$N(1650)\ 1/2^-$

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

Older and obsolete values are listed and referenced in the 2014 edition, Chinese Physics **C38** 070001 (2014).

N(1650) POLE POSITION

REAL PART

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1640 to 1670 (≈ 1655) OUR ESTIMATE				
1652± 7	SOKHOYAN	15A	DPWA	Multichannel
1660± 3.5±1	[1] SVARC	14	L+P	$\pi N \to \pi N$
1648	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
1670	HOEHLER	93	ARGD	$\pi N \to \pi N$
1640±20	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1650	SHKLYAR	13	DPWA	Multichannel
1647± 6	ANISOVICH	12A	DPWA	Multichannel
1655	SHRESTHA	12A	DPWA	Multichannel
1646± 8	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
1663	VRANA	00	DPWA	Multichannel

−2×IMAGINARY PART

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
100 to 170 (≈ 135) OUR ESTIMATE				
102± 8	SOKHOYAN	15A	DPWA	Multichannel
167± 8±2	[1] SVARC	14	L+P	$\pi N \to \pi N$
80	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
163	HOEHLER	93	ARGD	$\pi N \to \pi N$
150±30	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
89	SHKLYAR	13	DPWA	Multichannel
103± 8	ANISOVICH	12A	DPWA	Multichannel
123	SHRESTHA	12A	DPWA	Multichannel
204±17	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
240	VRANA	00	DPWA	Multichannel

N(1650) ELASTIC POLE RESIDUE

MODULUS $|r|$

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
20 to 50 (≈ 35) OUR ESTIMATE				
27± 6	SOKHOYAN	15A	DPWA	Multichannel
47± 3±1	[1] SVARC	14	L+P	$\pi N \to \pi N$
14	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
39	HOEHLER	93	ARGD	$\pi N \to \pi N$
60±10	CUTKOSKY	80	IPWA	$\pi N \to \pi N$

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

19	SHKLYAR	13	DPWA	Multichannel
24± 3	ANISOVICH	12A	DPWA	Multichannel
100	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$

PHASE θ

VALUE (°)	DOCUMENT ID		TECN	COMMENT
50 to 80 (≈ 70) OUR ESTIMATE				
−60±20	SOKHOYAN	15A	DPWA	Multichannel
−47± 3±1	[1] SVARC	14	L+P	$\pi N \to \pi N$
−69	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
−37	HOEHLER	93	ARGD	$\pi N \to \pi N$
−75±25	CUTKOSKY	80	IPWA	$\pi N \to \pi N$

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

−46	SHKLYAR	13	DPWA	Multichannel
−75±12	ANISOVICH	12A	DPWA	Multichannel
−65	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$

N(1650) INELASTIC POLE RESIDUE

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

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

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.29±0.03	134 ± 10	ANISOVICH	12A	DPWA	Multichannel

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

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.23±0.09	85 ± 9	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \to N(1650) \to \Delta\pi$, *D*-wave

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.19±0.06	−30 ± 20	SOKHOYAN	15A	DPWA	Multichannel

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

0.23±0.04	−30 ± 20	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \to N(1650) \to N\sigma$

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.20±0.15	undefined	SOKHOYAN	15A	DPWA	Multichannel

Normalized residue in $N\pi \to N(1650) \to N(1440)\pi$

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.30±0.17	undefined	SOKHOYAN	15A	DPWA	Multichannel

N(1650) BREIT-WIGNER MASS

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1645 to 1670 (≈ 1655) OUR ESTIMATE				
1654 ± 6	SOKHOYAN	15A	DPWA	Multichannel
1665 ± 2	SHKLYAR	13	DPWA	Multichannel
1634.7 ± 1.1	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
1650 ± 30	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1670 ± 8	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1651 ± 6	ANISOVICH	12A	DPWA	Multichannel
1664 ± 2	SHRESTHA	12A	DPWA	Multichannel
1652 ± 9	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
1665 ± 2	PENNER	02C	DPWA	Multichannel
1647 ± 20	BAI	01B	BES	$J/\psi \to p\overline{p}\eta$
1689 ± 12	VRANA	00	DPWA	Multichannel

N(1650) BREIT-WIGNER WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
110 to 170 (≈ 140) OUR ESTIMATE				
102 ± 8	SOKHOYAN	15A	DPWA	Multichannel
147 ± 14	SHKLYAR	13	DPWA	Multichannel
115.4 ± 2.8	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
150 ± 40	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
180 ± 20	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
104 ± 10	ANISOVICH	12A	DPWA	Multichannel
126 ± 3	SHRESTHA	12A	DPWA	Multichannel
202 ± 16	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
138 ± 7	PENNER	02C	DPWA	Multichannel
145^{+80}_{-45}	BAI	01B	BES	$J/\psi \to p\overline{p}\eta$
202 ± 40	VRANA	00	DPWA	Multichannel

N(1650) DECAY MODES

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	50–70 %
Γ_2	$N\eta$	14–22 %
Γ_3	ΛK	5–15 %
Γ_4	$N\pi\pi$	8–36 %
Γ_5	$\Delta(1232)\pi$	

Γ_6	$\Delta(1232)\pi$, D-wave	6–18 %
Γ_7	$N\sigma$	2–18 %
Γ_8	$N(1440)\pi$	6–26 %
Γ_9	$p\gamma$, helicity=1/2	0.04–0.20 %
Γ_{10}	$n\gamma$, helicity=1/2	0.003–0.17 %

