$N(1680)\ 5/2^+$

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

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

N(1680) POLE POSITION

REAL PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1665 to 1680 (≈ 1675) OUR ESTIMATE				
1678±5	SOKHOYAN	15A	DPWA	Multichannel
1674±2±1	[1] SVARC	14	L+P	$\pi N \to \pi N$
1667±5	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1669	ROENCHEN	15A	DPWA	Multichannel
1660	SHKLYAR	13	DPWA	Multichannel
1676±6	ANISOVICH	12A	DPWA	Multichannel
1669	SHRESTHA	12A	DPWA	Multichannel
1666±8	BATINIC	10	DPWA	$\pi N \to N\pi,\ N\eta$
1674	ARNDT	06	DPWA	$\pi N \to \pi N,\ \eta N$
1667	VRANA	00	DPWA	Multichannel
1673	HOEHLER	93	ARGD	$\pi N \to \pi N$

[1] Fit to the amplitudes of HOEHLER 79.

−2×IMAGINARY PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
110 to 135 (≈ 120) OUR ESTIMATE				
113± 4	SOKHOYAN	15A	DPWA	Multichannel
129± 3±1	[1] SVARC	14	L+P	$\pi N \to \pi N$
110±10	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
100	ROENCHEN	15A	DPWA	Multichannel
98	SHKLYAR	13	DPWA	Multichannel
113± 4	ANISOVICH	12A	DPWA	Multichannel
119	SHRESTHA	12A	DPWA	Multichannel
135± 6	BATINIC	10	DPWA	$\pi N \to N\pi,\ N\eta$
115	ARNDT	06	DPWA	$\pi N \to \pi N,\ \eta N$
122	VRANA	00	DPWA	Multichannel
135	HOEHLER	93	ARGD	$\pi N \to \pi N$

[1] Fit to the amplitudes of HOEHLER 79.

N(1680) ELASTIC POLE RESIDUE

MODULUS $|r|$

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
35 to 45 (≈ 40) OUR ESTIMATE				
45±4	SOKHOYAN	15A	DPWA	Multichannel
44±1±1	[1] SVARC	14	L+P	$\pi N \to \pi N$
34±2	CUTKOSKY	80	IPWA	$\pi N \to \pi N$

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

34	ROENCHEN	15A	DPWA	Multichannel
33	SHKLYAR	13	DPWA	Multichannel
43±4	ANISOVICH	12A	DPWA	Multichannel
44	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
42	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
44	HOEHLER	93	ARGD	$\pi N \rightarrow \pi N$

[1] Fit to the amplitudes of HOEHLER 79.

PHASE θ

VALUE (°)	DOCUMENT ID		TECN	COMMENT
−20 to 10 (≈ − 5) OUR ESTIMATE				
5±10	SOKHOYAN	15A	DPWA	Multichannel
−16± 1±1	[1] SVARC	14	L+P	$\pi N \rightarrow \pi N$
−25± 5	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−19	ROENCHEN	15A	DPWA	Multichannel
−32	SHKLYAR	13	DPWA	Multichannel
− 2±10	ANISOVICH	12A	DPWA	Multichannel
−19	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
− 4	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
−17	HOEHLER	93	ARGD	$\pi N \rightarrow \pi N$

[1] Fit to the amplitudes of HOEHLER 79.

N(1680) INELASTIC POLE RESIDUE

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

Normalized residue in $N\pi \rightarrow N(1680) \rightarrow \Delta\pi$, *P*-wave

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.15±0.03	−60 ± 30	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.15±0.03	−70 ± 45	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \rightarrow N(1680) \rightarrow \Delta\pi$, *F*-wave

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.23±0.04	90 ± 12	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.23±0.04	85 ± 15	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \rightarrow N(1680) \rightarrow N\eta$

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.027	136	ROENCHEN	15A	DPWA	Multichannel

Normalized residue in $N\pi \rightarrow N(1680) \rightarrow \Lambda K$

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.001	90	ROENCHEN	15A	DPWA	Multichannel

Normalized residue in $N\pi \rightarrow N(1680) \rightarrow \Sigma K$

MODULUS	*PHASE (°)*	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.004	148	ROENCHEN	15A	DPWA	Multichannel

Normalized residue in $N\pi \rightarrow N(1680) \rightarrow N\,(\pi\pi)^{I=0}_{S-wave}$

MODULUS	*PHASE (°)*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.29±0.06	−45 ± 15	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.26±0.04	−56 ± 15	ANISOVICH	12A	DPWA	Multichannel

