$N(1675)\ D_{15}$

$I(J^P) = \frac{1}{2}(\frac{5}{2}^-)$ 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, G **33** 1 (2006).

N(1675) BREIT-WIGNER MASS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1670 to 1680 (≈ 1675) OUR ESTIMATE				
1674.1± 0.2	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
1676 ± 2	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N \pi \pi$
1675 ±10	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1679 ± 8	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1678 ±15	THOMA	08	DPWA	Multichannel
1676.2± 0.6	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
1685 ± 4	VRANA	00	DPWA	Multichannel
1673 ± 5	ARNDT	96	IPWA	$\gamma N \to \pi N$
1673	ARNDT	95	DPWA	$\pi N \to N \pi$
1683 ±19	BATINIC	95	DPWA	$\pi N \to N \pi, N \eta$
1666	LI	93	IPWA	$\gamma N \to \pi N$
1670	SAXON	80	DPWA	$\pi^- p \to \Lambda K^0$
1650	[1] LONGACRE	77	IPWA	$\pi N \to N \pi \pi$
1660	[2] LONGACRE	75	IPWA	$\pi N \to N \pi \pi$

N(1675) BREIT-WIGNER WIDTH

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
130 to 165 (≈ 150) OUR ESTIMATE				
146.5± 1.0	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
159 ± 7	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N \pi \pi$
160 ±20	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
120 ±15	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
220 ±25	THOMA	08	DPWA	Multichannel
151.8± 3.0	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
131 ±10	VRANA	00	DPWA	Multichannel
154 ± 7	ARNDT	96	IPWA	$\gamma N \to \pi N$
154	ARNDT	95	DPWA	$\pi N \to N \pi$
142 ±23	BATINIC	95	DPWA	$\pi N \to N \pi, N \eta$
136	LI	93	IPWA	$\gamma N \to \pi N$
40	SAXON	80	DPWA	$\pi^- p \to \Lambda K^0$
130	[1] LONGACRE	77	IPWA	$\pi N \to N \pi \pi$
150	[2] LONGACRE	75	IPWA	$\pi N \to N \pi \pi$

N(1675) POLE POSITION

REAL PART

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1655 to 1665 (≈ 1660) OUR ESTIMATE				
1657	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
1656	[3] HOEHLER	93	ARGD	$\pi N \to \pi N$
1660±10	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1639±10	THOMA	08	DPWA	Multichannel
1659	ARNDT	04	DPWA	$\pi N \to \pi N$, ηN
1674	VRANA	00	DPWA	Multichannel
1663	ARNDT	95	DPWA	$\pi N \to N \pi$
1655	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90
1663 or 1668	[4] LONGACRE	78	IPWA	$\pi N \to N \pi \pi$
1649 or 1650	[1] LONGACRE	77	IPWA	$\pi N \to N \pi \pi$

−2×IMAGINARY PART

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
125 to 150 (≈ 135) OUR ESTIMATE				
139	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
126	[3] HOEHLER	93	ARGD	$\pi N \to \pi N$
140±10	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
180±20	THOMA	08	DPWA	Multichannel
146	ARNDT	04	DPWA	$\pi N \to \pi N$, ηN
120	VRANA	00	DPWA	Multichannel
152	ARNDT	95	DPWA	$\pi N \to N \pi$
124	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90
146 or 171	[4] LONGACRE	78	IPWA	$\pi N \to N \pi \pi$
127 or 127	[1] LONGACRE	77	IPWA	$\pi N \to N \pi \pi$

N(1675) ELASTIC POLE RESIDUE

MODULUS $|r|$

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
27	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
23	HOEHLER	93	ARGD	$\pi N \to \pi N$
31±5	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
29	ARNDT	04	DPWA	$\pi N \to \pi N$, ηN
29	ARNDT	95	DPWA	$\pi N \to N \pi$
28	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90

PHASE θ

VALUE (°)	DOCUMENT ID		TECN	COMMENT
−21	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
−22	HOEHLER	93	ARGD	$\pi N \to \pi N$
−30±10	CUTKOSKY	80	IPWA	$\pi N \to \pi N$

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

−22	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
− 6	ARNDT	95	DPWA	$\pi N \to N\pi$
−17	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90

N(1675) DECAY MODES

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	0.35 to 0.45
Γ_2	$N\eta$	(0.0 ±1.0) %
Γ_3	ΛK	<1 %
Γ_4	ΣK	
Γ_5	$N\pi\pi$	50–60 %
Γ_6	$\Delta\pi$	50–60 %
Γ_7	$\Delta(1232)\pi$, D-wave	
Γ_8	$\Delta(1232)\pi$, G-wave	
Γ_9	$N\rho$	< 1–3 %
Γ_{10}	$N\rho$, S=1/2, D-wave	
Γ_{11}	$N\rho$, S=3/2, D-wave	
Γ_{12}	$N\rho$, S=3/2, G-wave	
Γ_{13}	$N(\pi\pi)^{I=0}_{S\text{-wave}}$	
Γ_{14}	$p\gamma$	0.004–0.023 %
Γ_{15}	$p\gamma$, helicity=1/2	0.0–0.015 %
Γ_{16}	$p\gamma$, helicity=3/2	0.0–0.011 %
Γ_{17}	$n\gamma$	0.02–0.12 %
Γ_{18}	$n\gamma$, helicity=1/2	0.006–0.046 %
Γ_{19}	$n\gamma$, helicity=3/2	0.01–0.08 %

