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

$I(J^P) = \frac{1}{2}(\frac{5}{2}^+)$ 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*
1660 to 1680 (≈ 1670) OUR ESTIMATE				
1657±2	ROENCHEN	22	DPWA	Multichannel
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. • • •				
1668	HUNT	19	DPWA	Multichannel
1669	ROENCHEN	15A	DPWA	Multichannel
1660	SHKLYAR	13	DPWA	Multichannel
1676±6	ANISOVICH	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				
120± 1	ROENCHEN	22	DPWA	Multichannel
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. • • •				
118	HUNT	19	DPWA	Multichannel
100	ROENCHEN	15A	DPWA	Multichannel
98	SHKLYAR	13	DPWA	Multichannel
113± 4	ANISOVICH	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				
36±1	ROENCHEN	22	DPWA	Multichannel
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	$\pi N \to N\pi$, $N\eta$
42	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
44	HOEHLER	93	ARGD	$\pi N \to \pi N$

[1] Fit to the amplitudes of HOEHLER 79.

PHASE θ

VALUE (°)	*DOCUMENT ID*		*TECN*	*COMMENT*
−30 to −10 (≈ − 20) OUR ESTIMATE				
−31± 1	ROENCHEN	22	DPWA	Multichannel
5±10	SOKHOYAN	15A	DPWA	Multichannel
−16± 1±1	[1] SVARC	14	L+P	$\pi N \to \pi N$
−25± 5	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • 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	$\pi N \to N\pi$, $N\eta$
− 4	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
−17	HOEHLER	93	ARGD	$\pi N \to \pi N$

[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 $N\pi \to N(1680) \to \Delta\pi$, *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 $N\pi \to N(1680) \to \Delta\pi$, *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 $N\pi \to N(1680) \to N\eta$

MODULUS	*PHASE (°)*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.006±0.004	118 ± 1	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.027	136	ROENCHEN	15A	DPWA	Multichannel

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

MODULUS	*PHASE (°)*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.006±0.001	−119 ± 2	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.001	90	ROENCHEN	15A	DPWA	Multichannel

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

MODULUS	*PHASE (°)*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.001±0.001	−46 ± 15	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.004	148	ROENCHEN	15A	DPWA	Multichannel

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

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				
1686 ± 5	GOLOVATCH	19	DPWA	$\gamma p \to \pi^+\pi^- p$
1681.0± 0.1	[1] HUNT	19	DPWA	Multichannel
1690 ± 5	SOKHOYAN	15A	DPWA	Multichannel
1676 ± 2	[1] SHKLYAR	13	DPWA	Multichannel
1680.1± 0.2	[1] ARNDT	06	DPWA	$\pi N \to \pi N,\ \eta N$
1680 ±10	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1684 ± 3	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1689 ± 6	ANISOVICH	12A	DPWA	Multichannel
1682.7± 0.5	[1] SHRESTHA	12A	DPWA	Multichannel
1680 ± 7	BATINIC	10	DPWA	$\pi N \to N\pi,\ N\eta$
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				
118 ±20	GOLOVATCH	19	DPWA	$\gamma p \to \pi^+\pi^- p$
123 ± 3	[1] HUNT	19	DPWA	Multichannel
119 ± 4	SOKHOYAN	15A	DPWA	Multichannel

115 ± 1	[1]	SHKLYAR	13	DPWA	Multichannel
128.0± 1.1	[1]	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
120 ±10		CUTKOSKY	80	IPWA	$\pi N \to \pi N$
128 ± 8		HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
118 ± 6		ANISOVICH	12A	DPWA	Multichannel
126 ± 1	[1]	SHRESTHA	12A	DPWA	Multichannel
142 ± 7		BATINIC	10	DPWA	$\pi N \to N\pi, N\eta$
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	$N\pi\pi$	28–53 %
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	$N\rho$	8–11 %
Γ_8	$N\rho$, S=3/2 , *P*-wave	6–8 %
Γ_9	$N\rho$, S=3/2 , *F*-wave	2–3 %
Γ_{10}	$N\sigma$	9–19 %
Γ_{11}	$p\gamma$	0.21–0.32 %
Γ_{12}	$p\gamma$, helicity=1/2	0.001–0.011 %
Γ_{13}	$p\gamma$, helicity=3/2	0.20–0.32 %
Γ_{14}	$n\gamma$	0.021–0.046 %
Γ_{15}	$n\gamma$, helicity=1/2	0.004–0.029 %
Γ_{16}	$n\gamma$, 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				
68.0±0.1	[1] HUNT	19	DPWA	Multichannel
62 ±4	SOKHOYAN	15A	DPWA	Multichannel
68 ±1	[1] SHKLYAR	13	DPWA	Multichannel
70.1±0.1	[1] ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
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
68.0±0.5	[1] SHRESTHA	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
0.2 ±0.1	MUELLER	20	DPWA	Multichannel
0.09±0.02	[1] HUNT	19	DPWA	Multichannel
<1	SHKLYAR	13	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. • • •

1.0 ±0.3	[1] SHRESTHA	12A	DPWA	Multichannel
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.

