NODE=B013

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

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

NODE=B013

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, G **33** 1 (2006).

Δ(1930) BREIT-WIGNER MASS

NODE=B013205

NODE=B013M

→ NOT CHECKED ←

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1900 to 2020 (≈ 1960) OUR ESTIMATE				
2233 ± 53	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
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. • • •				
2046 ± 45	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$
1932 ±100	VRANA	00	DPWA	Multichannel
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	$\pi^+ p \rightarrow \pi^+ p$

Δ(1930) BREIT-WIGNER WIDTH

NODE=B013210

NODE=B013W

→ NOT CHECKED ←

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
220 to 500 (≈ 360) OUR ESTIMATE				
773 ±187	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
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. • • •				
402 ±198	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$
316 ±237	VRANA	00	DPWA	Multichannel
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	$\pi^+ p \rightarrow \pi^+ p$

Δ(1930) POLE POSITION

NODE=B013215

REAL PART

NODE=B013RE

NODE=B013RE

→ NOT CHECKED ←

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1840 to 1960 (≈ 1900) OUR ESTIMATE				
2001	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
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. • • •				
1966	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$
1883	VRANA	00	DPWA	Multichannel
1913	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
2018	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

−2×IMAGINARY PART

NODE=B013IM

NODE=B013IM

→ NOT CHECKED ←

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

$\Delta(1930)$ ELASTIC POLE RESIDUE

NODE=B013220

MODULUS $|r|$

NODE=B013RER
NODE=B013RER

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±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

NODE=B013IMR
NODE=B013IMR

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

$\Delta(1930)$ DECAY MODES

NODE=B013225;NODE=B013

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

NODE=B013

	Mode	Fraction (Γ_i/Γ)	
Γ_1	$N\pi$	0.05 to 0.15	DESIG=1
Γ_2	ΣK		DESIG=2
Γ_3	$N\pi\pi$		DESIG=3
Γ_4	$N\gamma$	0.0–0.02 %	DESIG=184;OUR EST
Γ_5	$N\gamma$, helicity=1/2	0.0–0.01 %	DESIG=4;OUR EST
Γ_6	$N\gamma$, helicity=3/2	0.0–0.01 %	DESIG=5;OUR EST

$\Delta(1930)$ BRANCHING RATIOS

NODE=B013230

$\Gamma(N\pi)/\Gamma_{total}$ Γ_1/Γ

NODE=B013R1
NODE=B013R1
→ NOT CHECKED ←

VALUE	DOCUMENT ID		TECN	COMMENT
0.05 to 0.15 OUR ESTIMATE				
0.081±0.012	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
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. • • •				
0.040±0.014	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
0.09 ±0.08	VRANA	00	DPWA	Multichannel
0.11	ARNDT	95	DPWA	$\pi N \to N\pi$
0.11	CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$

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

NODE=B013R2
NODE=B013R2

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	$\pi p \to \Sigma K$

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

NODE=B013R3
NODE=B013R3

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

$\Delta(1930)$ PHOTON DECAY AMPLITUDES

NODE=B013235

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

NODE=B013235

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

NODE=B013A1
NODE=B013A1

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. • • •				
−0.019±0.001	LI	93	IPWA	$\gamma N \to \pi N$

→ NOT CHECKED ←

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

NODE=B013A2
NODE=B013A2

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. • • •				
0.009±0.001	LI	93	IPWA	$\gamma N \to \pi N$

→ NOT CHECKED ←

$\Delta(1930)$ FOOTNOTES

NODE=B013

[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.

NODE=B010;LINKAGE=H9

$\Delta(1930)$ REFERENCES

NODE=B013

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

NODE=B013

ARNDT	06	PR C74 045205	R.A. Arndt *et al.*	(GWU)	REFID=51535
PDG	06	JPG 33 1	W.-M. Yao *et al.*	(PDG Collab.)	REFID=51004
ARNDT	04	PR C69 035213	R.A. Arndt *et al.*	(GWU, TRIU)	REFID=49947
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman,, T.-S.H. Lee	(PITT+)	REFID=47593
ARNDT	96	PR C53 430	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI)	REFID=44675
ARNDT	95	PR C52 2120	R.A. Arndt *et al.*	(VPI, BRCO)	REFID=44535
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)	REFID=43821
LI	93	PR C47 2759	Z.J. Li *et al.*	(VPI)	REFID=43327
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KENT) IJP	REFID=41535
Also		PR D30 904	D.M. Manley *et al.*	(VPI)	REFID=30071
ARNDT	91	PR D43 2131	R.A. Arndt *et al.*	(VPI, TELE) IJP	REFID=41467
CANDLIN	84	NP B238 477	D.J. Candlin *et al.*	(EDIN, RAL, LOWC)	REFID=40339
PDG	82	PL 111B 1	M. Roos *et al.*	(HELS, CIT, CERN)	REFID=41167
AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)	REFID=30067
Also		NP B197 365	K. Fujii *et al.*	(NAGO)	REFID=30068
CHEW	80	Toronto Conf. 123	D.M. Chew	(LBL) IJP	REFID=31151
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky *et al.*	(CMU, LBL) IJP	REFID=30064
Also		PR D20 2839	R.E. Cutkosky *et al.*	(CMU, LBL) IJP	REFID=40096
LIVANOS	80	Toronto Conf. 35	P. Livanos *et al.*	(SACL) IJP	REFID=30402
HOEHLER	79	PDAT 12-1	G. Hohler *et al.*	(KARLT) IJP	REFID=30058
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP	REFID=30859
LONGACRE	75	PL 55B 415	R.S. Longacre *et al.*	(LBL, SLAC) IJP	REFID=30047