

$N(1860) 5/2^+$ $I(J^P) = \frac{1}{2}(5/2^+)$ Status: **

OMITTED FROM SUMMARY TABLE

Before the 2012 *Review*, all the evidence for a $J^P = 5/2^+$ state with a mass above 1800 MeV was filed under a two-star $N(2000)$. There is now some evidence from ANISOVICH 12A for two $5/2^+$ states in this region, so we have split the older data (according to mass) between two two-star $5/2^+$ states, an $N(1860)$ and an $N(2000)$.

 $N(1860)$ POLE POSITION**REAL PART**

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1870 ± 25	SARANTSEV 25	DPWA	Multichannel
$1834 \pm 19 \pm 6$	¹ SVARC 14	L+P	$\pi N \rightarrow \pi N$
••• We do not use the following data for averages, fits, limits, etc. •••			
1871	HUNT 19	DPWA	Multichannel
1830^{+120}_{-60}	ANISOVICH 12A	DPWA	Multichannel
1807	ARNDT 06	DPWA	$\pi N \rightarrow \pi N, \eta N$

¹Fit to the amplitudes of HOEHLER 79.**–2×IMAGINARY PART**

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
290 ± 40	SARANTSEV 25	DPWA	Multichannel
$122 \pm 34 \pm 7$	² SVARC 14	L+P	$\pi N \rightarrow \pi N$
••• We do not use the following data for averages, fits, limits, etc. •••			
337	HUNT 19	DPWA	Multichannel
250^{+150}_{-50}	ANISOVICH 12A	DPWA	Multichannel
109	ARNDT 06	DPWA	$\pi N \rightarrow \pi N, \eta N$

²Fit to the amplitudes of HOEHLER 79. **$N(1860)$ ELASTIC POLE RESIDUE****MODULUS $|r|$**

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
$4 \pm 1 \pm 1$	³ SVARC 14	L+P	$\pi N \rightarrow \pi N$
50 ± 20	ANISOVICH 12A	DPWA	Multichannel
••• We do not use the following data for averages, fits, limits, etc. •••			
60	ARNDT 06	DPWA	$\pi N \rightarrow \pi N, \eta N$

³Fit to the amplitudes of HOEHLER 79.**PHASE θ**

VALUE (°)	DOCUMENT ID	TECN	COMMENT
$-39 \pm 18 \pm 9$	⁴ SVARC 14	L+P	$\pi N \rightarrow \pi N$
-80 ± 40	ANISOVICH 12A	DPWA	Multichannel
••• We do not use the following data for averages, fits, limits, etc. •••			
-67	ARNDT 06	DPWA	$\pi N \rightarrow \pi N, \eta N$

⁴Fit to the amplitudes of HOEHLER 79. **$N(1860)$ BREIT-WIGNER MASS**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1920 \pm 25	SARANTSEV 25	DPWA	Multichannel
1928 \pm 21	⁵ HUNT 19	DPWA	Multichannel
1882 \pm 10	HOEHLER 79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
1860 $\begin{smallmatrix} +120 \\ -60 \end{smallmatrix}$	ANISOVICH 12A	DPWA	Multichannel
1900 \pm 7	⁵ SHRESTHA 12A	DPWA	Multichannel
1817.7	ARNDT 06	DPWA	$\pi N \rightarrow \pi N, \eta N$

⁵Statistical error only. **$N(1860)$ BREIT-WIGNER WIDTH**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
300 \pm 35	SARANTSEV 25	DPWA	Multichannel
376 \pm 58	⁶ HUNT 19	DPWA	Multichannel
95 \pm 20	HOEHLER 79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
270 $\begin{smallmatrix} +140 \\ -50 \end{smallmatrix}$	ANISOVICH 12A	DPWA	Multichannel
219 \pm 23	⁶ SHRESTHA 12A	DPWA	Multichannel
117.6	ARNDT 06	DPWA	$\pi N \rightarrow \pi N, \eta N$

