$\Delta(1910)\ P_{31}$

$I(J^P) = \frac{3}{2}(\frac{1}{2}^+)$ 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 1980 were last included in our 2006 edition, Journal of Physics, G **33** 1 (2006).

Δ(1910) BREIT-WIGNER MASS

VALUE (MeV)		*DOCUMENT ID*		*TECN*	*COMMENT*
1870 to 1920 (≈ 1910) OUR ESTIMATE					
2067.9 ± 1.7		ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
1882 ± 10		MANLEY	92	IPWA	$\pi N \to \pi N$ & $N \pi \pi$
1910 ± 40		CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1888 ± 20		HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1995 ± 12		VRANA	00	DPWA	Multichannel
2152		ARNDT	95	DPWA	$\pi N \to N \pi$
1960.1 ± 21.0	1	CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$
$2121.4^{+13.0}_{-14.3}$	1	CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$
1921		CRAWFORD	80	DPWA	$\gamma N \to \pi N$
1790	2	LONGACRE	77	IPWA	$\pi N \to N \pi \pi$

Δ(1910) BREIT-WIGNER WIDTH

VALUE (MeV)		*DOCUMENT ID*		*TECN*	*COMMENT*
190 to 270 (≈ 250) OUR ESTIMATE					
543 ± 10		ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
239 ± 25		MANLEY	92	IPWA	$\pi N \to \pi N$ & $N \pi \pi$
225 ± 50		CUTKOSKY	80	IPWA	$\pi N \to \pi N$
280 ± 50		HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
713 ± 465		VRANA	00	DPWA	Multichannel
760		ARNDT	95	DPWA	$\pi N \to N \pi$
152.9 ± 60.0	1	CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$
172.2 ± 37.0	1	CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$
351		CRAWFORD	80	DPWA	$\gamma N \to \pi N$
170	2	LONGACRE	77	IPWA	$\pi N \to N \pi \pi$

Δ(1910) POLE POSITION

REAL PART

VALUE (MeV)		*DOCUMENT ID*		*TECN*	*COMMENT*
1830 to 1880 (≈ 1855) OUR ESTIMATE					
1771		ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
1874	3	HOEHLER	93	SPED	$\pi N \to \pi N$
1880 ± 30		CUTKOSKY	80	IPWA	$\pi N \to \pi N$

• • • We do not use the following data for averages, fits, limits, etc. • • •

1880	VRANA	00	DPWA	Multichannel
1810	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
1950	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90
1792 or 1801	[2] LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$

−2×IMAGINARY PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
200 to 500 (≈ 350) OUR ESTIMATE				
479	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
283	[3] HOEHLER	93	SPED	$\pi N \rightarrow \pi N$
200±40	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
496	VRANA	00	DPWA	Multichannel
494	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
398	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90
172 or 165	[2] LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$

$\Delta(1910)$ ELASTIC POLE RESIDUE

MODULUS $|r|$

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
45	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
38	HOEHLER	93	SPED	$\pi N \rightarrow \pi N$
20±4	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
53	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
37	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

PHASE θ

VALUE (°)	*DOCUMENT ID*		*TECN*	*COMMENT*
+172	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
− 90±30	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−176	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
− 91	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

$\Delta(1910)$ DECAY MODES

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	15–30 %
Γ_2	ΣK	
Γ_3	$N\pi\pi$	
Γ_4	$\Delta\pi$	
Γ_5	$\Delta(1232)\pi$, P-wave	

Γ_6	$N\rho$	
Γ_7	$N\rho$, S=3/2, P-wave	
Γ_8	$N(1440)\pi$	
Γ_9	$N(1440)\pi$, P-wave	
Γ_{10}	$N\gamma$	0.0–0.2 %
Γ_{11}	$N\gamma$, helicity=1/2	0.0–0.2 %

$\Delta(1910)$ BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{total}$ — Γ_1/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.15 to 0.3 OUR ESTIMATE				
0.239±0.001	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
0.23 ±0.08	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
0.19 ±0.03	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
0.24 ±0.06	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.29 ±0.21	VRANA	00	DPWA	Multichannel
0.26	ARNDT	95	DPWA	$\pi N \to N\pi$
0.17	[1] CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$
0.40	[1] CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1910) \to \Sigma K$ — $(\Gamma_1\Gamma_2)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
$<$ 0.03	CANDLIN	84	DPWA	$\pi^+ p \to \Sigma^+ K^+$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.019	LIVANOS	80	DPWA	$\pi p \to \Sigma K$

Note: Signs of couplings from $\pi N \to N\pi\pi$ analyses were changed in the 1986 edition to agree with the baryon-first convention; the overall phase ambiguity is resolved by choosing a negative sign for the $\Delta(1620)$ S_{31} coupling to $\Delta(1232)\pi$.

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1910) \to \Delta(1232)\pi$, P-wave — $(\Gamma_1\Gamma_5)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
+0.06	[2] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1910) \to N\rho$, S=3/2, P-wave — $(\Gamma_1\Gamma_7)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
+0.29	[2] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1910) \to N(1440)\pi$, P-wave — $(\Gamma_1\Gamma_9)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
−0.39±0.04	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

$\Gamma(N(1440)\pi)/\Gamma_{total}$ — Γ_8/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.56 ± 0.07	VRANA	00	DPWA	Multichannel

Δ(1910) PHOTON DECAY AMPLITUDES

$\Delta(1910) \rightarrow N\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
$+0.003\pm0.014$ OUR ESTIMATE				
-0.002 ± 0.008	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
0.014 ± 0.030	CRAWFORD	83	IPWA	$\gamma N \rightarrow \pi N$
0.025 ± 0.011	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
-0.012 ± 0.005	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 1)
-0.031 ± 0.004	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 2)
-0.005 ± 0.030	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.032 ± 0.003	LI	93	IPWA	$\gamma N \rightarrow \pi N$

Δ(1910) FOOTNOTES

[1] CHEW 80 reports four resonances in the P_{31} wave — see also the Δ(1750). Problems with this analysis are discussed in section 2.1.11 of HOEHLER 83.

[2] LONGACRE 77 pole positions 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. The other LONGACRE 77 values are from eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.

[3] 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.

Δ(1910) REFERENCES

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

ARNDT	06	PR C74 045205	R.A. Arndt *et al.*	(GWU)
PDG	06	JPG 33 1	W.-M. Yao *et al.*	(PDG Collab.)
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	(KENT) 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)
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)
HOEHLER	83	Landolt-Boernstein 1/9B2	G. Hohler	(KARLT)
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)
ARAI	80	Toronto Conf. 93	I. Arai	(INUS)
Also		NP B194 251	I. Arai, H. Fujii	(INUS)
CHEW	80	Toronto Conf. 123	D.M. Chew	(LBL) IJP

CRAWFORD	80	Toronto Conf. 107	R.L. Crawford	(GLAS)
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	77	NP B122 493	R.S. Longacre, J. Dolbeau	(SACL) IJP
Also		NP B108 365	J. Dolbeau *et al.*	(SACL) IJP