

$N(1650) 1/2^-$ $I(J^P) = \frac{1}{2}(\frac{1}{2}^-)$ 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 1984 were last included in our 2006 edition, *Journal of Physics* **G33** 1 (2006).

 $N(1650)$ BREIT-WIGNER MASS

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1645 to 1670 (≈ 1655) OUR ESTIMATE			
1665 ± 2	SHKLYAR	13	DPWA Multichannel
1651 ± 6	ANISOVICH	12A	DPWA Multichannel
1634.7 ± 1.1	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1650 ± 30	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
1670 ± 8	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1664 ± 2	SHRESTHA	12A	DPWA Multichannel
1680 ± 40	ANISOVICH	10	DPWA Multichannel
1652 ± 9	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
1655 ± 15	THOMA	08	DPWA Multichannel
1651.2 ± 4.7	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
1665 ± 2	PENNER	02C	DPWA Multichannel
1647 ± 20	BAI	01B	BES $J/\psi \rightarrow p\bar{p}\eta$
1689 ± 12	VRANA	00	DPWA Multichannel
1677 ± 8	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
1667	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
1712	¹ ARNDT	95	DPWA $\pi N \rightarrow N\pi$
1674	LI	93	IPWA $\gamma N \rightarrow \pi N$
1659 ± 9	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$
1672	MUSETTE	80	IPWA $\pi^- p \rightarrow \Lambda K^0$
1680	SAXON	80	DPWA $\pi^- p \rightarrow \Lambda K^0$
1700	² LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$
1660	³ LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$

 $N(1650)$ BREIT-WIGNER WIDTH

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
110 to 170 (≈ 140) OUR ESTIMATE			
147 ± 14	SHKLYAR	13	DPWA Multichannel
104 ± 10	ANISOVICH	12A	DPWA Multichannel
115.4 ± 2.8	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
167.9 ± 9.4	GREEN	97	DPWA $\pi N \rightarrow \pi N, \eta N$
150 ± 40	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
180 ± 20	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$

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

126 ± 3	SHRESTHA	12A	DPWA	Multichannel
170 ± 45	ANISOVICH	10	DPWA	Multichannel
202 ± 16	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
180 ± 20	THOMA	08	DPWA	Multichannel
130.6 ± 7.0	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$
138 ± 7	PENNER	02C	DPWA	Multichannel
145 +80 -45	BAI	01B	BES	$J/\psi \rightarrow p\bar{p}\eta$
202 ± 40	VRANA	00	DPWA	Multichannel
160 ± 12	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
90	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
184	¹ ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
225	LI	93	IPWA	$\gamma N \rightarrow \pi N$
173 ± 12	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$
179	MUSETTE	80	IPWA	$\pi^- p \rightarrow \Lambda K^0$
120	SAXON	80	DPWA	$\pi^- p \rightarrow \Lambda K^0$
170	² LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$
130	³ LONGACRE	75	IPWA	$\pi N \rightarrow N\pi\pi$

N(1650) POLE POSITION

REAL PART

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1640 to 1670 (\approx 1655) OUR ESTIMATE			
1660 ± 3.5 ± 1	⁴ SVARC	14	MLS $\pi N \rightarrow \pi N$
1647 ± 6	ANISOVICH	12A	DPWA Multichannel
1648	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1670	⁵ HOEHLER	93	ARGD $\pi N \rightarrow \pi N$
1640 ± 20	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$

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

1650	SHKLYAR	13	DPWA	Multichannel
1655	SHRESTHA	12A	DPWA	Multichannel
1670 ± 35	ANISOVICH	10	DPWA	Multichannel
1646 ± 8	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
1645 ± 15	THOMA	08	DPWA	Multichannel
1653	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$
1663	VRANA	00	DPWA	Multichannel
1660 ± 10	⁶ ARNDT	98	DPWA	$\pi N \rightarrow \pi N, \eta N$
1673	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
1689	¹ ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
1657	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90
1648 or 1651	⁷ LONGACRE	78	IPWA	$\pi N \rightarrow N\pi\pi$
1699 or 1698	² LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$

