

$\Delta(1905) \ 5/2^+$ $I(J^P) = \frac{3}{2}(\frac{5}{2}^+)$ Status: ****

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

 $\Delta(1905)$ POLE POSITION**REAL PART**

<i>VALUE</i> (MeV)	<i>DOCUMENT ID</i>	<i>TECN</i>	<i>COMMENT</i>
1770 to 1830 (\approx 1800) OUR ESTIMATE			
1800 \pm 6	SOKHOYAN	15A	DPWA Multichannel
1752 \pm 3 \pm 2	¹ SVARC	14	L+P $\pi N \rightarrow \pi N$
1830 \pm 40	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1819	HUNT	19	DPWA Multichannel
1795	ROENCHEN	15A	DPWA Multichannel
1800 \pm 6	GUTZ	14	DPWA Multichannel
1805 \pm 10	ANISOVICH	12A	DPWA Multichannel
1819	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1793	VRANA	00	DPWA Multichannel
1829	HOEHLER	93	SPED $\pi N \rightarrow \pi N$

¹ Fit to the amplitudes of HOEHLER 79.

−2×IMAGINARY PART

<i>VALUE</i> (MeV)	<i>DOCUMENT ID</i>	<i>TECN</i>	<i>COMMENT</i>
260 to 340 (\approx 300) OUR ESTIMATE			
290 \pm 15	SOKHOYAN	15A	DPWA Multichannel
346 \pm 6 \pm 2	¹ SVARC	14	L+P $\pi N \rightarrow \pi N$
280 \pm 60	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
253	HUNT	19	DPWA Multichannel
247	ROENCHEN	15A	DPWA Multichannel
290 \pm 15	GUTZ	14	DPWA Multichannel
300 \pm 15	ANISOVICH	12A	DPWA Multichannel
247	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
302	VRANA	00	DPWA Multichannel
303	HOEHLER	93	SPED $\pi N \rightarrow \pi N$

¹ Fit to the amplitudes of HOEHLER 79.

 $\Delta(1905)$ ELASTIC POLE RESIDUE**MODULUS $|r|$**

<i>VALUE</i> (MeV)	<i>DOCUMENT ID</i>	<i>TECN</i>	<i>COMMENT</i>
15 to 25 (\approx 20) OUR ESTIMATE			
19 \pm 2	SOKHOYAN	15A	DPWA Multichannel
24 \pm 1 \pm 1	¹ SVARC	14	L+P $\pi N \rightarrow \pi N$
25 \pm 8	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$

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

5.3	ROENCHEN	15A	DPWA	Multichannel
19 ± 2	GUTZ	14	DPWA	Multichannel
20 ± 2	ANISOVICH	12A	DPWA	Multichannel
15	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
25	HOEHLER	93	SPED	$\pi N \rightarrow \pi N$

¹Fit to the amplitudes of HOEHLER 79.

PHASE θ

VALUE (°)	DOCUMENT ID	TECN	COMMENT
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–120 to –30 (\approx –50) OUR ESTIMATE

– 45 ± 4	SOKHOYAN	15A	DPWA	Multichannel
– 114 ± 1 ± 2	¹ SVARC	14	L+P	$\pi N \rightarrow \pi N$
– 50 ± 20	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$

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

– 89	ROENCHEN	15A	DPWA	Multichannel
– 45 ± 4	GUTZ	14	DPWA	Multichannel
– 44 ± 5	ANISOVICH	12A	DPWA	Multichannel
– 30	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$

¹Fit to the amplitudes of HOEHLER 79.