N(1675) BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{total}$ — Γ_1/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.35 to 0.45 OUR ESTIMATE				
0.393±0.001	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
0.47 ±0.02	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
0.38 ±0.05	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
0.38 ±0.03	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.30 ±0.08	THOMA	08	DPWA	Multichannel
0.400±0.002	ARNDT	04	DPWA	$\pi N \to \pi N, \eta N$
0.35 ±0.01	VRANA	00	DPWA	Multichannel
0.38	ARNDT	95	DPWA	$\pi N \to N\pi$
0.31 ±0.06	BATINIC	95	DPWA	$\pi N \to N\pi, N\eta$

$\Gamma(N\eta)/\Gamma_{total}$ — Γ_2/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.00 ±0.01	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.03 ±0.03	THOMA	08	DPWA	Multichannel
0.001±0.001	BATINIC	95	DPWA	$\pi N \to N\pi$, $N\eta$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1675) \to \Lambda K$ — $(\Gamma_1\Gamma_3)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
±0.04 to ±0.08 OUR ESTIMATE				
−0.01	BELL	83	DPWA	$\pi^- p \to \Lambda K^0$
+0.036	[5] SAXON	80	DPWA	$\pi^- p \to \Lambda K^0$

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 $N\pi \to N(1675) \to \Delta(1232)\pi$, D-wave — $(\Gamma_1\Gamma_7)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
+0.46 to +0.50 OUR ESTIMATE				
+0.496±0.003	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
+0.46	[1,6] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
+0.50	[2] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

$\Gamma(\Delta(1232)\pi, D\text{-wave})/\Gamma_{total}$ — Γ_7/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.63±0.02	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.24±0.08	THOMA	08	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1675) \to N\rho$, S=1/2, D-wave — $(\Gamma_1\Gamma_{10})^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
+0.04±0.02	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

$\Gamma(N\rho, S=1/2, D\text{-wave})/\Gamma_{total}$ — Γ_{10}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.00±0.01	VRANA	00	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1675) \to N\rho$, S=3/2, D-wave — $(\Gamma_1\Gamma_{11})^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
−0.12 to −0.06 OUR ESTIMATE				
−0.03±0.02	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
−0.15	[1,6] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

$\Gamma(N\rho, S=3/2, D\text{-wave})/\Gamma_{total}$ — Γ_{11}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.01±0.01	VRANA	00	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \rightarrow N(1675) \rightarrow N(\pi\pi)^{I=0}_{S\text{-wave}}$ $(\Gamma_1\Gamma_{13})^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
+0.03	[1,6] LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$

N(1675) PHOTON DECAY AMPLITUDES

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

$N(1675) \rightarrow p\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
+0.019±0.008 OUR ESTIMATE				
0.018±0.002	DUGGER	07	DPWA	$\gamma N \rightarrow \pi N$
0.015±0.010	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
0.021±0.011	CRAWFORD	83	IPWA	$\gamma N \rightarrow \pi N$
0.034±0.005	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.015	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$
0.012±0.002	LI	93	IPWA	$\gamma N \rightarrow \pi N$

$N(1675) \rightarrow p\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
+0.015±0.009 OUR ESTIMATE				
0.021±0.001	DUGGER	07	DPWA	$\gamma N \rightarrow \pi N$
0.010±0.007	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
0.015±0.009	CRAWFORD	83	IPWA	$\gamma N \rightarrow \pi N$
0.024±0.008	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.022	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$
0.021±0.002	LI	93	IPWA	$\gamma N \rightarrow \pi N$

$N(1675) \rightarrow n\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.043±0.012 OUR ESTIMATE				
−0.049±0.010	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
−0.057±0.024	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
−0.033±0.004	FUJII	81	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.062	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$
−0.060±0.003	LI	93	IPWA	$\gamma N \rightarrow \pi N$

$N(1675) \rightarrow n\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.058±0.013 OUR ESTIMATE				
−0.051±0.010	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
−0.077±0.018	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
−0.069±0.004	FUJII	81	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.084	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$
−0.074±0.003	LI	93	IPWA	$\gamma N \rightarrow \pi N$

N(1675) FOOTNOTES

[1] 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.

[2] From method II of LONGACRE 75: 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.

[4] 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.

[5] SAXON 80 finds the coupling phase is near 90°.

[6] LONGACRE 77 considers this coupling to be well determined.

N(1675) REFERENCES

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

THOMA	08	PL B659 87	U. Thoma *et al.*	(CB-ELSA Collab.)	
DRECHSEL	07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)	
DUGGER	07	PR C76 025211	M. Dugger *et al.*	(Jefferson Lab CLAS Collab.)	
ARNDT	06	PR C74 045205	R.A. Arndt *et al.*	(GWU)	
PDG	06	JPG 33 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)	
BATINIC	95	PR C51 2310	M. Batinic *et al.*	(BOSK, UCLA)	
Also		PR C57 1004 (erratum)	M. Batinic *et al.*		
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
BELL	83	NP B222 389	K.W. Bell *et al.*	(RL)	IJP
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)	
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)	
FUJII	81	NP B187 53	K. Fujii *et al.*	(NAGO, OSAK)	
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
SAXON	80	NP B162 522	D.H. Saxon *et al.*	(RHEL, BRIS)	IJP
HOEHLER	79	PDAT 12-1	G. Hohler *et al.*	(KARLT)	IJP
Also		Toronto Conf. 3	R. Koch	(KARLT)	IJP
LONGACRE	78	PR D17 1795	R.S. Longacre *et al.*	(LBL, SLAC)	
LONGACRE	77	NP B122 493	R.S. Longacre, J. Dolbeau	(SACL)	IJP
Also		NP B108 365	J. Dolbeau *et al.*	(SACL)	IJP
LONGACRE	75	PL 55B 415	R.S. Longacre *et al.*	(LBL, SLAC)	IJP