–2×IMAGINARY PART

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
100 to 170 (≈ 135) OUR ESTIMATE			
167± 8±2	⁴ SVARC 14	MLS	$\pi N \rightarrow \pi N$
103± 8	ANISOVICH 12A	DPWA	Multichannel
80	ARNDT 06	DPWA	$\pi N \rightarrow \pi N, \eta N$
163	⁵ HOEHLER 93	ARGD	$\pi N \rightarrow \pi N$
150±30	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
89	SHKLYAR 13	DPWA	Multichannel
123	SHRESTHA 12A	DPWA	Multichannel
170±40	ANISOVICH 10	DPWA	Multichannel
204±17	BATINIC 10	DPWA	$\pi N \rightarrow N\pi, N\eta$
187±20	THOMA 08	DPWA	Multichannel
182	ARNDT 04	DPWA	$\pi N \rightarrow \pi N, \eta N$
240	VRANA 00	DPWA	Multichannel
140±20	⁶ ARNDT 98	DPWA	$\pi N \rightarrow \pi N, \eta N$
82	ARNDT 95	DPWA	$\pi N \rightarrow N\pi$
192	¹ ARNDT 95	DPWA	$\pi N \rightarrow N\pi$
160	ARNDT 91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90
117 or 119	⁷ LONGACRE 78	IPWA	$\pi N \rightarrow N\pi\pi$
174 or 173	² LONGACRE 77	IPWA	$\pi N \rightarrow N\pi\pi$

N(1650) ELASTIC POLE RESIDUE

MODULUS |r|

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
20 to 50 (≈ 35) OUR ESTIMATE			
47± 3±1	⁴ SVARC 14	MLS	$\pi N \rightarrow \pi N$
24± 3	ANISOVICH 12A	DPWA	Multichannel
14	ARNDT 06	DPWA	$\pi N \rightarrow \pi N, \eta N$
39	HOEHLER 93	ARGD	$\pi N \rightarrow \pi N$
60±10	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
19	SHKLYAR 13	DPWA	Multichannel
100	BATINIC 10	DPWA	$\pi N \rightarrow N\pi, N\eta$
69	ARNDT 04	DPWA	$\pi N \rightarrow \pi N, \eta N$
22	ARNDT 95	DPWA	$\pi N \rightarrow N\pi$
72	¹ ARNDT 95	DPWA	$\pi N \rightarrow N\pi$
54	ARNDT 91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

PHASE θ

VALUE (°)	DOCUMENT ID	TECN	COMMENT
50 to 80 (≈ 70) OUR ESTIMATE			
–47± 3±1	⁴ SVARC 14	MLS	$\pi N \rightarrow \pi N$
–75±12	ANISOVICH 12A	DPWA	Multichannel
–69	ARNDT 06	DPWA	$\pi N \rightarrow \pi N, \eta N$
–37	HOEHLER 93	ARGD	$\pi N \rightarrow \pi N$
–75±25	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$

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

–46	SHKLYAR	13	DPWA	Multichannel
–65	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
–55	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$
29	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
–85	¹ ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
–38	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

N(1650) INELASTIC POLE RESIDUE

The “normalized residue” is the residue divided by $\Gamma_{pole}/2$.