$\Delta(1905)$ INELASTIC POLE RESIDUE

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

Normalized residue in $N\pi \rightarrow \Delta(1905) \rightarrow \Delta\pi, P$ -wave

MODULUS	PHASE (°)	DOCUMENT ID	TECN	COMMENT
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0.19 ± 0.07	10 ± 30	SOKHOYAN	15A	DPWA Multichannel
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• • • We do not use the following data for averages, fits, limits, etc. • • •

0.0870	72	ROENCHEN	15A	DPWA Multichannel
0.25 ± 0.06	0 ± 15	ANISOVICH	12A	DPWA Multichannel

Normalized residue in $N\pi \rightarrow \Delta(1905) \rightarrow \Delta\pi, F$ -wave

MODULUS	PHASE (°)	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

0.009	64	ROENCHEN	15A	DPWA Multichannel
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Normalized residue in $N\pi \rightarrow \Delta(1905) \rightarrow \Sigma K$

MODULUS	PHASE (°)	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

0.001	– 155	ROENCHEN	15A	DPWA Multichannel
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Normalized residue in $N\pi \rightarrow \Delta(1905) \rightarrow N(1535)\pi$

MODULUS	PHASE (°)	DOCUMENT ID	TECN	COMMENT
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0.025 ± 0.010	130 ± 35	GUTZ	14	DPWA Multichannel
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Normalized residue in $N\pi \rightarrow \Delta(1905) \rightarrow \Delta(1232)\eta$

MODULUS	PHASE (°)	DOCUMENT ID	TECN	COMMENT
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0.07 ± 0.02	40 ± 20	GUTZ	14	DPWA Multichannel
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$\Delta(1905)$ BREIT-WIGNER MASS

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1855 to 1910 (≈ 1880) OUR ESTIMATE			
1883 ± 19	GOLOVATCH	19	DPWA $\gamma p \rightarrow \pi^+ \pi^- p$
1866 ± 9	¹ HUNT	19	DPWA Multichannel
1856 ± 6	SOKHOYAN	15A	DPWA Multichannel
1857.8 ± 1.6	¹ ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1910 ± 30	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
1905 ± 20	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1856 ± 6	GUTZ	14	DPWA Multichannel
1861 ± 6	ANISOVICH	12A	DPWA Multichannel
1818 ± 8	¹ SHRESTHA	12A	DPWA Multichannel
1873 ± 77	VRANA	00	DPWA Multichannel

¹Statistical error only. **$\Delta(1905)$ BREIT-WIGNER WIDTH**

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
270 to 400 (≈ 330) OUR ESTIMATE			
327 ± 69	GOLOVATCH	19	DPWA $\gamma p \rightarrow \pi^+ \pi^- p$
289 ± 20	¹ HUNT	19	DPWA Multichannel
325 ± 15	SOKHOYAN	15A	DPWA Multichannel
320.6 ± 8.6	¹ ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
400 ± 100	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
260 ± 20	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
325 ± 15	GUTZ	14	DPWA Multichannel
335 ± 18	ANISOVICH	12A	DPWA Multichannel
278 ± 18	¹ SHRESTHA	12A	DPWA Multichannel
461 ± 111	VRANA	00	DPWA Multichannel

¹Statistical error only. **$\Delta(1905)$ DECAY MODES**

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

Mode	Fraction (Γ_i/Γ)
Γ_1 $N\pi$	9–15%
Γ_2 $N\pi\pi$	>65%
Γ_3 $\Delta(1232)\pi$	>48%
Γ_4 $\Delta(1232)\pi$, P -wave	8–43%
Γ_5 $\Delta(1232)\pi$, F -wave	40–58%
Γ_6 $N\rho$, $S=3/2$, P -wave	17–35%
Γ_7 $N(1535)\pi$	< 1 %
Γ_8 $N(1680)\pi$, P -wave	5–15%

Γ_9	$\Delta(1232)\eta$	2–6%
Γ_{10}	$N\gamma$	0.012–0.036 %
Γ_{11}	$N\gamma$, helicity=1/2	0.002–0.006 %
Γ_{12}	$N\gamma$, helicity=3/2	0.01–0.03 %

$\Delta(1905)$ BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{\text{total}}$				Γ_1/Γ
<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	

9–15% OUR ESTIMATE

17 \pm 1	¹ HUNT	19	DPWA	Multichannel
13 \pm 2	SOKHOYAN	15A	DPWA	Multichannel
12.2 \pm 0.1	¹ ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
8 \pm 3	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
15 \pm 2	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$

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

13 \pm 2	GUTZ	14	DPWA	Multichannel
13 \pm 2	ANISOVICH	12A	DPWA	Multichannel
6 \pm 1	¹ SHRESTHA	12A	DPWA	Multichannel
9 \pm 1	VRANA	00	DPWA	Multichannel

¹Statistical error only.

