

**$N(1875) 3/2^-$**  $I(J^P) = \frac{1}{2}(3/2^-)$  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>
<b>1850 to 1950 (<math>\approx</math> 1900) OUR ESTIMATE</b>			
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. • • •			
1810	SHKLYAR	13	DPWA Multichannel
1860 $\pm$ 25	ANISOVICH	12A	DPWA Multichannel
1975	SHRESTHA	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>
<b>100 to 220 (<math>\approx</math> 160) OUR ESTIMATE</b>			
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. • • •			
98	SHKLYAR	13	DPWA Multichannel
200 $\pm$ 20	ANISOVICH	12A	DPWA Multichannel
495	SHRESTHA	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>
<b>3 to 12 (<math>\approx</math> 10) OUR ESTIMATE</b>			
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  $\theta$** 

<u>VALUE (<math>^{\circ}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>50 to 200 (<math>\approx 100</math>) OUR ESTIMATE</b>			
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 (<math>^{\circ}</math>)</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 (<math>^{\circ}</math>)</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 (<math>^{\circ}</math>)</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 (<math>^{\circ}</math>)</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 (<math>^{\circ}</math>)</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 (<math>^{\circ}</math>)</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>
<b>1850 to 1920 (<math>\approx 1875</math>) OUR ESTIMATE</b>			
1875 $\pm$ 20	SOKHOYAN	15A	DPWA Multichannel
1934 $\pm$ 10	<sup>1</sup> SHKLYAR	13	DPWA Multichannel
1951 $\pm$ 27	<sup>1</sup> SHRESTHA	12A	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
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

<sup>1</sup>Statistical error only.

## N(1875) BREIT-WIGNER WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
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### 120 to 250 (≈ 200) OUR ESTIMATE

200 ± 25	SOKHOYAN	15A	DPWA	Multichannel
857 ± 100	<sup>1</sup> SHKLYAR	13	DPWA	Multichannel
500 ± 45	<sup>1</sup> SHRESTHA	12A	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
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

<sup>1</sup>Statistical error only.

## N(1875) DECAY MODES

Mode	Fraction ( $\Gamma_i/\Gamma$ )
$\Gamma_1$ $N\pi$	3–11 %
$\Gamma_2$ $N\eta$	<1 %
$\Gamma_3$ $N\omega$	15–25 %
$\Gamma_4$ $\Lambda K$	seen
$\Gamma_5$ $\Sigma K$	seen
$\Gamma_6$ $N\pi\pi$	40–95 %
$\Gamma_7$ $\Delta(1232)\pi$	10–35 %
$\Gamma_8$ $\Delta(1232)\pi$ , S-wave	7–21 %
$\Gamma_9$ $\Delta(1232)\pi$ , D-wave	2–12 %
$\Gamma_{10}$ $N\rho$ , S=3/2, S-wave	seen
$\Gamma_{11}$ $\Lambda K^*(892)$	
$\Gamma_{12}$ $N\sigma$	30–60 %
$\Gamma_{13}$ $N(1440)\pi$	2–8 %
$\Gamma_{14}$ $N(1520)\pi$	<2 %
$\Gamma_{15}$ $p\gamma$	0.001–0.025 %
$\Gamma_{16}$ $p\gamma$ , helicity=1/2	0.001–0.021 %
$\Gamma_{17}$ $p\gamma$ , helicity=3/2	<0.003 %

$\Gamma_{18}$	$n\gamma$	<0.040 %
$\Gamma_{19}$	$n\gamma$ , helicity=1/2	<0.007 %
$\Gamma_{20}$	$n\gamma$ , helicity=3/2	<0.033 %

### N(1875) BRANCHING RATIOS

#### $\Gamma(N\pi)/\Gamma_{\text{total}}$ $\Gamma_1/\Gamma$

VALUE (%)	DOCUMENT ID	TECN	COMMENT
<b>3 to 11 (<math>\approx 7</math>) OUR ESTIMATE</b>			
$4 \pm 2$	SOKHOYAN	15A	DPWA Multichannel
$11 \pm 1$	<sup>1</sup> SHKLYAR	13	DPWA Multichannel
$7 \pm 2$	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel
$10 \pm 4$	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (lower $m$ )
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$3 \pm 2$	ANISOVICH	12A	DPWA Multichannel
$17 \pm 7$	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
$12 \pm 2$	PENNER	02C	DPWA Multichannel
$13 \pm 3$	VRANA	00	DPWA Multichannel

<sup>1</sup>Statistical error only.

