$\Delta(1930)\ D_{35}$

$I(J^P) = \frac{3}{2}(\frac{5}{2}^-)$ Status: ∗∗∗

Most of the results published before 1975 are now obsolete and have been omitted. They may be found in our 1982 edition, Physics Letters **111B** (1982).

The various analyses are not in good agreement.

$\Delta(1930)$ BREIT-WIGNER MASS

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1920 to 1970 (≈ 1930) OUR ESTIMATE				
1956 ±22	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
1940 ±30	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
1901 ±15	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1955 ±15	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
2056	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
1963	LI	93	IPWA	$\gamma N \rightarrow \pi N$
$1910.0^{+15.0}_{-17.2}$	CHEW	80	BPWA	$\pi^+ p \rightarrow \pi^+ p$
2000	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$
2024	BARBOUR	78	DPWA	$\gamma N \rightarrow \pi N$

$\Delta(1930)$ BREIT-WIGNER WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
250 to 450 (≈ 350) OUR ESTIMATE				
530 ±140	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
320 ± 60	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
195 ± 60	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
350 ± 20	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
590	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
260	LI	93	IPWA	$\gamma N \rightarrow \pi N$
$74.8^{+17.0}_{-16.0}$	CHEW	80	BPWA	$\pi^+ p \rightarrow \pi^+ p$
442	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$
462	BARBOUR	78	DPWA	$\gamma N \rightarrow \pi N$

$\Delta(1930)$ POLE POSITION

REAL PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1840 to 1940 (≈ 1890) OUR ESTIMATE				
1913	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
1850	[1] HOEHLER	93	SPED	$\pi N \rightarrow \pi N$
1890±50	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2018	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

−2×IMAGINARY PART

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
200 to 300 (≈ 250) OUR ESTIMATE				
246	ARNDT	95	DPWA	$\pi N \to N\pi$
180	[1] HOEHLER	93	SPED	$\pi N \to \pi N$
260±60	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
398	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90

Δ(1930) ELASTIC POLE RESIDUE

MODULUS |r|

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

PHASE θ

VALUE (°)	DOCUMENT ID		TECN	COMMENT
−47	ARNDT	95	DPWA	$\pi N \to N\pi$
−20±40	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−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	$N\pi$	10–20 %
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

$\Gamma(N\pi)/\Gamma_{total}$ — Γ_1/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.1 to 0.2 OUR ESTIMATE				
0.18±0.02	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
0.14±0.04	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
0.04±0.03	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.11	ARNDT	95	DPWA	$\pi N \to N\pi$
0.11	CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$

$(\Gamma_i\Gamma_f)^{½}/\Gamma_{total}$ in $N\pi \to \Delta(1930) \to \Sigma K$ $(\Gamma_1\Gamma_2)^{½}/\Gamma$

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	$\pi p \to \Sigma K$
0.018 to 0.035	[2] DEANS	75	DPWA	$\pi N \to \Sigma K$

$(\Gamma_i\Gamma_f)^{½}/\Gamma_{total}$ in $N\pi \to \Delta(1930) \to N\pi\pi$ $(\Gamma_1\Gamma_3)^{½}/\Gamma$

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

Δ(1930) PHOTON DECAY AMPLITUDES

$\Delta(1930) \to N\gamma$, 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	$\gamma N \to \pi N$
−0.030±0.047	CRAWFORD	80	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.019±0.001	LI	93	IPWA	$\gamma N \to \pi N$
−0.062±0.064	BARBOUR	78	DPWA	$\gamma N \to \pi N$

$\Delta(1930) \to N\gamma$, 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	$\gamma N \to \pi N$
−0.033±0.060	CRAWFORD	80	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.009±0.001	LI	93	IPWA	$\gamma N \to \pi N$
+0.019±0.054	BARBOUR	78	DPWA	$\gamma N \to \pi N$

Δ(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.

[2] The range given for DEANS 75 is from the four best solutions.

$\Delta(1930)$ REFERENCES

For early references, see Physics Letters **111B** 70 (1982).

ARNDT	96	PR C53 430	+Strakovsky, Workman	(VPI)	
ARNDT	95	PR C52 2120	+Strakovsky, Workman, Pavan	(VPI, BRCO)	
HOEHLER	93	πN Newsletter 9 1		(KARL)	
LI	93	PR C47 2759	+Arndt, Roper, Workman	(VPI)	
MANLEY	92	PR D45 4002	+Saleski	(KENT)	IJP
Also	84	PR D30 904	Manley, Arndt, Goradia, Teplitz	(VPI)	
ARNDT	91	PR D43 2131	+Li, Roper, Workman, Ford	(VPI, TELE)	IJP
CANDLIN	84	NP B238 477	+Lowe, Peach, Scotland+	(EDIN, RAL, LOWC)	
PDG	82	PL 111B	Roos, Porter, Aguilar-Benitez+	(HELS, CIT, CERN)	
AWAJI	81	Bonn Conf. 352	+Kajikawa	(NAGO)	
Also	82	NP B197 365	Fujii, Hayashii, Iwata, Kajikawa+	(NAGO)	
CHEW	80	Toronto Conf. 123		(LBL)	IJP
CRAWFORD	80	Toronto Conf. 107		(GLAS)	
CUTKOSKY	80	Toronto Conf. 19	+Forsyth, Babcock, Kelly, Hendrick	(CMU, LBL)	IJP
Also	79	PR D20 2839	Cutkosky, Forsyth, Hendrick, Kelly	(CMU, LBL)	IJP
LIVANOS	80	Toronto Conf. 35	+Baton, Coutures, Kochowski, Neveu	(SACL)	IJP
HOEHLER	79	PDAT 12-1	+Kaiser, Koch, Pietarinen	(KARLT)	IJP
Also	80	Toronto Conf. 3	Koch	(KARLT)	IJP
BARBOUR	78	NP B141 253	+Crawford, Parsons	(GLAS)	
DEANS	75	NP B96 90	+Mitchell, Montgomery+	(SFLA, ALAH)	IJP
LONGACRE	75	PL 55B 415	+Rosenfeld, Lasinski, Smadja+	(LBL, SLAC)	IJP