

$N(1875) 3/2^-$

$$I(J^P) = \frac{1}{2}(3/2^-) \text{ Status: } ***$$

Before the 2012 *Review*, all the evidence for a $J^P = 3/2^-$ state with a mass above 1800 MeV was filed under a two-star $N(2080)$.

There is now evidence from ANISOVICH 12A for two $3/2^-$ states in this region, so we have split the older data (according to mass) between a three-star $N(1875)$ and a two-star $N(2120)$.

 $N(1875)$ POLE POSITION**REAL PART**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1850 to 1950 (\approx 1900) OUR ESTIMATE			
1870 \pm 20	SOKHOYAN	15A	DPWA Multichannel
1880 \pm 100	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (lower m)
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1993	HUNT	19	DPWA Multichannel
1810	SHKLYAR	13	DPWA Multichannel
1860 \pm 25	ANISOVICH	12A	DPWA Multichannel
1957 \pm 49	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
1824	VRANA	00	DPWA Multichannel

-2xIMAGINARY PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
100 to 220 (\approx 160) OUR ESTIMATE			
200 \pm 15	SOKHOYAN	15A	DPWA Multichannel
160 \pm 80	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (lower m)
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
319	HUNT	19	DPWA Multichannel
98	SHKLYAR	13	DPWA Multichannel
200 \pm 20	ANISOVICH	12A	DPWA Multichannel
467 \pm 106	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
614	VRANA	00	DPWA Multichannel

 $N(1875)$ ELASTIC POLE RESIDUE**MODULUS $|r|$**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
3 to 12 (\approx 10) OUR ESTIMATE			
3 \pm 1.5	SOKHOYAN	15A	DPWA Multichannel
10 \pm 5	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (lower m)
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
3	SHKLYAR	13	DPWA Multichannel
2.5 \pm 1.0	ANISOVICH	12A	DPWA Multichannel
53	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$

PHASE θ

<u>VALUE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
50 to 200 (≈ 100) OUR ESTIMATE			
160 \pm 50	SOKHOYAN	15A	DPWA Multichannel
100 \pm 80	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (lower m)
• • • We do not use the following data for averages, fits, limits, etc. • • •			
– 76	SHKLYAR	13	DPWA Multichannel
– 65	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$

 $N(1875)$ INELASTIC POLE RESIDUE

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

Normalized residue in $N\pi \rightarrow N(1875) \rightarrow \Lambda K$

<u>MODULUS</u>	<u>PHASE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.015 \pm 0.005		ANISOVICH	12A	DPWA Multichannel

Normalized residue in $N\pi \rightarrow N(1875) \rightarrow \Sigma K$

<u>MODULUS</u>	<u>PHASE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.04 \pm 0.02		ANISOVICH	12A	DPWA Multichannel

Normalized residue in $N\pi \rightarrow N(1875) \rightarrow N\sigma$

<u>MODULUS</u>	<u>PHASE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.09 \pm 0.03	– 175 \pm 45	SOKHOYAN	15A	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.08 \pm 0.03	– 170 \pm 65	ANISOVICH	12A	DPWA Multichannel

Normalized residue in $N\pi \rightarrow N(1875) \rightarrow \Delta(1232)\pi, S$ -wave

<u>MODULUS</u>	<u>PHASE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.05 \pm 0.03	undefined	SOKHOYAN	15A	DPWA Multichannel

Normalized residue in $N\pi \rightarrow N(1875) \rightarrow \Delta(1232)\pi, D$ -wave

<u>MODULUS</u>	<u>PHASE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.04 \pm 0.02	undefined	SOKHOYAN	15A	DPWA Multichannel

Normalized residue in $N\pi \rightarrow N(1875) \rightarrow N(1440)\pi$

<u>MODULUS</u>	<u>PHASE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.03 \pm 0.02	undefined	SOKHOYAN	15A	DPWA Multichannel

 $N(1875)$ BREIT-WIGNER MASS

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1850 to 1920 (≈ 1875) OUR ESTIMATE			
2005 \pm 12	¹ HUNT	19	DPWA Multichannel
1875 \pm 20	SOKHOYAN	15A	DPWA Multichannel
1934 \pm 10	¹ SHKLYAR	13	DPWA Multichannel
1880 \pm 100	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$

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

1880 ± 20	ANISOVICH	12A	DPWA	Multichannel
1951 ± 27	¹ SHRESTHA	12A	DPWA	Multichannel
2048 ± 65	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
1946 ± 1	PENNER	02C	DPWA	Multichannel
1895	MART	00	DPWA	$\gamma p \rightarrow \Lambda K^+$
2003 ± 18	VRANA	00	DPWA	Multichannel

¹Statistical error only.

N(1875) BREIT-WIGNER WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
120 to 250 (≈ 200) OUR ESTIMATE			
321 ± 21	¹ HUNT	19	DPWA Multichannel
200 ± 25	SOKHOYAN	15A	DPWA Multichannel
857 ± 100	¹ SHKLYAR	13	DPWA Multichannel
180 ± 60	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (lower m)

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

200 ± 25	ANISOVICH	12A	DPWA	Multichannel
500 ± 45	¹ SHRESTHA	12A	DPWA	Multichannel
529 ± 128	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
859 ± 7	PENNER	02C	DPWA	Multichannel
372	MART	00	DPWA	$\gamma p \rightarrow \Lambda K^+$
1070 ± 858	VRANA	00	DPWA	Multichannel

¹Statistical error only.