$\Gamma(N\pi\pi)/\Gamma_{\text{total}}$				Γ_2/Γ
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	

>65% OUR ESTIMATE

0.85 \pm 0.15	GOLOVATCH	19	DPWA	$\gamma p \rightarrow \pi^+ \pi^- p$
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$\Gamma(\Delta(1232)\pi, P\text{-wave})/\Gamma_{\text{total}}$				Γ_4/Γ
<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	

8–43% OUR ESTIMATE

8.4 \pm 0.5	¹ HUNT	19	DPWA	Multichannel
33 \pm 10	SOKHOYAN	15A	DPWA	Multichannel
45 \pm 14	ANISOVICH	12A	DPWA	Multichannel
28 \pm 7	¹ SHRESTHA	12A	DPWA	Multichannel
23 \pm 1	VRANA	00	DPWA	Multichannel

¹Statistical error only.

$\Gamma(\Delta(1232)\pi, F\text{-wave})/\Gamma_{\text{total}}$				Γ_5/Γ
<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	

40–58% OUR ESTIMATE

49 \pm 9	¹ HUNT	19	DPWA	Multichannel
64 \pm 8	¹ SHRESTHA	12A	DPWA	Multichannel
44 \pm 1	VRANA	00	DPWA	Multichannel

¹Statistical error only.

$\Gamma(N\rho, S=3/2, P\text{-wave})/\Gamma_{\text{total}}$ Γ_6/Γ

VALUE (%)	DOCUMENT ID	TECN	COMMENT
17-35% OUR ESTIMATE			
26 ± 9	¹ HUNT	19	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
< 6	¹ SHRESTHA	12A	DPWA Multichannel
24 ± 1	VRANA	00	DPWA Multichannel
¹ Statistical error only.			

 $\Gamma(N(1535)\pi)/\Gamma_{\text{total}}$ Γ_7/Γ

VALUE (%)	DOCUMENT ID	TECN	COMMENT
< 1 % OUR ESTIMATE			
< 1	GUTZ	14	DPWA Multichannel

 $\Gamma(N(1680)\pi, P\text{-wave})/\Gamma_{\text{total}}$ Γ_8/Γ

VALUE (%)	DOCUMENT ID	TECN	COMMENT
5-15% OUR ESTIMATE			
10 ± 5	SOKHOYAN	15A	DPWA Multichannel

 $\Gamma(\Delta(1232)\eta)/\Gamma_{\text{total}}$ Γ_9/Γ

VALUE (%)	DOCUMENT ID	TECN	COMMENT
2-6% OUR ESTIMATE			
4 ± 2	GUTZ	14	DPWA Multichannel

 $\Delta(1905)$ PHOTON DECAY AMPLITUDES AT THE POLE **$\Delta(1905) \rightarrow N\gamma$, helicity-1/2 amplitude $A_{1/2}$**

MODULUS ($\text{GeV}^{-1/2}$)	PHASE ($^\circ$)	DOCUMENT ID	TECN	COMMENT
0.025 ± 0.005	-28 ± 12	SOKHOYAN	15A	DPWA Multichannel
$0.013^{+0.013}_{-0.005}$	64^{+72}_{-36}	ROENCHEN	14	DPWA
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.053	89	ROENCHEN	15A	DPWA Multichannel

 $\Delta(1905) \rightarrow N\gamma$, helicity-3/2 amplitude $A_{3/2}$

MODULUS ($\text{GeV}^{-1/2}$)	PHASE ($^\circ$)	DOCUMENT ID	TECN	COMMENT
-0.050 ± 0.004	5 ± 10	SOKHOYAN	15A	DPWA Multichannel
0.072 ± 0.016	113^{+13}_{-7}	ROENCHEN	14	DPWA
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-0.030	80	ROENCHEN	15A	DPWA Multichannel