Normalized residue in $N\pi \rightarrow N(1650) \rightarrow N\eta$

MODULUS (%)	PHASE (°)	DOCUMENT ID	TECN	COMMENT
29±3	134 ± 10	ANISOVICH	12A DPWA	Multichannel

Normalized residue in $N\pi \rightarrow N(1650) \rightarrow \Lambda K$

MODULUS (%)	PHASE (°)	DOCUMENT ID	TECN	COMMENT
23±9	85 ± 9	ANISOVICH	12A DPWA	Multichannel

Normalized residue in $N\pi \rightarrow N(1650) \rightarrow \Delta\pi, D\text{-wave}$

MODULUS (%)	PHASE (°)	DOCUMENT ID	TECN	COMMENT
23±4	–30 ± 20	ANISOVICH	12A DPWA	Multichannel

N(1650) DECAY MODES

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

Mode	Fraction (Γ_i/Γ)
Γ_1 $N\pi$	50–90 %
Γ_2 $N\eta$	5–15 %
Γ_3 ΛK	3–11 %
Γ_4 ΣK	
Γ_5 $N\pi\pi$	10–20 %
Γ_6 $\Delta\pi$	0–25 %
Γ_7 $\Delta(1232)\pi, D\text{-wave}$	0–25 %
Γ_8 $N\rho$	4–12 %
Γ_9 $N\rho, S=1/2, S\text{-wave}$	(1.0±1.0) %
Γ_{10} $N\rho, S=3/2, D\text{-wave}$	(13.0±3.0) %
Γ_{11} $N(\pi\pi)_{S\text{-wave}}^{I=0}$	<4 %
Γ_{12} $N(1440)\pi$	<5 %
Γ_{13} $p\gamma$	0.04–0.20 %
Γ_{14} $p\gamma, \text{helicity}=1/2$	0.04–0.20 %
Γ_{15} $n\gamma$	0.003–0.17 %
Γ_{16} $n\gamma, \text{helicity}=1/2$	0.003–0.17 %

N(1650) BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{\text{total}}$					Γ_1/Γ
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
50 to 70 (≈ 60) OUR ESTIMATE					
74 \pm 3	SHKLYAR	13	DPWA	Multichannel	
51 \pm 4	ANISOVICH	12A	DPWA	Multichannel	
100	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$	
73.5 \pm 1.1	GREEN	97	DPWA	$\pi N \rightarrow \pi N, \eta N$	
65 \pm 10	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$	
61 \pm 4	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
57 \pm 2	SHRESTHA	12A	DPWA	Multichannel	
50 \pm 25	ANISOVICH	10	DPWA	Multichannel	
79 \pm 6	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$	
70 \pm 15	THOMA	08	DPWA	Multichannel	
100.0	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$	
65 \pm 4	PENNER	02C	DPWA	Multichannel	
74 \pm 2	VRANA	00	DPWA	Multichannel	
99	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$	
27	¹ ARNDT	95	DPWA	$\pi N \rightarrow N\pi$	
89 \pm 7	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$	

$\Gamma(N\eta)/\Gamma_{\text{total}}$					Γ_2/Γ
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
5 to 15 OUR ESTIMATE					
1 \pm 2	SHKLYAR	13	DPWA	Multichannel	
18 \pm 4	ANISOVICH	12A	DPWA	Multichannel	
1.0 \pm 0.6	PENNER	02C	DPWA	Multichannel	
6 \pm 1	VRANA	00	DPWA	Multichannel	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
21 \pm 2	SHRESTHA	12A	DPWA	Multichannel	
13 \pm 5	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$	
15 \pm 6	THOMA	08	DPWA	Multichannel	

$\Gamma(\Lambda K)/\Gamma_{\text{total}}$					Γ_3/Γ
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
2.9 \pm 0.4 OUR AVERAGE Error includes scale factor of 1.2.					
10 \pm 5	ANISOVICH	12A	DPWA	Multichannel	
4 \pm 1	SHKLYAR	05	DPWA	Multichannel	
2.7 \pm 0.4	PENNER	02C	DPWA	Multichannel	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
8 \pm 1	SHRESTHA	12A	DPWA	Multichannel	

$(\Gamma_i \Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow N(1650) \rightarrow \Lambda K$					$(\Gamma_1 \Gamma_3)^{1/2}/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT		
-0.27 to -0.17 OUR ESTIMATE					
-0.22	BELL	83	DPWA	$\pi^- p \rightarrow \Lambda K^0$	
-0.22	SAXON	80	DPWA	$\pi^- p \rightarrow \Lambda K^0$	