N(1875) DECAY MODES

Mode	Fraction (Γ_i/Γ)
Γ_1 $N\pi$	3–11 %
Γ_2 $N\eta$	3–16 %
Γ_3 $N\omega$	15–25 %
Γ_4 ΛK	1–2 %
Γ_5 ΣK	0.3–1.1 %
Γ_6 $N\pi\pi$	>56 %
Γ_7 $\Delta(1232)\pi$	4–44 %
Γ_8 $\Delta(1232)\pi$, S-wave	2–21 %
Γ_9 $\Delta(1232)\pi$, D-wave	2–23 %
Γ_{10} $N\rho$, S=3/2, S-wave	36–56 %
Γ_{11} $N\sigma$	16–60 %
Γ_{12} $N(1440)\pi$	2–8 %
Γ_{13} $N(1520)\pi$	<2 %
Γ_{14} $\Lambda K^*(892)$	<0.2 %
Γ_{15} $p\gamma$	0.001–0.025 %

Γ_{16}	$p\gamma$, helicity=1/2	0.001–0.021 %
Γ_{17}	$p\gamma$, helicity=3/2	<0.003 %
Γ_{18}	$n\gamma$	<0.040 %
Γ_{19}	$n\gamma$, helicity=1/2	<0.007 %
Γ_{20}	$n\gamma$, helicity=3/2	<0.033 %

$N(1875)$ BRANCHING RATIOS

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

VALUE (%)	DOCUMENT ID	TECN	COMMENT
3 to 11 (≈ 7) OUR ESTIMATE			
7.5 ± 0.1	¹ HUNT	19	DPWA Multichannel
4 ± 2	SOKHOYAN	15A	DPWA Multichannel
11 ± 1	¹ SHKLYAR	13	DPWA Multichannel
10 ± 4	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (lower m)
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
3 ± 2	ANISOVICH	12A	DPWA Multichannel
7 ± 2	¹ SHRESTHA	12A	DPWA Multichannel
17 ± 7	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
12 ± 2	PENNER	02C	DPWA Multichannel
13 ± 3	VRANA	00	DPWA Multichannel

¹Statistical error only.

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

VALUE (%)	DOCUMENT ID	TECN	COMMENT
3–16 % OUR ESTIMATE			
10 ± 6	MUELLER	20	DPWA Multichannel
3.3 ± 0.8	¹ HUNT	19	DPWA Multichannel
< 1	SHKLYAR	13	DPWA Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
8 ± 3	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
7 ± 2	PENNER	02C	DPWA Multichannel
0 ± 2	VRANA	00	DPWA Multichannel

¹Statistical error only.

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

VALUE (%)	DOCUMENT ID	TECN	COMMENT
13 ± 7	DENISENKO	16	DPWA Multichannel
20 ± 5	¹ SHKLYAR	13	DPWA Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
21 ± 7	PENNER	02C	DPWA Multichannel

¹Statistical error only.

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

VALUE (%)	DOCUMENT ID	TECN	COMMENT
1–2 % OUR ESTIMATE			
1.1 ± 0.4	¹ HUNT	19	DPWA Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.2 ± 0.2	PENNER	02C	DPWA Multichannel

¹Statistical error only.

$$\Gamma(\Sigma K)/\Gamma_{\text{total}} \qquad \Gamma_5/\Gamma$$

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.3–1.1 % OUR ESTIMATE			
0.7±0.4	PENNER	02C	DPWA Multichannel

$$\Gamma(\Delta(1232)\pi, S\text{-wave})/\Gamma_{\text{total}} \qquad \Gamma_8/\Gamma$$

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
2–21 % OUR ESTIMATE			
< 2	¹ HUNT	19	DPWA Multichannel
14± 7	SOKHOYAN	15A	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
87± 3	¹ SHRESTHA	12A	DPWA Multichannel
40±10	VRANA	00	DPWA Multichannel
¹ Statistical error only.			

$$\Gamma(\Delta(1232)\pi, D\text{-wave})/\Gamma_{\text{total}} \qquad \Gamma_9/\Gamma$$

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
2–23 % OUR ESTIMATE			
17± 6	¹ HUNT	19	DPWA Multichannel
7± 5	SOKHOYAN	15A	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
< 6	¹ SHRESTHA	12A	DPWA Multichannel
17±10	VRANA	00	DPWA Multichannel
¹ Statistical error only.			

$$\Gamma(N\rho, S=3/2, S\text{-wave})/\Gamma_{\text{total}} \qquad \Gamma_{10}/\Gamma$$

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
36–56 % OUR ESTIMATE			
46±10	¹ HUNT	19	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
< 5	¹ SHRESTHA	12A	DPWA Multichannel
6± 6	VRANA	00	DPWA Multichannel
¹ Statistical error only.			