N(1650) BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{total}$ — Γ_1/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
50 to 70 (≈ 60) OUR ESTIMATE				
51±4	SOKHOYAN	15A	DPWA	Multichannel
74±3	SHKLYAR	13	DPWA	Multichannel
65±10	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
61±4	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
51±4	ANISOVICH	12A	DPWA	Multichannel
57±2	SHRESTHA	12A	DPWA	Multichannel
79±6	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
100	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
65±4	PENNER	02C	DPWA	Multichannel
74±2	VRANA	00	DPWA	Multichannel

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

VALUE (%)	DOCUMENT ID		TECN	COMMENT
1 ±2	SHKLYAR	13	DPWA	Multichannel
18 ±4	ANISOVICH	12A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
21 ±2	SHRESTHA	12A	DPWA	Multichannel
13 ±5	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
1.0±0.6	PENNER	02C	DPWA	Multichannel
6 ±1	VRANA	00	DPWA	Multichannel

$\Gamma(\Lambda K)/\Gamma_{total}$ — Γ_3/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
5 to 15 OUR ESTIMATE				
10 ±5	ANISOVICH	12A	DPWA	Multichannel
4 ±1	SHKLYAR	05	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
8 ±1	SHRESTHA	12A	DPWA	Multichannel
2.7±0.4	PENNER	02C	DPWA	Multichannel

$\Gamma(\Delta(1232)\pi, D\text{-wave})/\Gamma_{total}$ — Γ_6/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
12±6	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
19±9	ANISOVICH	12A	DPWA	Multichannel
7±2	SHRESTHA	12A	DPWA	Multichannel
2±1	VRANA	00	DPWA	Multichannel

$\Gamma(N\sigma)/\Gamma_{total}$ — Γ_7/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
10±8	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
< 1	SHRESTHA	12A	DPWA	Multichannel
1±1	VRANA	00	DPWA	Multichannel

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

VALUE (%)	DOCUMENT ID		TECN	COMMENT
16±10	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
< 1	SHRESTHA	12A	DPWA	Multichannel
3± 1	VRANA	00	DPWA	Multichannel

N(1650) PHOTON DECAY AMPLITUDES AT THE POLE

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

MODULUS (GeV$^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.032±0.006	−2 ± 11	SOKHOYAN	15A	DPWA	Multichannel
$0.023^{+0.003}_{-0.008}$	6^{+28}_{-15}	ROENCHEN	14	DPWA	

N(1650) BREIT-WIGNER PHOTON DECAY AMPLITUDES

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

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
+0.045±0.010 OUR ESTIMATE				
0.032±0.006	SOKHOYAN	15A	DPWA	Multichannel
0.055±0.030	WORKMAN	12A	DPWA	$\gamma N \to N\pi$
0.022±0.007	DUGGER	07	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.063±0.006	SHKLYAR	13	DPWA	Multichannel
0.033±0.007	ANISOVICH	12A	DPWA	Multichannel
0.030±0.003	SHRESTHA	12A	DPWA	Multichannel
0.033	DRECHSEL	07	DPWA	$\gamma N \to \pi N$
0.049	PENNER	02D	DPWA	Multichannel

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

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.050±0.020 OUR ESTIMATE				
0.025±0.020	ANISOVICH	13B	DPWA	Multichannel
−0.040±0.010	CHEN	12A	DPWA	$\gamma N \to \pi N$
• • • 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	$\gamma N \to \pi N$
−0.011	PENNER	02D	DPWA	Multichannel

N(1650) FOOTNOTES

[1] Fit to the amplitudes of HOEHLER 79.

N(1650) REFERENCES

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

SOKHOYAN	15A	EPJ A51 95	V. Sokhoyan *et al.*	(CBELSA/TAPS Collab.)
PDG	14	CP C38 070001	K. Olive *et al.*	(PDG Collab.)
ROENCHEN	14	EPJ A50 101	D. Roenchen *et al.*	
Also		EPJ A51 63 (errat.)	D. Roenchen *et al.*	
SVARC	14	PR C89 045205	A. Svarc *et al.*	
ANISOVICH	13B	EPJ A49 67	A.V. Anisovich *et al.*	
SHKLYAR	13	PR C87 015201	V. Shklyar, H. Lenske, U. Mosel	(GIES)
ANISOVICH	12A	EPJ A48 15	A.V. Anisovich *et al.*	(BONN, PNPI)
CHEN	12A	PR C86 015206	W. Chen *et al.*	(DUKE, GWU, MSST, ITEP+)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
WORKMAN	12A	PR C86 015202	R. Workman *et al.*	(GWU)
BATINIC	10	PR C82 038203	M. Batinic *et al.*	(ZAGR)
DRECHSEL	07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)
DUGGER	07	PR C76 025211	M. Dugger *et al.*	(JLab CLAS Collab.)
ARNDT	06	PR C74 045205	R.A. Arndt *et al.*	(GWU)
SHKLYAR	05	PR C72 015210	V. Shklyar, H. Lenske, U. Mosel	(GIES)
PENNER	02C	PR C66 055211	G. Penner, U. Mosel	(GIES)
PENNER	02D	PR C66 055212	G. Penner, U. Mosel	(GIES)
BAI	01B	PL B510 75	J.Z. Bai *et al.*	(BES Collab.)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman, T.-S.H. Lee	(PITT, ANL)
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)
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
HOEHLER	79	PDAT 12-1	G. Hohler *et al.*	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP