

N(1675) D₁₅

$$I(J^P) = \frac{1}{2}(\frac{5}{2}^-) \text{ Status: } ****$$

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 $\pi N \rightarrow \pi N, \eta N$
1676 ± 2	MANLEY	92	IPWA $\pi N \rightarrow \pi N \ \& \ N\pi\pi$
1675 ± 10	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
1679 ± 8	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● 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 $\pi N \rightarrow \pi N, \eta N$
1685 ± 4	VRANA	00	DPWA Multichannel
1673 ± 5	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
1673	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
1683 ± 19	BATINIC	95	DPWA $\pi N \rightarrow N\pi, N\eta$
1666	LI	93	IPWA $\gamma N \rightarrow \pi N$
1670	SAXON	80	DPWA $\pi^- p \rightarrow \Lambda K^0$
1650	¹ LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$
1660	² LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$

N(1675) BREIT-WIGNER WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
130 to 165 (≈ 150) OUR ESTIMATE			
146.5 ± 1.0	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
159 ± 7	MANLEY	92	IPWA $\pi N \rightarrow \pi N \ \& \ N\pi\pi$
160 ± 20	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
120 ± 15	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● 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 $\pi N \rightarrow \pi N, \eta N$
131 ± 10	VRANA	00	DPWA Multichannel
154 ± 7	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
154	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
142 ± 23	BATINIC	95	DPWA $\pi N \rightarrow N\pi, N\eta$
136	LI	93	IPWA $\gamma N \rightarrow \pi N$
40	SAXON	80	DPWA $\pi^- p \rightarrow \Lambda K^0$
130	¹ LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$
150	² LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$

N(1675) POLE POSITION

REAL PART

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

– 2×IMAGINARY PART

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

N(1675) ELASTIC POLE RESIDUE

MODULUS $|r|$

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
27	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
23	HOEHLER	93	ARGD $\pi N \rightarrow \pi N$
31 \pm 5	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
29	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
29	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
28	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

PHASE θ

<u>VALUE ($^\circ$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
– 21	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
– 22	HOEHLER	93	ARGD $\pi N \rightarrow \pi N$
– 30 \pm 10	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$

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

– 22	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$
– 6	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
– 17	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ 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 \pm 1.0) %
Γ_3 ΛK	< 1 %
Γ_4 ΣK	
Γ_5 $N\pi\pi$	50–60 %
Γ_6 $\Delta\pi$	50–60 %
Γ_7 $\Delta(1232)\pi$, <i>D</i> -wave	
Γ_8 $\Delta(1232)\pi$, <i>G</i> -wave	
Γ_9 $N\rho$	< 1–3 %
Γ_{10} $N\rho$, <i>S</i> =1/2, <i>D</i> -wave	
Γ_{11} $N\rho$, <i>S</i> =3/2, <i>D</i> -wave	
Γ_{12} $N\rho$, <i>S</i> =3/2, <i>G</i> -wave	
Γ_{13} $N(\pi\pi)_{S\text{-wave}}^{I=0}$	
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

$\Gamma(N\pi)/\Gamma_{\text{total}}$					Γ_1/Γ
VALUE	DOCUMENT ID	TECN	COMMENT		
0.35 to 0.45 OUR ESTIMATE					
0.393 \pm 0.001	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$	
0.47 \pm 0.02	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$	
0.38 \pm 0.05	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$	
0.38 \pm 0.03	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.30 \pm 0.08	THOMA	08	DPWA	Multichannel	
0.400 \pm 0.002	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$	
0.35 \pm 0.01	VRANA	00	DPWA	Multichannel	
0.38	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$	
0.31 \pm 0.06	BATINIC	95	DPWA	$\pi N \rightarrow N\pi, N\eta$	

$\Gamma(N\eta)/\Gamma_{\text{total}}$				Γ_2/Γ
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
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	$\pi N \rightarrow N\pi, N\eta$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow N(1675) \rightarrow \Lambda K$				$(\Gamma_1\Gamma_3)^{1/2}/\Gamma$
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
±0.04 to ±0.08 OUR ESTIMATE				
−0.01	BELL	83	DPWA	$\pi^- p \rightarrow \Lambda K^0$
+0.036	⁵ SAXON	80	DPWA	$\pi^- p \rightarrow \Lambda K^0$

Note: Signs of couplings from $\pi N \rightarrow N\pi\pi$ 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 $\Delta(1232)\pi$.