$\Gamma(N\pi\pi)/\Gamma_{\text{total}}$ Γ_3/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
28–53 % OUR ESTIMATE				
24±4	GOLOVATCH	19	DPWA	$\gamma p \to \pi^+\pi^- p$

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

VALUE (%)	DOCUMENT ID		TECN	COMMENT
13 ±1	[1] HUNT	19	DPWA	Multichannel
7 ±3	SOKHOYAN	15A	DPWA	Multichannel

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

5 ±3	ANISOVICH	12A	DPWA	Multichannel
10.5±0.9	[1] SHRESTHA	12A	DPWA	Multichannel
14 ±3	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

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

VALUE (%)	DOCUMENT ID		TECN	COMMENT
< 0.3	[1] HUNT	19	DPWA	Multichannel
10 ±3	SOKHOYAN	15A	DPWA	Multichannel

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

10 ±3	ANISOVICH	12A	DPWA	Multichannel
1.0±0.1	[1] SHRESTHA	12A	DPWA	Multichannel
1 ±1	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

$\Gamma(N\rho, S{=}3/2, P\text{-wave})/\Gamma_{total}$ Γ_8/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
6–8 % OUR ESTIMATE				
7±1	[1] HUNT	19	DPWA	Multichannel

[1] Statistical error only.

$\Gamma(N\rho, S{=}3/2, F\text{-wave})/\Gamma_{total}$ Γ_9/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
2–3 % OUR ESTIMATE				
2.4±0.4	[1] HUNT	19	DPWA	Multichannel

[1] Statistical error only.

$\Gamma(N\sigma)/\Gamma_{total}$ Γ_{10}/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
8.7±1.5	[1] HUNT	19	DPWA	Multichannel
14 ±5	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
14 ±7	ANISOVICH	12A	DPWA	Multichannel
9.4±0.8	[1] SHRESTHA	12A	DPWA	Multichannel
9 ±1	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

N(1680) PHOTON DECAY AMPLITUDES AT THE POLE

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

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
−0.017±0.003	70 ± 7	ROENCHEN	22	DPWA	Multichannel
−0.013±0.003	−20 ± 17	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
−0.022	−28	ROENCHEN	15A	DPWA	Multichannel

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

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.095±0.003	−57 ± 4	ROENCHEN	22	DPWA	Multichannel
0.135±0.005	1 ± 3	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.102	−11	ROENCHEN	15A	DPWA	Multichannel

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

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.032±0.003	−7 ± 5	ANISOVICH	17E	DPWA	Multichannel

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

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
−0.063±0.004	−10 ± 5	ANISOVICH	17E	DPWA	Multichannel

$N(1680)$ BREIT-WIGNER PHOTON DECAY AMPLITUDES

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

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
-0.018 to -0.005 (≈ -0.010) OUR ESTIMATE				
-0.0278 ± 0.0036	GOLOVATCH	19	DPWA	$\gamma p \rightarrow \pi^+\pi^- p$
-0.026 ± 0.004	[1] HUNT	19	DPWA	Multichannel
-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	$\gamma N \rightarrow N\pi$
-0.017 ± 0.001	[1] DUGGER	07	DPWA	$\gamma N \rightarrow \pi N$
• • • 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	$\gamma N \rightarrow \pi N$

[1] Statistical error only.

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

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
0.130 to 0.140 ($\approx$ 0.135) OUR ESTIMATE				
0.128 ± 0.011	GOLOVATCH	19	DPWA	$\gamma p \rightarrow \pi^+\pi^- p$
0.112 ± 0.005	[1] HUNT	19	DPWA	Multichannel
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	$\gamma N \rightarrow N\pi$
0.134 ± 0.002	[1] DUGGER	07	DPWA	$\gamma N \rightarrow \pi N$
• • • 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	$\gamma N \rightarrow \pi N$

[1] Statistical error only.

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

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
0.020 to 0.040 ($\approx$ 0.030) OUR ESTIMATE				
0.005 ± 0.004	[1] HUNT	19	DPWA	Multichannel
0.033 ± 0.003	ANISOVICH	17E	DPWA	Multichannel
0.026 ± 0.004	[1] CHEN	12A	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.034 ± 0.006	ANISOVICH	13B	DPWA	Multichannel
0.029 ± 0.002	[1] SHRESTHA	12A	DPWA	Multichannel
0.028	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$

[1] Statistical error only.

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

VALUE ($GeV^{-1/2}$)	*DOCUMENT ID*		*TECN*	*COMMENT*
-0.050 to -0.025 (≈ -0.035) OUR ESTIMATE				
-0.061 ± 0.004	[1] HUNT	19	DPWA	Multichannel
-0.063 ± 0.004	ANISOVICH	17E	DPWA	Multichannel
-0.029 ± 0.002	[1] CHEN	12A	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-0.044 ± 0.009	ANISOVICH	13B	DPWA	Multichannel
-0.059 ± 0.002	[1] SHRESTHA	12A	DPWA	Multichannel
-0.038	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$

[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	22	EPJ A58 229	D. Roenchen *et al.*	(JULI, GWU, BONN+)
MUELLER	20	PL B803 135323	J. Mueller *et al.*	(CBELSA/TAPS Collab.)
GOLOVATCH	19	PL B788 371	E. Golovatch *et al.*	(CLAS Collab.)
HUNT	19	PR C99 055205	B.C. Hunt, D.M. Manley	
ANISOVICH	17E	PR C96 055202	A.V. Anisovich *et al.*	(BONN, PNPI, JLAB+)
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.)
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