$N(1710)$ $1/2^+$

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

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

$N(1710)$ POLE POSITION

REAL PART

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1650 to 1750 (≈ 1700) OUR ESTIMATE				
1605±7	ROENCHEN	22	DPWA	Multichannel
1690±15	ANISOVICH	17A	DPWA	Multichannel
1697±23	[1] ANISOVICH	17A	L+P	γp, $\pi^- p \to K\Lambda$
1770±5±2	[2] SVARC	14	L+P	$\pi N \to \pi N$
1690±20	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1615	HUNT	19	DPWA	Multichannel
1651	ROENCHEN	15A	DPWA	Multichannel
1690±15	SOKHOYAN	15A	DPWA	Multichannel
1690±15	GUTZ	14	DPWA	Multichannel
1670	SHKLYAR	13	DPWA	Multichannel
1687±17	ANISOVICH	12A	DPWA	Multichannel
1711±15	[3] BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
1679	VRANA	00	DPWA	Multichannel
1690	HOEHLER	93	SPED	$\pi N \to \pi N$
1698	CUTKOSKY	90	IPWA	$\pi N \to \pi N$

[1] Statistical error only.
[2] Fit to the amplitudes of HOEHLER 79.
[3] BATINIC 10 finds evidence for a second P_{11} state with all parameters except for the phase of the pole residue very similar to the parameters we give here.

−2×IMAGINARY PART

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
80 to 160 (≈ 120) OUR ESTIMATE				
115±5	ROENCHEN	22	DPWA	Multichannel
155±25	ANISOVICH	17A	DPWA	Multichannel
84±34	[1] ANISOVICH	17A	L+P	γp, $\pi^- p \to K\Lambda$
98±8±5	[2] SVARC	14	L+P	$\pi N \to \pi N$
80±20	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
169	HUNT	19	DPWA	Multichannel
121	ROENCHEN	15A	DPWA	Multichannel
170±20	SOKHOYAN	15A	DPWA	Multichannel
170±20	GUTZ	14	DPWA	Multichannel
159	SHKLYAR	13	DPWA	Multichannel
200±25	ANISOVICH	12A	DPWA	Multichannel
174±16	[3] BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$

132	VRANA	00	DPWA	Multichannel
200	HOEHLER	93	SPED	$\pi N \rightarrow \pi N$
88	CUTKOSKY	90	IPWA	$\pi N \rightarrow \pi N$

[1] Statistical error only.
[2] Fit to the amplitudes of HOEHLER 79.
[3] BATINIC 10 finds evidence for a second P_{11} state with all parameters except for the phase of the pole residue very similar to the parameters we give here.

N(1710) ELASTIC POLE RESIDUE

MODULUS |r|

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
4 to 10 (≈ 7) OUR ESTIMATE				
5.5±2.4	ROENCHEN	22	DPWA	Multichannel
6 ±3	SOKHOYAN	15A	DPWA	Multichannel
5 ±1 ±1	[1] SVARC	14	L+P	$\pi N \rightarrow \pi N$
8 ±2	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
3.2	ROENCHEN	15A	DPWA	Multichannel
6 ±3	GUTZ	14	DPWA	Multichannel
11	SHKLYAR	13	DPWA	Multichannel
6 ±4	ANISOVICH	12A	DPWA	Multichannel
24	[2] BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
15	HOEHLER	93	SPED	$\pi N \rightarrow \pi N$
9	CUTKOSKY	90	IPWA	$\pi N \rightarrow \pi N$

[1] Fit to the amplitudes of HOEHLER 79.
[2] BATINIC 10 finds evidence for a second P_{11} state with all parameters except for the phase of the pole residue very similar to the parameters we give here.

PHASE θ

VALUE (°)	DOCUMENT ID		TECN	COMMENT
120 to 270 (≈ 190) OUR ESTIMATE				
−114±29	ROENCHEN	22	DPWA	Multichannel
130±35	SOKHOYAN	15A	DPWA	Multichannel
−104± 7±3	[1] SVARC	14	L+P	$\pi N \rightarrow \pi N$
175±35	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
55	ROENCHEN	15A	DPWA	Multichannel
120±45	GUTZ	14	DPWA	Multichannel
9	SHKLYAR	13	DPWA	Multichannel
120±70	ANISOVICH	12A	DPWA	Multichannel
20	[2] BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
−167	CUTKOSKY	90	IPWA	$\pi N \rightarrow \pi N$

[1] Fit to the amplitudes of HOEHLER 79.
[2] BATINIC 10 finds evidence for a second P_{11} state with all parameters except for the phase of the pole residue very similar to the parameters we give here.

N(1710) INELASTIC POLE RESIDUE

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

Normalized residue in $N\pi \to N(1710) \to N\eta$

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.28±0.13	91 ± 32	ROENCHEN	22	DPWA	Multichannel
0.12±0.04	0 ± 45	ANISOVICH	12A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.16	−180	ROENCHEN	15A	DPWA	Multichannel

Normalized residue in $N\pi \to N(1710) \to \Lambda K$

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.20±0.10	−144 ± 39	ROENCHEN	22	DPWA	Multichannel
0.16±0.05	−160 ± 25	ANISOVICH	17A	DPWA	Multichannel
$0.12^{+0.24}_{-0.12}$	−119 ± 83	[1] ANISOVICH	17A	L+P	γp, $\pi^- p \to K\Lambda$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.12	−32	ROENCHEN	15A	DPWA	Multichannel
0.17±0.06	−110 ± 20	ANISOVICH	12A	DPWA	Multichannel

[1] Statistical error only.

Normalized residue in $N\pi \to N(1710) \to \Sigma K$

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.055±0.024	**162 ± 153**	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.004	−43	ROENCHEN	15A	DPWA	Multichannel

Normalized residue in $N\pi \to N(1710) \to N(1535)\pi$

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.10±0.04	140 ± 40	GUTZ	14	DPWA	Multichannel

N(1710) BREIT-WIGNER MASS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1680 to 1740 (≈ 1710) OUR ESTIMATE				
1648±16	[1] HUNT	19	DPWA	Multichannel
1715±20	SOKHOYAN	15A	DPWA	Multichannel
1737±17	[1] SHKLYAR	13	DPWA	Multichannel
1700±50	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1723± 9	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1715±20	GUTZ	14	DPWA	Multichannel
1710±20	ANISOVICH	12A	DPWA	Multichannel
1662± 7	[1] SHRESTHA	12A	DPWA	Multichannel
1729±16	[2] BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$

1752± 3	PENNER	02C	DPWA	Multichannel
1699±65	VRANA	00	DPWA	Multichannel

[1] Statistical error only.
[2] BATINIC 10 finds evidence for a second P_{11} state with all parameters except for the phase of the pole residue very similar to the parameters we give here.

N(1710) BREIT-WIGNER WIDTH

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
80 to 200 (≈ 140) OUR ESTIMATE				
195± 46	[1] HUNT	19	DPWA	Multichannel
175± 15	SOKHOYAN	15A	DPWA	Multichannel
368±120	[1] SHKLYAR	13	DPWA	Multichannel
93± 30	CUTKOSKY	90	IPWA	$\pi N \rightarrow \pi N$
90± 30	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. • • •				
175± 15	GUTZ	14	DPWA	Multichannel
200± 18	ANISOVICH	12A	DPWA	Multichannel
116± 17	[1] SHRESTHA	12A	DPWA	Multichannel
180± 17	[2] BATINIC	10	DPWA	$\pi N \rightarrow N\pi$, $N\eta$
386± 59	PENNER	02C	DPWA	Multichannel
143±100	VRANA	00	DPWA	Multichannel

[1] Statistical error only.
[2] BATINIC 10 finds evidence for a second P_{11} state with all parameters except for the phase of the pole residue very similar to the parameters we give here.

N(1710) DECAY MODES

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	5–20 %
Γ_2	$N\eta$	10–50 %
Γ_3	$N\omega$	1–5 %
Γ_4	ΛK	5–25 %
Γ_5	ΣK	seen
Γ_6	$N\pi\pi$	14–48 %
Γ_7	$\Delta(1232)\pi$, P-wave	3–9 %
Γ_8	$N\rho$, S=1/2, P-wave	11–23 %
Γ_9	$N\sigma$	<16 %
Γ_{10}	$N(1535)\pi$	9–21 %
Γ_{11}	$p\gamma$, helicity=1/2	0.002–0.08 %
Γ_{12}	$n\gamma$, helicity=1/2	0.0–0.02%

N(1710) BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{total}$ — Γ_1/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
5 to 20 (≈ 10) OUR ESTIMATE				
12± 6	[1] HUNT	19	DPWA	Multichannel
5± 3	SOKHOYAN	15A	DPWA	Multichannel
2± 2	[1] SHKLYAR	13	PWA	Multichannel
20± 4	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
12± 4	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
5± 3	GUTZ	14	DPWA	Multichannel
5± 4	ANISOVICH	12A	DPWA	Multichannel
15± 4	[1] SHRESTHA	12A	DPWA	Multichannel
22±24	[2] BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
14± 8	PENNER	02C	DPWA	Multichannel
27±13	VRANA	00	DPWA	Multichannel

[1] Statistical error only.
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$\Gamma(N\eta)/\Gamma_{total}$ — Γ_2/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
10 to 50 (≈ 30) OUR ESTIMATE				
18±10	MUELLER	20	DPWA	Multichannel
17± 8	[1] HUNT	19	DPWA	Multichannel
45± 4	[1] SHKLYAR	13	DPWA	Multichannel
17±10	ANISOVICH	12A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
11± 7	[1] SHRESTHA	12A	DPWA	Multichannel
6± 8	[2] BATINIC	10	DPWA	$\pi N \to N\pi$, $N\eta$
36±11	PENNER	02C	DPWA	Multichannel
6± 1	VRANA	00	DPWA	Multichannel

[1] Statistical error only.
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$\Gamma(N\omega)/\Gamma_{total}$ — Γ_3/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
1 to 5 (≈ 3) OUR ESTIMATE				
2±2	DENISENKO	16	DPWA	Multichannel
3±2	[1] SHKLYAR	13	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
13±2	PENNER	02C	DPWA	Multichannel

[1] Statistical error only.

$\Gamma(\Lambda K)/\Gamma_{total}$ — Γ_4/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
5 to 25 (≈ 15) OUR ESTIMATE				
1.8± 1.5	[1] HUNT	19	DPWA	Multichannel
23 ± 7	ANISOVICH	12A	DPWA	Multichannel
5 ± 3	SHKLYAR	05	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
8 ± 4	[1] SHRESTHA	12A	DPWA	Multichannel
5 ± 2	PENNER	02C	DPWA	Multichannel
10 ±10	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

$\Gamma(\Sigma K)/\Gamma_{total}$ — Γ_5/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
7±7	PENNER	02C	DPWA	Multichannel

$\Gamma(\Delta(1232)\pi, P\text{-wave})/\Gamma_{total}$ — Γ_7/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
3–9 % OUR ESTIMATE				
28±9	[1] HUNT	19	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
6±3	[1] SHRESTHA	12A	DPWA	Multichannel
39±8	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

$\Gamma(N\rho, S=1/2, P\text{-wave})/\Gamma_{total}$ — Γ_8/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
11–23 % OUR ESTIMATE				
17±9	[1] HUNT	19	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
17±6	[1] SHRESTHA	12A	DPWA	Multichannel
17±1	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

$\Gamma(N\sigma)/\Gamma_{total}$ — Γ_9/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
<16 % OUR ESTIMATE				
<16	[1] HUNT	19	DPWA	Multichannel

[1] Statistical error only.

$\Gamma(N(1535)\pi)/\Gamma_{total}$ — Γ_{10}/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
15±6	GUTZ	14	DPWA	Multichannel

N(1710) PHOTON DECAY AMPLITUDES AT THE POLE

N(1710) → $p\gamma$, helicity-1/2 amplitude $A_{1/2}$

MODULUS (GeV$^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
−0.018±0.010	40 ± 55	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.020	−83	ROENCHEN	15A	DPWA	Multichannel

N(1710) BREIT-WIGNER PHOTON DECAY AMPLITUDES

N(1710) → $p\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
0.014±0.008	[1] HUNT	19	DPWA	Multichannel
0.050±0.010	SOKHOYAN	15A	DPWA	Multichannel
−0.050±0.001	[1] SHKLYAR	13	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.05 ±0.01	GUTZ	14	DPWA	Multichannel
0.052±0.015	ANISOVICH	12A	DPWA	Multichannel
−0.008±0.003	[1] SHRESTHA	12A	DPWA	Multichannel
0.044	PENNER	02D	DPWA	Multichannel

[1] Statistical error only.

N(1710) → $n\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE (GeV$^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
0.0053±0.0003	[1] HUNT	19	DPWA	Multichannel
−0.040 ±0.020	ANISOVICH	13B	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.017 ±0.003	[1] SHRESTHA	12A	DPWA	Multichannel
−0.024	PENNER	02D	DPWA	Multichannel

[1] Statistical error only.

N(1710) REFERENCES

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

ROENCHEN	22	EPJ A58 229	D. Roenchen *et al.*	(JULI, GWU, BONN+)
MUELLER	20	PL B803 135323	J. Mueller *et al.*	(CBELSA/TAPS Collab.)
HUNT	19	PR C99 055205	B.C. Hunt, D.M. Manley	
ANISOVICH	17A	PRL 119 062004	A.V. Anisovich *et al.*	
DENISENKO	16	PL B755 97	I. Denisenko *et al.*	
ROENCHEN	15A	EPJ A51 70	D. Roenchen *et al.*	
SOKHOYAN	15A	EPJ A51 95	V. Sokhoyan *et al.*	(CBELSA/TAPS Collab.)
GUTZ	14	EPJ A50 74	E. Gutz *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)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)

BATINIC	10	PR C82 038203	M. Batinic *et al.*	(ZAGR)
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)
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	90	PR D42 235	R.E. Cutkosky, S. Wang	(CMU)
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