 $\Delta\pi$	
Γ_5 $\Delta(1232)\pi, D\text{-wave}$	

Γ_6	$N\rho$
Γ_7	$N\rho, S=1/2, S\text{-wave}$
Γ_8	$N\rho, S=3/2, D\text{-wave}$
Γ_9	$N(1440)\pi, S\text{-wave}$
Γ_{10}	$N\gamma, \text{helicity}=1/2$

$\Delta(1900)$ BRANCHING RATIOS

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

VALUE (%)	DOCUMENT ID	TECN	COMMENT
7 ± 3	ANISOVICH	12A	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. • • •			
8 ± 1	SHRESTHA	12A	DPWA Multichannel
33 ± 10	VRANA	00	DPWA Multichannel
41 ± 4	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$
28	CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1900) \rightarrow \Sigma K$ $(\Gamma_1\Gamma_2)^{1/2}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
<0.03	CANDLIN	84	DPWA $\pi^+ p \rightarrow \Sigma^+ K^+$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1900) \rightarrow \Delta(1232)\pi, D\text{-wave}$ $(\Gamma_1\Gamma_5)^{1/2}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
$+0.25 \pm 0.07$	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$

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

VALUE (%)	DOCUMENT ID	TECN	COMMENT
15^{+50}_{-10}	ANISOVICH	12A	DPWA Multichannel
28 ± 1	VRANA	00	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
56 ± 6	SHRESTHA	12A	DPWA Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1900) \rightarrow N\rho, S=1/2, S\text{-wave}$ $(\Gamma_1\Gamma_7)^{1/2}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
-0.14 ± 0.11	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$

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

VALUE (%)	DOCUMENT ID	TECN	COMMENT
30 ± 2	VRANA	00	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
12 ± 4	SHRESTHA	12A	DPWA Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1900) \rightarrow N\rho, S=3/2, D\text{-wave}$ $(\Gamma_1 \Gamma_8)^{1/2} / \Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
-0.37 ± 0.07	MANLEY	92	IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$

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

VALUE (%)	DOCUMENT ID	TECN	COMMENT
5 ± 1	VRANA	00	DPWA Multichannel
23 ± 5	SHRESTHA	12A	DPWA Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1900) \rightarrow N(1440)\pi, S\text{-wave}$ $(\Gamma_1 \Gamma_9)^{1/2} / \Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
-0.16 ± 0.11	MANLEY	92	IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$

$\Gamma(N(1440)\pi, S\text{-wave}) / \Gamma_{\text{total}}$ Γ_9 / Γ

VALUE (%)	DOCUMENT ID	TECN	COMMENT
4 ± 1	VRANA	00	DPWA Multichannel
< 1	SHRESTHA	12A	DPWA Multichannel

$\Delta(1900)$ PHOTON DECAY AMPLITUDES

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

$\Delta(1900) \rightarrow N\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
0.059 ± 0.016	³ ANISOVICH	12A	DPWA Phase = $(60 \pm 25)^\circ$
-0.004 ± 0.016	CRAWFORD	83	IPWA $\gamma N \rightarrow \pi N$
0.029 ± 0.008	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
-0.082 ± 0.009	SHRESTHA	12A	DPWA Multichannel

$\Delta(1900)$ FOOTNOTES

¹ 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.

² 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.

³ This ANISOVICH 12A value is the complex helicity amplitude at the pole position.

Δ(1900) REFERENCES

For early references, see Physics Letters **111B** 1 (1982).

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)
ARNDT	06	PR C74 045205	R.A. Arndt <i>et al.</i>	(GWU)
PDG	06	JPG 33 1	W.-M. Yao <i>et al.</i>	(PDG Collab.)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman,, T.-S.H. Lee	(PITT+)
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)
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
CANDLIN	84	NP B238 477	D.J. Candlin <i>et al.</i>	(EDIN, RAL, LOWC)
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)
AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)
Also		NP B197 365	K. Fujii <i>et al.</i>	(NAGO)
CHEW	80	Toronto Conf. 123	D.M. Chew	(LBL) IJP
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)
