

$N(1875) 3/2^-$

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

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 $N(2120)$.

The latest GWU analysis (ARNDT 06) finds no evidence for this resonance.

 $N(1875)$ BREIT-WIGNER MASS

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1820 to 1920 (≈ 1875) OUR ESTIMATE			
1880 ± 20	ANISOVICH	12A	DPWA Multichannel
1804 ± 55	MANLEY	92	IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$
1920	BELL	83	DPWA $\pi^- p \rightarrow \Lambda K^0$
1880 ± 100	¹ CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
1900	SAXON	80	DPWA $\pi^- p \rightarrow \Lambda K^0$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
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
1880	BAKER	79	DPWA $\pi^- p \rightarrow n\eta$

 $N(1875)$ BREIT-WIGNER WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
160 to 320 (≈ 220) OUR ESTIMATE			
200 ± 25	ANISOVICH	12A	DPWA Multichannel
450 ± 185	MANLEY	92	IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$
320	BELL	83	DPWA $\pi^- p \rightarrow \Lambda K^0$
180 ± 60	¹ CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (lower m)
240	SAXON	80	DPWA $\pi^- p \rightarrow \Lambda K^0$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
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
87	BAKER	79	DPWA $\pi^- p \rightarrow n\eta$

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

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1800 to 1950 OUR ESTIMATE			
1860 ± 25	ANISOVICH	12A	DPWA Multichannel
1880 ± 100	¹ CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (lower m)
• • • We do not use the following data for averages, fits, limits, etc. • • •			
1957 ± 49	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
1824	VRANA	00	DPWA Multichannel
not seen	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

–2×IMAGINARY PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
150 to 250 OUR ESTIMATE			
200 ± 20	ANISOVICH	12A	DPWA Multichannel
160 ± 80	¹ CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (lower m)
• • • We do not use the following data for averages, fits, limits, etc. • • •			
467 ± 106	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
614	VRANA	00	DPWA Multichannel
not seen	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

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

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
2 to 10 OUR ESTIMATE			
2.5 ± 1.0	ANISOVICH	12A	DPWA Multichannel
10 ± 5	¹ CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (lower m)
• • • We do not use the following data for averages, fits, limits, etc. • • •			
53	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$

PHASE θ

<u>VALUE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
100 ± 80	¹ CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (lower m)
• • • We do not use the following data for averages, fits, limits, etc. • • •			
– 65	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$

 $N(1875)$ INELASTIC POLE RESIDUE

The “normalized residue” is the residue divided by Γ_{pole} .

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

<u>MODULUS (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1.5 ± 0.5	ANISOVICH	12A	DPWA Multichannel

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

<u>MODULUS (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
4 ± 2	ANISOVICH	12A	DPWA Multichannel

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

<u>MODULUS (%)</u>	<u>PHASE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
8±3	-170 ± 65	ANISOVICH	12A DPWA	Multichannel

N(1875) DECAY MODES

Mode	Fraction (Γ_i/Γ)	Scale factor
Γ_1 $N\pi$	(12 ± 10) %	
Γ_2 $N\eta$	(3.5 ± 3.5) %	2.5
Γ_3 $N\omega$	(21 ± 7) %	
Γ_4 ΛK		
Γ_5 ΣK	(7 ± 4) × 10 ⁻³	
Γ_6 $N\pi\pi$		
Γ_7 $\Delta(1232)\pi$, S-wave	(40 ± 10) %	
Γ_8 $\Delta(1232)\pi$, D-wave	(17 ± 10) %	
Γ_9 $N\rho$, S=3/2, S-wave	(6 ± 6) %	
Γ_{10} $N(\pi\pi)_{S\text{-wave}}^{I=0}$	(24 ± 24) %	
Γ_{11} $n\gamma$, helicity=1/2		
Γ_{12} $n\gamma$, helicity=3/2		
Γ_{13} $p\gamma$	0.008–0.016 %	
Γ_{14} $p\gamma$, helicity=1/2	0.006–0.010 %	
Γ_{15} $p\gamma$, helicity=3/2	0.002–0.006 %	

N(1875) BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{\text{total}}$	Γ_1/Γ
<u>VALUE (%)</u>	<u>DOCUMENT ID</u> <u>TECN</u> <u>COMMENT</u>
12±10 OUR ESTIMATE	
3 ± 2	ANISOVICH 12A DPWA Multichannel
23 ± 3	MANLEY 92 IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$
10 ± 4	¹ CUTKOSKY 80 IPWA $\pi N \rightarrow \pi N$ (lower m)
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●	
17 ± 7	BATINIC 10 DPWA $\pi N \rightarrow N\pi$, $N\eta$
12 ± 2	PENNER 02C DPWA Multichannel
13 ± 3	VRANA 00 DPWA Multichannel