$$\Gamma(N\sigma)/\Gamma_{\text{total}} \qquad \Gamma_{11}/\Gamma$$

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
16–60 % OUR ESTIMATE			
24.3± 8.6	¹ HUNT	19	DPWA Multichannel
45 ±15	SOKHOYAN	15A	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
< 4	¹ SHRESTHA	12A	DPWA Multichannel
24 ±24	VRANA	00	DPWA Multichannel
¹ Statistical error only.			

$$\Gamma(N(1440)\pi)/\Gamma_{\text{total}} \qquad \Gamma_{12}/\Gamma$$

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
5±3	SOKHOYAN	15A	DPWA Multichannel

$\Gamma(N(1520)\pi)/\Gamma_{\text{total}}$					Γ_{13}/Γ
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
<2	SOKHOYAN	15A	DPWA	Multichannel	

$\Gamma(\Lambda K^*(892))/\Gamma_{\text{total}}$					Γ_{14}/Γ
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
<0.2 % OUR ESTIMATE					
<0.2	ANISOVICH	17B	DPWA	Multichannel	

$N(1875)$ PHOTON DECAY AMPLITUDES AT THE POLE

$N(1875) \rightarrow p\gamma$, helicity-1/2 amplitude $A_{1/2}$

MODULUS ($\text{GeV}^{-1/2}$)	PHASE ($^\circ$)	DOCUMENT ID	TECN	COMMENT
0.017 ± 0.009	-110 ± 40	SOKHOYAN	15A	DPWA Multichannel

$N(1875) \rightarrow p\gamma$, helicity-3/2 amplitude $A_{3/2}$

MODULUS ($\text{GeV}^{-1/2}$)	PHASE ($^\circ$)	DOCUMENT ID	TECN	COMMENT
0.008 ± 0.004	180 ± 40	SOKHOYAN	15A	DPWA Multichannel

$N(1875)$ BREIT-WIGNER PHOTON DECAY AMPLITUDES

$N(1875) \rightarrow p\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
0.010 to 0.025 (≈ 0.015) OUR ESTIMATE			
-0.013 ± 0.008	¹ HUNT	19	DPWA Multichannel
0.011 ± 0.001	¹ SHKLYAR	13	DPWA Multichannel
0.018 ± 0.010	ANISOVICH	12A	DPWA Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.007 ± 0.008	¹ SHRESTHA	12A	DPWA Multichannel
0.012	PENNER	02D	DPWA Multichannel

¹Statistical error only.

$N(1875) \rightarrow p\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
-0.010 to 0.025 (≈ -0.005) OUR ESTIMATE			
-0.093 ± 0.009	¹ HUNT	19	DPWA Multichannel
-0.007 ± 0.004	SOKHOYAN	15A	DPWA Multichannel
0.026 ± 0.001	¹ SHKLYAR	13	DPWA Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
-0.009 ± 0.005	ANISOVICH	12A	DPWA Multichannel
0.043 ± 0.022	¹ SHRESTHA	12A	DPWA Multichannel
-0.010	PENNER	02D	DPWA Multichannel

¹Statistical error only.

$N(1875) \rightarrow n\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
0.050 ± 0.009	¹ HUNT	19	DPWA Multichannel
0.010 ± 0.006	ANISOVICH	13B	DPWA Multichannel

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

0.055±0.021	¹ SHRESTHA	12A	DPWA	Multichannel
0.023	PENNER	02D	DPWA	Multichannel

¹Statistical error only.

$N(1875) \rightarrow n\gamma$, helicity-3/2 amplitude $A_{3/2}$

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.141±0.022	¹ HUNT	19	DPWA Multichannel
-0.020±0.015	ANISOVICH	13B	DPWA Multichannel

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

-0.085±0.031	¹ SHRESTHA	12A	DPWA	Multichannel
-0.009	PENNER	02D	DPWA	Multichannel

¹Statistical error only.

$N(1875)$ REFERENCES

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

MUELLER	20	PL B803 135323	J. Mueller <i>et al.</i>	(CBELSA/TAPS Collab.)
HUNT	19	PR C99 055205	B.C. Hunt, D.M. Manley	
ANISOVICH	17B	PL B771 142	A.V. Anisovich <i>et al.</i>	
DENISENKO	16	PL B755 97	I. Denisenko <i>et al.</i>	
SOKHOYAN	15A	EPJ A51 95	V. Sokhoyan <i>et al.</i>	(CBELSA/TAPS Collab.)
ANISOVICH	13B	EPJ A49 67	A.V. Anisovich <i>et al.</i>	
SHKLYAR	13	PR C87 015201	V. Shklyar, H. Lenske, U. Mosel	(GIES)
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)
BATINIC	10	PR C82 038203	M. Batinic <i>et al.</i>	(ZAGR)
PENNER	02C	PR C66 055211	G. Penner, U. Mosel	(GIES)
PENNER	02D	PR C66 055212	G. Penner, U. Mosel	(GIES)
MART	00	PR C61 012201	T. Mart, C. Bennhold	
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman, T.-S.H. Lee	(PITT, ANL)
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