⁶Statistical error only. **$N(1860)$ DECAY MODES**

<u>Mode</u>	<u>Fraction (Γ_i/Γ)</u>
Γ_1 $N\pi$	4–20 %
Γ_2 $N\eta$	0–6 %
Γ_3 ΛK	<0.01 %
Γ_4 $N\pi\pi$	>61 %
Γ_5 $\Delta\pi$	20–54 %
Γ_6 $\Delta\pi, P\text{-wave}$	4–16 %
Γ_7 $\Delta\pi, F\text{-wave}$	16–38 %
Γ_8 $N\rho$	<8.6 %
Γ_9 $N\rho, S=1/2$	(16 \pm 9) %
Γ_{10} $N\rho, S=3/2, P\text{-wave}$	<8.5 %
Γ_{11} $N\rho, S=3/2, F\text{-wave}$	<0.1 %
Γ_{12} $N\sigma$	41–61 %
Γ_{13} $p\gamma$	
Γ_{14} $p\gamma, \text{helicity}=1/2$	seen
Γ_{15} $p\gamma, \text{helicity}=3/2$	seen

Γ_{16}	$n\gamma$	0.0017–0.062 %
Γ_{17}	$n\gamma$, helicity=1/2	0.0003–0.019 %
Γ_{18}	$n\gamma$, helicity=3/2	0.0014–0.043 %

$N(1860)$ BRANCHING RATIOS

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
4–20 % OUR ESTIMATE			
12 ± 4	SEIFEN	25	DPWA Multichannel
8.0±0.1	⁷ HUNT	19	DPWA Multichannel
4 ± 2	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
20 ± 6	ANISOVICH	12A	DPWA Multichannel
17 ± 1	⁷ SHRESTHA	12A	DPWA Multichannel
12.7	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
⁷ Statistical error only.			

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0–6 % OUR ESTIMATE			
0.11±0.09	⁸ HUNT	19	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
4 ± 2	⁸ SHRESTHA	12A	DPWA Multichannel
⁸ Statistical error only.			

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<0.01 % OUR ESTIMATE			
<0.01	⁹ HUNT	19	DPWA Multichannel
⁹ Statistical error only.			

$\Gamma(\Delta\pi)/\Gamma_{\text{total}}$ Γ_5/Γ

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
7±3			
	SARANTSEV	25	DPWA Multichannel

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
4–16 % OUR ESTIMATE			
2±2	SARANTSEV	25	DPWA Multichannel
2±2	SEIFEN	25	DPWA Multichannel
10±6	¹⁰ HUNT	19	DPWA Multichannel
¹⁰ Statistical error only.			

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
16–38 % OUR ESTIMATE			
5 ± 2	SARANTSEV	25	DPWA Multichannel
4 ± 2	SEIFEN	25	DPWA Multichannel
27±11	¹¹ HUNT	19	DPWA Multichannel
¹¹ Statistical error only.			

$\Gamma(N\rho)/\Gamma_{\text{total}}$					Γ_8/Γ
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
54 ± 16	SARANTSEV	25	DPWA	Multichannel	

$\Gamma(N\rho, S=1/2)/\Gamma_{\text{total}}$					Γ_9/Γ
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
16 ± 9	SARANTSEV	25	DPWA	Multichannel	

$\Gamma(N\rho, S=3/2, P\text{-wave})/\Gamma_{\text{total}}$					Γ_{10}/Γ
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
< 8.5 % OUR ESTIMATE					
13 ± 5	SARANTSEV	25	DPWA	Multichannel	
< 8.5	¹² HUNT	19	DPWA	Multichannel	
¹² Statistical error only.					

$\Gamma(N\rho, S=3/2, F\text{-wave})/\Gamma_{\text{total}}$					Γ_{11}/Γ
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
< 0.1 % OUR ESTIMATE					
25 ± 12	SARANTSEV	25	DPWA	Multichannel	
< 0.1	¹³ HUNT	19	DPWA	Multichannel	
¹³ Statistical error only.					