$N(1680)$ BREIT-WIGNER MASS

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1680 to 1690 (≈ 1685) OUR ESTIMATE				
1690 ± 5	SOKHOYAN	15A	DPWA	Multichannel
1676 ± 2	[1] SHKLYAR	13	DPWA	Multichannel
1682.7± 0.5	[1] SHRESTHA	12A	DPWA	Multichannel
1680.1± 0.2	[1] ARNDT	06	DPWA	$\pi N \rightarrow \pi N,\ \eta N$
1680 ±10	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
1684 ± 3	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1689 ± 6	ANISOVICH	12A	DPWA	Multichannel
1680 ± 7	BATINIC	10	DPWA	$\pi N \rightarrow N\pi,\ N\eta$
1679 ± 3	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

$N(1680)$ BREIT-WIGNER WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
115 to 130 (≈ 120) OUR ESTIMATE				
119 ± 4	SOKHOYAN	15A	DPWA	Multichannel
115 ± 1	[1] SHKLYAR	13	DPWA	Multichannel
126 ± 1	[1] SHRESTHA	12A	DPWA	Multichannel
128.0± 1.1	[1] ARNDT	06	DPWA	$\pi N \rightarrow \pi N,\ \eta N$
120 ±10	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
128 ± 8	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
118 ± 6	ANISOVICH	12A	DPWA	Multichannel
142 ± 7	BATINIC	10	DPWA	$\pi N \rightarrow N\pi,\ N\eta$
128 ± 9	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

N(1680) DECAY MODES

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	60–70 %
Γ_2	$N\eta$	<1 %
Γ_3	$N\pi\pi$	20–40 %
Γ_4	$\Delta(1232)\pi$	11–23 %
Γ_5	$\Delta(1232)\pi$, P-wave	4–10 %
Γ_6	$\Delta(1232)\pi$, F-wave	1–13 %
Γ_7	$N\sigma$	9–19 %
Γ_8	$p\gamma$	0.21–0.32 %
Γ_9	$p\gamma$, helicity=1/2	0.001–0.011 %
Γ_{10}	$p\gamma$, helicity=3/2	0.20–0.32 %
Γ_{11}	$n\gamma$	0.021–0.046 %
Γ_{12}	$n\gamma$, helicity=1/2	0.004–0.029 %
Γ_{13}	$n\gamma$, helicity=3/2	0.01–0.024 %

N(1680) BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE (%)	*DOCUMENT ID*		*TECN*	*COMMENT*
60 to 70 (≈ 65) OUR ESTIMATE				
62 ±4	SOKHOYAN	15A	DPWA	Multichannel
68 ±1	[1] SHKLYAR	13	DPWA	Multichannel
68.0±0.5	[1] SHRESTHA	12A	DPWA	Multichannel
70.1±0.1	[1] ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
62 ±5	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
65 ±2	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
64 ±5	ANISOVICH	12A	DPWA	Multichannel
67 ±3	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
69 ±2	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

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

VALUE (%)	*DOCUMENT ID*		*TECN*	*COMMENT*
<1	SHKLYAR	13	DPWA	Multichannel
1.0 ±0.3	[1] SHRESTHA	12A	DPWA	Multichannel
$0.15^{+0.35}_{-0.10}$	TIATOR	99	DPWA	$\gamma p \to p\eta$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.4 ±0.2	BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
<1	THOMA	08	DPWA	Multichannel
0 ±1	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

$\Gamma(\Delta(1232)\pi, P\text{-wave})/\Gamma_{total}$ Γ_5/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
7 ±3	SOKHOYAN	15A	DPWA	Multichannel
10.5±0.9	[1] SHRESTHA	12A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
5 ±3	ANISOVICH	12A	DPWA	Multichannel
14 ±3	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

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

VALUE (%)	DOCUMENT ID		TECN	COMMENT
10 ±3	SOKHOYAN	15A	DPWA	Multichannel
1.0±0.1	[1] SHRESTHA	12A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
10 ±3	ANISOVICH	12A	DPWA	Multichannel
1 ±1	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

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

VALUE (%)	DOCUMENT ID		TECN	COMMENT
14 ±5	SOKHOYAN	15A	DPWA	Multichannel
9.4±0.8	[1] SHRESTHA	12A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
14 ±7	ANISOVICH	12A	DPWA	Multichannel
9 ±1	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