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(1650) \rightarrow \Sigma K$				$(\Gamma_1 \Gamma_4)^{1/2} / \Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-0.254	LIVANOS	80	DPWA	$\pi p \rightarrow \Sigma K$

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 $N\pi \rightarrow N(1650) \rightarrow \Delta(1232)\pi, D\text{-wave}$				$(\Gamma_1 \Gamma_7)^{1/2} / \Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
+0.15 to 0.23 OUR ESTIMATE				
+0.29	^{2,8} LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$
+0.15	³ LONGACRE	75	IPWA	$\pi N \rightarrow N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
+0.26 ± 0.14	THOMA	08	DPWA	Multichannel
+0.12 ± 0.04	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$

$\Gamma(\Delta(1232)\pi, D\text{-wave}) / \Gamma_{\text{total}}$				Γ_7 / Γ
VALUE (%)	DOCUMENT ID	TECN	COMMENT	
0 to 25 OUR ESTIMATE				
19 ± 9	ANISOVICH	12A	DPWA	Multichannel
2 ± 1	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
7 ± 2	SHRESTHA	12A	DPWA	Multichannel
10 ± 5	THOMA	08	DPWA	Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(1650) \rightarrow N\rho, S=1/2, S\text{-wave}$				$(\Gamma_1 \Gamma_9)^{1/2} / \Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
±0.03 to ±0.19 OUR ESTIMATE				
+0.17	^{2,8} LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$
-0.16	³ LONGACRE	75	IPWA	$\pi N \rightarrow N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-0.01 ± 0.09	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$

$\Gamma(N\rho, S=1/2, S\text{-wave}) / \Gamma_{\text{total}}$				Γ_9 / Γ
VALUE (%)	DOCUMENT ID	TECN	COMMENT	
1 ± 1				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
6 ± 1	SHRESTHA	12A	DPWA	Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(1650) \rightarrow N\rho, S=3/2, D\text{-wave}$				$(\Gamma_1 \Gamma_{10})^{1/2} / \Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
+0.17 to +0.29 OUR ESTIMATE				
+0.29	^{2,8} LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
+0.16 ± 0.06	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$

$\Gamma(N\rho, S=3/2, D\text{-wave})/\Gamma_{\text{total}}$ Γ_{10}/Γ

VALUE (%)	DOCUMENT ID	TECN	COMMENT
13±3	VRANA	00	DPWA Multichannel
••• We do not use the following data for averages, fits, limits, etc. •••			
< 1	SHRESTHA	12A	DPWA Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow N(1650) \rightarrow N(\pi\pi)_{S\text{-wave}}^{I=0}$ $(\Gamma_1\Gamma_{11})^{1/2}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
+0.04 to +0.18 OUR ESTIMATE			
0.00	^{2,8} LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$
+0.25	³ LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$
••• We do not use the following data for averages, fits, limits, etc. •••			
+0.12±0.08	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$

$\Gamma(N(\pi\pi)_{S\text{-wave}}^{I=0})/\Gamma_{\text{total}}$ Γ_{11}/Γ

VALUE (%)	DOCUMENT ID	TECN	COMMENT
1±1	VRANA	00	DPWA Multichannel
••• We do not use the following data for averages, fits, limits, etc. •••			
<1	SHRESTHA	12A	DPWA Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow N(1650) \rightarrow N(1440)\pi$ $(\Gamma_1\Gamma_{12})^{1/2}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
••• We do not use the following data for averages, fits, limits, etc. •••			
+0.11±0.06	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$

$\Gamma(N(1440)\pi)/\Gamma_{\text{total}}$ Γ_{12}/Γ

VALUE (%)	DOCUMENT ID	TECN	COMMENT
3±1	VRANA	00	DPWA Multichannel
••• We do not use the following data for averages, fits, limits, etc. •••			
<1	SHRESTHA	12A	DPWA Multichannel

$N(1650)$ PHOTON DECAY AMPLITUDES

Papers on γN amplitudes predating 1981 may be found in our 2006 edition, *Journal of Physics* **G33** 1 (2006).