$\Gamma(N\sigma)/\Gamma_{\text{total}}$					Γ_{12}/Γ
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
41–61 % OUR ESTIMATE					
9 ± 3	SARANTSEV	25	DPWA	Multichannel	
4 ± 4	SEIFEN	25	DPWA	Multichannel	
51 ± 10	¹⁴ HUNT	19	DPWA	Multichannel	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
41 ± 6	¹⁴ SHRESTHA	12A	DPWA	Multichannel	
¹⁴ Statistical error only.					

$N(1860)$ PHOTON DECAY AMPLITUDES AT THE POLE

$N(1860) \rightarrow p\gamma$, helicity-1/2 amplitude $A_{1/2}$

MODULUS ($\text{GeV}^{-1/2}$)	PHASE ($^\circ$)	DOCUMENT ID	TECN	COMMENT
0.020 ± 0.006	85 ± 25	SARANTSEV	25	DPWA Multichannel

$N(1860) \rightarrow p\gamma$, helicity-3/2 amplitude $A_{3/2}$

MODULUS ($\text{GeV}^{-1/2}$)	PHASE ($^\circ$)	DOCUMENT ID	TECN	COMMENT
0.062 ± 0.015	-5 ± 15	SARANTSEV	25	DPWA Multichannel

$N(1860)$ BREIT-WIGNER PHOTON DECAY AMPLITUDES **$N(1860) \rightarrow p\gamma$, helicity-1/2 amplitude $A_{1/2}$**

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.022±0.006	¹⁵ SARANTSEV 25	DPWA	Multichannel
-0.022±0.020	¹⁶ HUNT 19	DPWA	Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
-0.017±0.003	¹⁶ SHRESTHA 12A	DPWA	Multichannel
¹⁵ Sign is undetermined.			
¹⁶ Statistical error only.			

 $N(1860) \rightarrow p\gamma$, helicity-3/2 amplitude $A_{3/2}$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.063±0.013	SARANTSEV 25	DPWA	Multichannel
-0.032±0.034	¹⁷ HUNT 19	DPWA	Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.029±0.004	¹⁷ SHRESTHA 12A	DPWA	Multichannel
¹⁷ Statistical error only.			

 $N(1860) \rightarrow n\gamma$, helicity-1/2 amplitude $A_{1/2}$

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.021±0.029	¹⁸ HUNT 19	DPWA	Multichannel
0.021±0.013	ANISOVICH 13B	DPWA	Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.010±0.005	¹⁸ SHRESTHA 12A	DPWA	Multichannel
¹⁸ Statistical error only.			

 $N(1860) \rightarrow n\gamma$, helicity-3/2 amplitude $A_{3/2}$

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.070±0.035	¹⁹ HUNT 19	DPWA	Multichannel
0.034±0.017	ANISOVICH 13B	DPWA	Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
-0.009±0.005	¹⁹ SHRESTHA 12A	DPWA	Multichannel
¹⁹ Statistical error only.			

 $N(1860)$ REFERENCES

SARANTSEV 25	PR C112 015202	A.V. Sarantsev <i>et al.</i>	(Bonn-Gatchina Collab.)
SEIFEN 25	EPJ A61 173	T. Seifen <i>et al.</i>	(CBELSA/TAPS Collab.)
HUNT 19	PR C99 055205	B.C. Hunt, D.M. Manley	
SVARC 14	PR C89 045205	A. Svarc <i>et al.</i>	(RBI Zagreb, UNI Tuzla)
ANISOVICH 13B	EPJ A49 67	A.V. Anisovich <i>et al.</i>	
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)
ARNDT 06	PR C74 045205	R.A. Arndt <i>et al.</i>	(GWU)
HOEHLER 79	PDAT 12-1	G. Hohler <i>et al.</i>	(KARLT)