N(1680) PHOTON DECAY AMPLITUDES AT THE POLE

$N(1680) \rightarrow p\gamma$, helicity-1/2 amplitude $A_{1/2}$

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
−0.013±0.003	−20 ± 17	SOKHOYAN	15A	DPWA	Multichannel
$-0.013^{+0.002}_{-0.005}$	-42^{+9}_{-18}	ROENCHEN	14	DPWA	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
−0.022	−28	ROENCHEN	15A	DPWA	Multichannel

$N(1680) \rightarrow p\gamma$, helicity-3/2 amplitude $A_{3/2}$

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.135±0.005	1 ± 3	SOKHOYAN	15A	DPWA	Multichannel
$0.126^{+0.001}_{-0.002}$	-7^{+3}_{-2}	ROENCHEN	14	DPWA	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.102	−11	ROENCHEN	15A	DPWA	Multichannel

N(1680) BREIT-WIGNER PHOTON DECAY AMPLITUDES

N(1680) → *pγ*, helicity-1/2 amplitude $A_{1/2}$

VALUE ($GeV^{-1/2}$)	*DOCUMENT ID*		*TECN*	*COMMENT*
−0.018 to −0.005 (≈ −0.010) OUR ESTIMATE				
−0.015±0.002	SOKHOYAN	15A	DPWA	Multichannel
0.003±0.001	[1] SHKLYAR	13	DPWA	Multichannel
−0.007±0.002	[1] WORKMAN	12A	DPWA	$\gamma N \to N\pi$
−0.017±0.001	[1] DUGGER	07	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.013±0.003	ANISOVICH	12A	DPWA	Multichannel
−0.017±0.001	[1] SHRESTHA	12A	DPWA	Multichannel
−0.025	DRECHSEL	07	DPWA	$\gamma N \to \pi N$

[1] Statistical error only.

N(1680) → *pγ*, helicity-3/2 amplitude $A_{3/2}$

VALUE ($GeV^{-1/2}$)	*DOCUMENT ID*		*TECN*	*COMMENT*
0.130 to 0.140 (≈ 0.135) OUR ESTIMATE				
0.136±0.005	SOKHOYAN	15A	DPWA	Multichannel
0.116±0.001	[1] SHKLYAR	13	DPWA	Multichannel
0.140±0.002	[1] WORKMAN	12A	DPWA	$\gamma N \to N\pi$
0.134±0.002	[1] DUGGER	07	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.135±0.006	ANISOVICH	12A	DPWA	Multichannel
0.136±0.001	[1] SHRESTHA	12A	DPWA	Multichannel
0.134	DRECHSEL	07	DPWA	$\gamma N \to \pi N$

[1] Statistical error only.

N(1680) → *nγ*, helicity-1/2 amplitude $A_{1/2}$

VALUE ($GeV^{-1/2}$)	*DOCUMENT ID*		*TECN*	*COMMENT*
0.020 to 0.040 (≈ 0.030) OUR ESTIMATE				
0.034±0.006	ANISOVICH	13B	DPWA	Multichannel
0.026±0.004	[1] CHEN	12A	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.029±0.002	[1] SHRESTHA	12A	DPWA	Multichannel
0.028	DRECHSEL	07	DPWA	$\gamma N \to \pi N$

[1] Statistical error only.

N(1680) → *nγ*, helicity-3/2 amplitude $A_{3/2}$

VALUE ($GeV^{-1/2}$)	*DOCUMENT ID*		*TECN*	*COMMENT*
−0.050 to −0.025 (≈ −0.035) OUR ESTIMATE				
−0.044±0.009	ANISOVICH	13B	DPWA	Multichannel
−0.029±0.002	[1] CHEN	12A	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.059±0.002	[1] SHRESTHA	12A	DPWA	Multichannel
−0.038	DRECHSEL	07	DPWA	$\gamma N \to \pi N$

[1] Statistical error only.

N(1680) REFERENCES

For early references, see Physics Letters **111B** 1 (1982). For very early references, see Reviews of Modern Physics **37** 633 (1965).

ROENCHEN	15A	EPJ A51 70	D. Roenchen *et al.*	
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.*	(RBI Zagreb, UNI Tuzla)
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)
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.*	(JLab CLAS Collab.)
ARNDT	06	PR C74 045205	R.A. Arndt *et al.*	(GWU)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman, T.-S.H. Lee	(PITT, ANL)
TIATOR	99	PR C60 035210	L. Tiator *et al.*	
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