 $\Delta(1905)$ BREIT-WIGNER PHOTON DECAY AMPLITUDES **$\Delta(1905) \rightarrow N\gamma$, helicity-1/2 amplitude $A_{1/2}$**

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
0.017 to 0.027 (≈ 0.022) OUR ESTIMATE			
0.019 ± 0.0076	GOLOVATCH	19	DPWA $\gamma p \rightarrow \pi^+ \pi^- p$
0.077 ± 0.010	¹ HUNT	19	DPWA Multichannel
0.025 ± 0.005	SOKHOYAN	15A	DPWA Multichannel
0.020 ± 0.002	¹ DUGGER	13	DPWA $\gamma N \rightarrow \pi N$
0.019 ± 0.002	¹ WORKMAN	12A	DPWA $\gamma N \rightarrow \pi N$

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

0.025 ± 0.005	GUTZ	14	DPWA	Multichannel
0.025 ± 0.004	ANISOVICH	12A	DPWA	Multichannel
0.066 ± 0.018	¹ SHRESTHA	12A	DPWA	Multichannel
0.018	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$

¹Statistical error only.

$\Delta(1905) \rightarrow N\gamma$, helicity-3/2 amplitude $A_{3/2}$

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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–0.055 to –0.035 (\approx –0.045) OUR ESTIMATE

-0.0432 ± 0.0173	GOLOVATCH	19	DPWA	$\gamma p \rightarrow \pi^+ \pi^- p$
-0.053 ± 0.029	¹ HUNT	19	DPWA	Multichannel
-0.050 ± 0.005	SOKHOYAN	15A	DPWA	Multichannel
-0.049 ± 0.005	¹ DUGGER	13	DPWA	$\gamma N \rightarrow \pi N$
-0.038 ± 0.004	WORKMAN	12A	DPWA	$\gamma N \rightarrow \pi N$

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

-0.050 ± 0.005	GUTZ	14	DPWA	Multichannel
-0.049 ± 0.004	ANISOVICH	12A	DPWA	Multichannel
-0.223 ± 0.029	¹ SHRESTHA	12A	DPWA	Multichannel
-0.028	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$

¹Statistical error only.

$\Delta(1905)$ REFERENCES

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

GOLOVATCH	19	PL B788 371	E. Golovatch <i>et al.</i>	(CLAS Collab.)
HUNT	19	PR C99 055205	B.C. Hunt, D.M. Manley	
ROENCHEN	15A	EPJ A51 70	D. Roenchen <i>et al.</i>	
SOKHOYAN	15A	EPJ A51 95	V. Sokhoyan <i>et al.</i>	(CBELSA/TAPS Collab.)
GUTZ	14	EPJ A50 74	E. Gutz <i>et al.</i>	(CBELSA/TAPS Collab.)
PDG	14	CP C38 070001	K. Olive <i>et al.</i>	(PDG Collab.)
ROENCHEN	14	EPJ A50 101	D. Roenchen <i>et al.</i>	
Also		EPJ A51 63 (errat.)	D. Roenchen <i>et al.</i>	
SVARC	14	PR C89 045205	A. Svarc <i>et al.</i>	(RBI Zagreb, UNI Tuzla)
DUGGER	13	PR C88 065203	M. Dugger <i>et al.</i>	(JLab CLAS Collab.)
ANISOVICH	12A	EPJ A48 15	A.V. Anisovich <i>et al.</i>	(BONN, PNPI)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
WORKMAN	12A	PR C86 015202	R. Workman <i>et al.</i>	(GWU)
DRECHSEL	07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)
ARNDT	06	PR C74 045205	R.A. Arndt <i>et al.</i>	(GWU)
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 <i>et al.</i>	(CMU, LBL) IJP
Also		PR D20 2839	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
HOEHLER	79	PDAT 12-1	G. Hohler <i>et al.</i>	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP