$$\boxed{\Delta(1930)\ 5/2^-}$$ $I(J^P) = \frac{3}{2}(\frac{5}{2}^-)$ 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).

$\Delta(1930)$ BREIT-WIGNER MASS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1900 to 2000 ($\approx$ 1950) OUR ESTIMATE				
2233 $\pm$ 53	ARNDT	06	DPWA	$\pi N \to \pi N,\ \eta N$
1940 $\pm$ 30	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1901 $\pm$ 15	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1930 $\pm$ 12	SHRESTHA	12A	DPWA	Multichannel
2046 $\pm$ 45	ARNDT	04	DPWA	$\pi N \to \pi N,\ \eta N$
1932 $\pm$ 100	VRANA	00	DPWA	Multichannel
1955 $\pm$ 15	ARNDT	96	IPWA	$\gamma N \to \pi N$
2056	ARNDT	95	DPWA	$\pi N \to N\pi$
1963	LI	93	IPWA	$\gamma N \to \pi N$
1956 $\pm$ 22	MANLEY	92	IPWA	$\pi N \to \pi N\ \&\ N\pi\pi$
1910.0$^{+\ 15.0}_{-\ 17.2}$	CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$

$\Delta(1930)$ BREIT-WIGNER WIDTH

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
220 to 500 ($\approx$ 360) OUR ESTIMATE				
773 $\pm$ 187	ARNDT	06	DPWA	$\pi N \to \pi N,\ \eta N$
320 $\pm$ 60	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
195 $\pm$ 60	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
235 $\pm$ 39	SHRESTHA	12A	DPWA	Multichannel
402 $\pm$ 198	ARNDT	04	DPWA	$\pi N \to \pi N,\ \eta N$
316 $\pm$ 237	VRANA	00	DPWA	Multichannel
350 $\pm$ 20	ARNDT	96	IPWA	$\gamma N \to \pi N$
590	ARNDT	95	DPWA	$\pi N \to N\pi$
260	LI	93	IPWA	$\gamma N \to \pi N$
530 $\pm$ 140	MANLEY	92	IPWA	$\pi N \to \pi N\ \&\ N\pi\pi$
74.8$^{+\ 17.0}_{-\ 16.0}$	CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$

$\Delta(1930)$ POLE POSITION

REAL PART

VALUE (MeV)		DOCUMENT ID		TECN	COMMENT
1840 to 1960 ($\approx$ 1900) OUR ESTIMATE					
2001		ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
1850	[1]	HOEHLER	93	SPED	$\pi N \to \pi N$
1890$\pm$50		CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1882		SHRESTHA	12A	DPWA	Multichannel
1966		ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
1883		VRANA	00	DPWA	Multichannel
1913		ARNDT	95	DPWA	$\pi N \to N \pi$
2018		ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90

$-2\times$IMAGINARY PART

VALUE (MeV)		DOCUMENT ID		TECN	COMMENT
175 to 360 ($\approx$ 270) OUR ESTIMATE					
387		ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
180	[1]	HOEHLER	93	SPED	$\pi N \to \pi N$
260$\pm$60		CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
187		SHRESTHA	12A	DPWA	Multichannel
364		ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
250		VRANA	00	DPWA	Multichannel
246		ARNDT	95	DPWA	$\pi N \to N \pi$
398		ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90

$\Delta(1930)$ ELASTIC POLE RESIDUE

MODULUS $|r|$

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
7	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
20	HOEHLER	93	SPED	$\pi N \to \pi N$
18$\pm$6	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
16	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
8	ARNDT	95	DPWA	$\pi N \to N \pi$
15	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90

PHASE θ

VALUE ($°$)	DOCUMENT ID		TECN	COMMENT
-12	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
-20 ± 40	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-21	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
-47	ARNDT	95	DPWA	$\pi N \to N \pi$
-24	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90

Δ(1930) DECAY MODES

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	5–15 %
Γ_2	ΣK	
Γ_3	$N\pi\pi$	
Γ_4	$N\gamma$	0.0–0.02 %
Γ_5	$N\gamma$, helicity=1/2	0.0–0.01 %
Γ_6	$N\gamma$, helicity=3/2	0.0–0.01 %

Δ(1930) BRANCHING RATIOS

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

VALUE (%)	DOCUMENT ID		TECN	COMMENT
5 to 15 OUR ESTIMATE				
8.1±1.2	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
14 ±4	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
4 ±3	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
7.9±0.4	SHRESTHA	12A	DPWA	Multichannel
4.0±1.4	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
9 ±8	VRANA	00	DPWA	Multichannel
11	ARNDT	95	DPWA	$\pi N \to N\pi$
18 ±2	MANLEY	92	IPWA	$\pi N \to \pi N \,\&\, N\pi\pi$
11	CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \to \Delta(1930) \to \Sigma K$ $(\Gamma_1\Gamma_2)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
< 0.015	CANDLIN	84	DPWA	$\pi^+ p \to \Sigma^+ K^+$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.031	LIVANOS	80	DPWA	$\pi p \to \Sigma K$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \to \Delta(1930) \to N\pi\pi$ $(\Gamma_1\Gamma_3)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
not seen	LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

Δ(1930) 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).

Δ(1930) → $N\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.009±0.028 OUR ESTIMATE				
−0.007±0.010	ARNDT	96	IPWA	$\gamma N \to \pi N$
0.009±0.009	AWAJI	81	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				

0.011 ± 0.003	SHRESTHA	12A	DPWA	Multichannel
-0.019 ± 0.001	LI	93	IPWA	$\gamma N \to \pi N$

$\Delta(1930) \to N\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.018±0.028 OUR ESTIMATE				
0.005 ± 0.010	ARNDT	96	IPWA	$\gamma N \to \pi N$
-0.025 ± 0.011	AWAJI	81	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.002 ± 0.002	SHRESTHA	12A	DPWA	Multichannel
0.009 ± 0.001	LI	93	IPWA	$\gamma N \to \pi N$

$\Delta(1930)$ 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.

$\Delta(1930)$ REFERENCES

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

SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
ARNDT	06	PR C74 045205	R.A. Arndt *et al.*	(GWU)
PDG	06	JP G33 1	W.-M. Yao *et al.*	(PDG Collab.)
ARNDT	04	PR C69 035213	R.A. Arndt *et al.*	(GWU, TRIU)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman,, T.-S.H. Lee	(PITT+)
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	πN 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
CANDLIN	84	NP B238 477	D.J. Candlin *et al.*	(EDIN, RAL, LOWC)
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)
CHEW	80	Toronto Conf. 123	D.M. Chew	(LBL) IJP
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
LIVANOS	80	Toronto Conf. 35	P. Livanos *et al.*	(SACL) IJP
HOEHLER	79	PDAT 12-1	G. Hohler *et al.*	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP
LONGACRE	75	PL 55B 415	R.S. Longacre *et al.*	(LBL, SLAC) IJP