$\Gamma(N\eta)/\Gamma_{\text{total}}$	Γ_2/Γ
<u>VALUE (%)</u>	<u>DOCUMENT ID</u> <u>TECN</u> <u>COMMENT</u>
3.5±3.5 OUR AVERAGE	Error includes scale factor of 2.5.
7 ± 2	PENNER 02C DPWA Multichannel
0 ± 2	VRANA 00 DPWA Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●	
8 ± 3	BATINIC 10 DPWA $\pi N \rightarrow N\pi$, $N\eta$

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(1875) \rightarrow N\eta$ $(\Gamma_1 \Gamma_2)^{1/2} / \Gamma$

VALUE (%)	DOCUMENT ID	TECN	COMMENT
6 ±4 OUR ESTIMATE			
5 ±2	ANISOVICH 12A	DPWA	Multichannel
6.5	BAKER 79	DPWA	$\pi^- p \rightarrow n\eta$

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

VALUE (%)	DOCUMENT ID	TECN	COMMENT
21 ±7	PENNER 02C	DPWA	Multichannel

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

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

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(1875) \rightarrow \Lambda K$ $(\Gamma_1 \Gamma_4)^{1/2} / \Gamma$

VALUE (%)	DOCUMENT ID	TECN	COMMENT
4 ±2 OUR ESTIMATE			
4 ±2	ANISOVICH 12A	DPWA	Multichannel
4	BELL 83	DPWA	$\pi^- p \rightarrow \Lambda K^0$
3	SAXON 80	DPWA	$\pi^- p \rightarrow \Lambda K^0$

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

VALUE (%)	DOCUMENT ID	TECN	COMMENT
0.7 ±0.4	PENNER 02C	DPWA	Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(1875) \rightarrow \Sigma K$ $(\Gamma_1 \Gamma_5)^{1/2} / \Gamma$

VALUE (%)	DOCUMENT ID	TECN	COMMENT
1 to 10 OUR ESTIMATE			
15 ±8	ANISOVICH 12A	DPWA	Multichannel
1.4 to 3.7	² DEANS 75	DPWA	$\pi N \rightarrow \Sigma K$

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(1875) \rightarrow \Delta(1232)\pi, S\text{-wave}$ $(\Gamma_1 \Gamma_7)^{1/2} / \Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
-0.09 ±0.09	MANLEY 92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$

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

VALUE (%)	DOCUMENT ID	TECN	COMMENT
40 ±10	VRANA 00	DPWA	Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(1875) \rightarrow \Delta(1232)\pi, D\text{-wave}$ $(\Gamma_1 \Gamma_8)^{1/2} / \Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
+0.22 ±0.07	MANLEY 92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$

$\Gamma(\Delta(1232)\pi, D\text{-wave}) / \Gamma_{\text{total}}$ Γ_8 / Γ

VALUE (%)	DOCUMENT ID	TECN	COMMENT
17 ±10	VRANA 00	DPWA	Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(1875) \rightarrow N\rho, S=3/2, S\text{-wave}$	$(\Gamma_1 \Gamma_9)^{1/2} / \Gamma$		
VALUE	DOCUMENT ID	TECN	COMMENT
-0.24 ± 0.06	MANLEY	92	IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$
$\Gamma(N\rho, S=3/2, S\text{-wave}) / \Gamma_{\text{total}}$		Γ_9 / Γ	
VALUE (%)	DOCUMENT ID	TECN	COMMENT
6 ± 6	VRANA	00	DPWA Multichannel
$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(1875) \rightarrow N(\pi\pi)_{S\text{-wave}}^{I=0}$	$(\Gamma_1 \Gamma_{10})^{1/2} / \Gamma$		
VALUE	DOCUMENT ID	TECN	COMMENT
$+0.25 \pm 0.06$	MANLEY	92	IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$
$\Gamma(N(\pi\pi)_{S\text{-wave}}^{I=0}) / \Gamma_{\text{total}}$		Γ_{10} / Γ	
VALUE (%)	DOCUMENT ID	TECN	COMMENT
24 ± 24	VRANA	00	DPWA Multichannel
$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $p\gamma \rightarrow N(1875) \rightarrow N\eta$	$(\Gamma_{13} \Gamma_2)^{1/2} / \Gamma$		
VALUE (%)	DOCUMENT ID	TECN	COMMENT
60 ± 12	ANISOVICH	12A	DPWA Multichannel
0.37	HICKS	73	MPWA $\gamma p \rightarrow p\eta$

N(1875) PHOTON DECAY AMPLITUDES

Papers on γN amplitudes predating 1981 may be found in our 2006 edition, Journal of Physics, G **33** 1 (2006).