$N(1650) \rightarrow p\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
+0.045±0.010 OUR ESTIMATE			
0.033±0.007	ANISOVICH	12A	DPWA Multichannel
0.055±0.030	WORKMAN	12A	DPWA $\gamma N \rightarrow N\pi$
0.022±0.007	DUGGER	07	DPWA $\gamma N \rightarrow \pi N$
0.033±0.015	CRAWFORD	83	IPWA $\gamma N \rightarrow \pi N$
0.050±0.010	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$

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

0.063±0.006	SHKLYAR	13	DPWA	Multichannel
0.030±0.003	SHRESTHA	12A	DPWA	Multichannel
0.060±0.020	ANISOVICH	10	DPWA	Multichannel
0.100±0.035	⁹ ANISOVICH	09A	DPWA	$\gamma d \rightarrow \eta N(N)$
0.033	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$
0.049	PENNER	02D	DPWA	Multichannel
0.069±0.005	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
0.068±0.003	LI	93	IPWA	$\gamma N \rightarrow \pi N$
0.091	WADA	84	DPWA	Compton scattering

$N(1650) \rightarrow n\gamma$, helicity-1/2 amplitude $A_{1/2}$

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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−0.050±0.020 OUR ESTIMATE

0.025±0.020	ANISOVICH	13B	DPWA	Multichannel
−0.040±0.010	CHEN	12A	DPWA	$\gamma N \rightarrow \pi N$
−0.055±0.020	¹⁰ ANISOVICH	09A	DPWA	$\gamma d \rightarrow \eta N(N)$
−0.008±0.004	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
0.004±0.004	FUJII	81	DPWA	$\gamma N \rightarrow \pi N$

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

0.011±0.002	SHRESTHA	12A	DPWA	Multichannel
0.009	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$
−0.011	PENNER	02D	DPWA	Multichannel
−0.015±0.005	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
−0.002±0.002	LI	93	IPWA	$\gamma N \rightarrow \pi N$

$N(1650) \quad \gamma p \rightarrow \Lambda K^+$ AMPLITUDES

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $p\gamma \rightarrow N(1650) \rightarrow \Lambda K^+$ (E_{0+} amplitude)

<u>VALUE (units 10⁻³)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
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- • • We do not use the following data for averages, fits, limits, etc. • • •

7.8 ±0.3	WORKMAN	90	DPWA
8.13	TANABE	89	DPWA

$p\gamma \rightarrow N(1650) \rightarrow \Lambda K^+$ phase angle θ (E_{0+} amplitude)

<u>VALUE (degrees)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
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- • • We do not use the following data for averages, fits, limits, etc. • • •

−107 ±3	WORKMAN	90	DPWA
−107.8	TANABE	89	DPWA

$N(1650)$ FOOTNOTES

¹ ARNDT 95 finds two distinct states.

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 From method II of LONGACRE 75: eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.

- ⁴ Fit to the amplitudes of HOEHLER 79.
- ⁵ 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.
- ⁶ ARNDT 98 also lists pole residues, which display more model dependence than do the associated pole positions.
- ⁷ 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.
- ⁸ LONGACRE 77 considers this coupling to be well determined.
- ⁹ This ANISOVICH 09A amplitude is evaluated at the pole position; the phase is $(25 \pm 20)^\circ$.
- ¹⁰ This ANISOVICH 09A amplitude is evaluated at the pole position; the phase is $(30 \pm 25)^\circ$.

$N(1650)$ REFERENCES

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

SVARC	14	PR C89 045205	A. Svarc <i>et al.</i>	
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