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow N(1675) \rightarrow \Delta(1232)\pi, D\text{-wave}$				$(\Gamma_1\Gamma_7)^{1/2}/\Gamma$
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
+0.46 to +0.50 OUR ESTIMATE				
+0.496 ± 0.003	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$
+0.46	^{1,6} LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$
+0.50	² LONGACRE	75	IPWA	$\pi N \rightarrow N\pi\pi$

$\Gamma(\Delta(1232)\pi, D\text{-wave})/\Gamma_{\text{total}}$				Γ_7/Γ
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
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

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow N(1675) \rightarrow N\rho, S=1/2, D\text{-wave}$				$(\Gamma_1\Gamma_{10})^{1/2}/\Gamma$
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
+0.04 ± 0.02	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$

$\Gamma(N\rho, S=1/2, D\text{-wave})/\Gamma_{\text{total}}$				Γ_{10}/Γ
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
0.00 ± 0.01	VRANA	00	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow N(1675) \rightarrow N\rho, S=3/2, D\text{-wave}$				$(\Gamma_1\Gamma_{11})^{1/2}/\Gamma$
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
−0.12 to −0.06 OUR ESTIMATE				
−0.03 ± 0.02	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$
−0.15	^{1,6} LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$

$\Gamma(N\rho, S=3/2, D\text{-wave})/\Gamma_{\text{total}}$				Γ_{11}/Γ
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
0.01 ± 0.01	VRANA	00	DPWA	Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(1675) \rightarrow N(\pi\pi)_{S\text{-wave}}^{I=0}$	$(\Gamma_1 \Gamma_{13})^{1/2} / \Gamma$
<u>VALUE</u>	<u>DOCUMENT ID</u> <u>TECN</u> <u>COMMENT</u>
+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 $A_{1/2}$

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
+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 $A_{3/2}$

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
+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 $A_{1/2}$

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-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 $A_{3/2}$

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-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 <i>et al.</i>	(CB-ELSA Collab.)
DRECHSEL	07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)
DUGGER	07	PR C76 025211	M. Dugger <i>et al.</i>	(Jefferson Lab CLAS Collab.)
ARNDT	06	PR C74 045205	R.A. Arndt <i>et al.</i>	(GWU)
PDG	06	JPG 33 1	W.-M. Yao <i>et al.</i>	(PDG Collab.)
ARNDT	04	PR C69 035213	R.A. Arndt <i>et al.</i>	(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 <i>et al.</i>	(VPI, BRCO)
BATINIC	95	PR C51 2310	M. Batinic <i>et al.</i>	(BOSK, UCLA)
Also		PR C57 1004 (erratum)	M. Batinic <i>et al.</i>	
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)
LI	93	PR C47 2759	Z.J. Li <i>et al.</i>	(VPI)
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KENT) IJP
Also		PR D30 904	D.M. Manley <i>et al.</i>	(VPI)
ARNDT	91	PR D43 2131	R.A. Arndt <i>et al.</i>	(VPI, TELE) IJP
BELL	83	NP B222 389	K.W. Bell <i>et al.</i>	(RL) IJP
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)
PDG	82	PL 111B 1	M. Roos <i>et al.</i>	(HELSE, CIT, CERN)
AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)
Also		NP B197 365	K. Fujii <i>et al.</i>	(NAGO)
FUJII	81	NP B187 53	K. Fujii <i>et al.</i>	(NAGO, OSAK)
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
Also		PR D20 2839	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
SAXON	80	NP B162 522	D.H. Saxon <i>et al.</i>	(RHEL, BRIS) IJP
HOEHLER	79	PDAT 12-1	G. Hohler <i>et al.</i>	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP
LONGACRE	78	PR D17 1795	R.S. Longacre <i>et al.</i>	(LBL, SLAC)
LONGACRE	77	NP B122 493	R.S. Longacre, J. Dolbeau	(SACL) IJP
Also		NP B108 365	J. Dolbeau <i>et al.</i>	(SACL) IJP
LONGACRE	75	PL 55B 415	R.S. Longacre <i>et al.</i>	(LBL, SLAC) IJP