#### $\Gamma(N\eta)/\Gamma_{\text{total}}$ $\Gamma_2/\Gamma$

VALUE (%)	DOCUMENT ID	TECN	COMMENT
<1	SHKLYAR	13	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$8 \pm 3$	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
$7 \pm 2$	PENNER	02C	DPWA Multichannel
$0 \pm 2$	VRANA	00	DPWA Multichannel

#### $\Gamma(N\omega)/\Gamma_{\text{total}}$ $\Gamma_3/\Gamma$

VALUE (%)	DOCUMENT ID	TECN	COMMENT
$13 \pm 7$	DENISENKO	16	DPWA Multichannel
$20 \pm 5$	<sup>1</sup> SHKLYAR	13	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$21 \pm 7$	PENNER	02C	DPWA Multichannel

<sup>1</sup>Statistical error only

#### $\Gamma(\Lambda K)/\Gamma_{\text{total}}$ $\Gamma_4/\Gamma$

VALUE (%)	DOCUMENT ID	TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$0.2 \pm 0.2$	PENNER	02C	DPWA Multichannel

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

VALUE (%)	DOCUMENT ID	TECN	COMMENT
$0.7 \pm 0.4$	PENNER	02C	DPWA Multichannel

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$14 \pm 7$	SOKHOYAN	15A	DPWA Multichannel
$87 \pm 3$	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
$40 \pm 10$	VRANA	00	DPWA Multichannel

<sup>1</sup> Statistical error only.

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$7 \pm 5$	SOKHOYAN	15A	DPWA Multichannel
$< 6$	SHRESTHA	12A	DPWA Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
$17 \pm 10$	VRANA	00	DPWA Multichannel

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$< 5$	SHRESTHA	12A	DPWA Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
$6 \pm 6$	VRANA	00	DPWA Multichannel

**$\Gamma(\Lambda K^*(892))/\Gamma_{\text{total}}$   $\Gamma_{11}/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$< 0.002$	ANISOVICH	17B	DPWA Multichannel

**$\Gamma(N\sigma)/\Gamma_{\text{total}}$   $\Gamma_{12}/\Gamma$**

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$45 \pm 15$	SOKHOYAN	15A	DPWA Multichannel
$< 4$	SHRESTHA	12A	DPWA Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
$24 \pm 24$	VRANA	00	DPWA Multichannel

**$\Gamma(N(1440)\pi)/\Gamma_{\text{total}}$   $\Gamma_{13}/\Gamma$**

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

**$\Gamma(N(1520)\pi)/\Gamma_{\text{total}}$   $\Gamma_{14}/\Gamma$**

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$< 2$	SOKHOYAN	15A	DPWA Multichannel

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

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

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

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

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

 **$N(1875)$  BREIT-WIGNER PHOTON DECAY AMPLITUDES** **$N(1875) \rightarrow p\gamma$ , helicity-1/2 amplitude  $A_{1/2}$** 

<u>VALUE (<math>\text{GeV}^{-1/2}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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**0.010 to 0.025 ( $\approx 0.015$ ) OUR ESTIMATE**

$0.011 \pm 0.001$	<sup>1</sup> SHKLYAR	13	DPWA Multichannel
$0.018 \pm 0.010$	ANISOVICH	12A	DPWA Multichannel

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

$0.007 \pm 0.008$	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel
0.012	PENNER	02D	DPWA Multichannel

<sup>1</sup>Statistical error only.

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

<u>VALUE (<math>\text{GeV}^{-1/2}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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**-0.010 to 0.025 ( $\approx -0.005$ ) OUR ESTIMATE**

$-0.007 \pm 0.004$	SOKHOYAN	15A	DPWA Multichannel
$0.026 \pm 0.001$	<sup>1</sup> SHKLYAR	13	DPWA Multichannel

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

$-0.009 \pm 0.005$	ANISOVICH	12A	DPWA Multichannel
$0.043 \pm 0.022$	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel
-0.010	PENNER	02D	DPWA Multichannel

<sup>1</sup>Statistical error only.

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

<u>VALUE (<math>\text{GeV}^{-1/2}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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$0.010 \pm 0.006$	ANISOVICH	13B	DPWA Multichannel
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• • • We do not use the following data for averages, fits, limits, etc. • • •

$0.055 \pm 0.021$	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel
0.023	PENNER	02D	DPWA Multichannel

<sup>1</sup>Statistical error only.

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

<u>VALUE (<math>\text{GeV}^{-1/2}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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$-0.020 \pm 0.015$	ANISOVICH	13B	DPWA Multichannel
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• • • We do not use the following data for averages, fits, limits, etc. • • •

$-0.085 \pm 0.031$	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel
-0.009	PENNER	02D	DPWA Multichannel

<sup>1</sup>Statistical error only.

## N(1875) REFERENCES

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

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

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