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

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
0.018 ± 0.010	ANISOVICH	12A	DPWA Multichannel
-0.020 ± 0.008	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.012	PENNER	02D	DPWA Multichannel
0.026 ± 0.052	DEVENISH	74	DPWA $\gamma N \rightarrow \pi N$

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

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
-0.009 ± 0.005	ANISOVICH	12A	DPWA Multichannel
0.017 ± 0.011	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
-0.010	PENNER	02D	DPWA Multichannel
0.128 ± 0.057	DEVENISH	74	DPWA $\gamma N \rightarrow \pi N$

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

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
0.007 ± 0.013	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.023	PENNER	02D	DPWA Multichannel
0.053 ± 0.083	DEVENISH	74	DPWA $\gamma N \rightarrow \pi N$

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

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.053±0.034	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
-0.009	PENNER	02D	DPWA Multichannel
0.100±0.141	DEVENISH	74	DPWA $\gamma N \rightarrow \pi N$

$N(1875) \quad \gamma p \rightarrow \Lambda K^+$ AMPLITUDES

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $p\gamma \rightarrow N(1875) \rightarrow \Lambda K^+$ (E_{2-} amplitude)

<u>VALUE (units 10⁻³)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
2.29 ^{+0.7} _{-0.2}	MART	00	DPWA $\gamma p \rightarrow \Lambda K^+$
5.5 ± 0.3	WORKMAN	90	DPWA
4.09	TANABE	89	DPWA

$p\gamma \rightarrow N(1875) \rightarrow \Lambda K^+$ phase angle θ (E_{2-} amplitude)

<u>VALUE (degrees)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
-48 ± 5	WORKMAN	90	DPWA
-35.9	TANABE	89	DPWA

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $p\gamma \rightarrow N(1875) \rightarrow \Lambda K^+$ (M_{2-} amplitude)

<u>VALUE (units 10⁻³)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
-6.7 ± 0.2	WORKMAN	90	DPWA
-4.09	TANABE	89	DPWA

$N(1875)$ FOOTNOTES

¹ CUTKOSKY 80 finds a lower mass D_{13} resonance, as well as one in this region. Both are listed here.

² The range given for DEANS 75 is from the four best solutions. Disagrees with $\pi^+ p \rightarrow \Sigma^+ K^+$ data of WINNIK 77 around 1920 MeV.

$N(1875)$ REFERENCES

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

ANISOVICH	12A	EPJ A48 15	A.V. Anisovich <i>et al.</i>	(BONN, PNPI)
BATINIC	10	PR C82 038203	M. Batinic <i>et al.</i>	(ZAGR)
ARNDT	06	PR C74 045205	R.A. Arndt <i>et al.</i>	(GWU)
PDG	06	JPG 33 1	W.-M. Yao <i>et al.</i>	(PDG Collab.)
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+)
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KENT) IJP
		Also PR D30 904	D.M. Manley <i>et al.</i>	(VPI)
ARNDT	91	PR D43 2131	R.A. Arndt <i>et al.</i>	(VPI, TELE) IJP
WORKMAN	90	PR C42 781	R.L. Workman	(VPI)

TANABE	89	PR C39 741	H. Tanabe, M. Kohno, C. Bennhold	(MANZ)
Also		NC 102A 193	M. Kohno, H. Tanabe, C. Bennhold	(MANZ)
BELL	83	NP B222 389	K.W. Bell <i>et al.</i>	(RL) IJP
AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)
Also		NP B197 365	K. Fujii <i>et al.</i>	(NAGO)
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
SAXON	80	NP B162 522	D.H. Saxon <i>et al.</i>	(RHEL, BRIS) IJP
BAKER	79	NP B156 93	R.D. Baker <i>et al.</i>	(RHEL) IJP
WINNIK	77	NP B128 66	M. Winnik <i>et al.</i>	(HAIF) I
DEANS	75	NP B96 90	S.R. Deans <i>et al.</i>	(SFLA, ALAH) IJP
DEVENISH	74	PL 52B 227	R.C.E. Devenish, D.H. Lyth, W.A. Rankin	(DESY+) IJP
HICKS	73	PR D7 2614	H.R. Hicks <i>et al.</i>	(CMU, ORNL, SFLA) IJP
