

**$N(2120) 3/2^-$** 

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

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  $N(2120)$ .

 **$N(2120)$  POLE POSITION****REAL PART**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>2050 to 2150 (<math>\approx 2100</math>) OUR ESTIMATE</b>			
2115 $\pm$ 40	SOKHOYAN	15A	DPWA Multichannel
2094 $\pm$ 7 $\pm$ 11	SVARC	14	L+P $\pi N \rightarrow \pi N$
2050 $\pm$ 70	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (higher $m$ )
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
2357	HUNT	19	DPWA Multichannel
2115 $\pm$ 40	GUTZ	14	DPWA Multichannel
2110 $\pm$ 50	ANISOVICH	12A	DPWA Multichannel

**−2×IMAGINARY PART**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>200 to 360 (<math>\approx 280</math>) OUR ESTIMATE</b>			
345 $\pm$ 35	SOKHOYAN	15A	DPWA Multichannel
296 $\pm$ 15 $\pm$ 4	SVARC	14	L+P $\pi N \rightarrow \pi N$
200 $\pm$ 80	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (higher $m$ )
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
503	HUNT	19	DPWA Multichannel
345 $\pm$ 35	GUTZ	14	DPWA Multichannel
340 $\pm$ 45	ANISOVICH	12A	DPWA Multichannel

 **$N(2120)$  ELASTIC POLE RESIDUE****MODULUS  $|r|$** 

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>10 to 30 (<math>\approx 20</math>) OUR ESTIMATE</b>			
11 $\pm$ 6	SOKHOYAN	15A	DPWA Multichannel
13 $\pm$ 1 $\pm$ 1	SVARC	14	L+P $\pi N \rightarrow \pi N$
30 $\pm$ 20	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (higher $m$ )
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
11 $\pm$ 6	GUTZ	14	DPWA Multichannel
13 $\pm$ 3	ANISOVICH	12A	DPWA Multichannel

**PHASE  $\theta$** 

<u>VALUE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>−40 to 20 (<math>\approx</math> − 10) OUR ESTIMATE</b>			
−30 ± 20	SOKHOYAN	15A	DPWA Multichannel
− 2 ± 4 ± 9	SVARC	14	L+P $\pi N \rightarrow \pi N$
0 ± 100	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (higher $m$ )
• • • We do not use the following data for averages, fits, limits, etc. • • •			
−30 ± 20	GUTZ	14	DPWA Multichannel
−20 ± 10	ANISOVICH	12A	DPWA Multichannel

 **$N(2120)$  INELASTIC POLE RESIDUE**The “normalized residue” is the residue divided by  $\Gamma_{pole}/2$ .**Normalized residue in  $N\pi \rightarrow N(2120) \rightarrow \Lambda K$** 

<u>MODULUS</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.03 ± 0.01	100 ± 30	ANISOVICH	12A	DPWA Multichannel

**Normalized residue in  $N\pi \rightarrow N(2120) \rightarrow \Sigma K$** 

<u>MODULUS</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.02 ± 0.015	−50 ± 40	ANISOVICH	12A	DPWA Multichannel

**Normalized residue in  $N\pi \rightarrow N(2120) \rightarrow N(1535)\pi$** 

<u>MODULUS</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.15 ± 0.08	−90 ± 40	GUTZ	14	DPWA Multichannel

**Normalized residue in  $N\pi \rightarrow N(2120) \rightarrow \Delta(1232)\pi$ , S-wave**

<u>MODULUS</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.25 ± 0.10	undefined	SOKHOYAN	15A	DPWA Multichannel

**Normalized residue in  $N\pi \rightarrow N(2120) \rightarrow \Delta(1232)\pi$ , D-wave**

<u>MODULUS</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.15 ± 0.06	−35 ± 30	SOKHOYAN	15A	DPWA Multichannel

**Normalized residue in  $N\pi \rightarrow N(2120) \rightarrow N\sigma$** 

<u>MODULUS</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.09 ± 0.05	−80 ± 50	SOKHOYAN	15A	DPWA Multichannel

 **$N(2120)$  BREIT-WIGNER MASS**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>2060 to 2160 (<math>\approx</math> 2120) OUR ESTIMATE</b>			
2353 ± 29	<sup>1</sup> HUNT	19	DPWA Multichannel
2120 ± 45	SOKHOYAN	15A	DPWA Multichannel
2060 ± 80	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
2081 ± 20	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
2120 ± 35	GUTZ	14	DPWA Multichannel
2150 ± 60	ANISOVICH	12A	DPWA Multichannel

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

**$N(2120)$  BREIT-WIGNER WIDTH**

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
<b>260 to 360 (<math>\approx 300</math>) OUR ESTIMATE</b>			
$503 \pm 62$	<sup>1</sup> HUNT	19	DPWA Multichannel
$340 \pm 35$	SOKHOYAN	15A	DPWA Multichannel
$300 \pm 100$	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (higher $m$ )
$265 \pm 40$	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$340 \pm 35$	GUTZ	14	DPWA Multichannel
$330 \pm 45$	ANISOVICH	12A	DPWA Multichannel

<sup>1</sup>Statistical error only. **$N(2120)$  DECAY MODES**

Mode	Fraction ( $\Gamma_i/\Gamma$ )
$\Gamma_1$ $N\pi$	5–15 %
$\Gamma_2$ $N\eta$	
$\Gamma_3$ $N\eta'$	2–6 %
$\Gamma_4$ $N\omega$	4–20 %
$\Gamma_5$ $\Lambda K$	
$\Gamma_6$ $N\pi\pi$	50–95 %
$\Gamma_7$ $\Delta(1232)\pi$	40–90 %
$\Gamma_8$ $\Delta(1232)\pi$ , $S$ -wave	30–70 %
$\Gamma_9$ $\Delta(1232)\pi$ , $D$ -wave	8–32 %
$\Gamma_{10}$ $N\rho$	
$\Gamma_{11}$ $N\rho$ , $S=3/2$ , $S$ -wave	
$\Gamma_{12}$ $\Lambda K^*(892)$	< 0.2 %
$\Gamma_{13}$ $N\sigma$	7–15 %
$\Gamma_{14}$ $N(1535)\pi$	7–23 %
$\Gamma_{15}$ $p\gamma$	0.16–2.1 %
$\Gamma_{16}$ $p\gamma$ , helicity=1/2	0.07–0.80 %
$\Gamma_{17}$ $p\gamma$ , helicity=3/2	0.09–1.3 %
$\Gamma_{18}$ $n\gamma$	0.04–0.72 %
$\Gamma_{19}$ $n\gamma$ , helicity=1/2	0.04–0.60 %
$\Gamma_{20}$ $n\gamma$ , helicity=3/2	0.001–0.12 %

 **$N(2120)$  BRANCHING RATIOS**

$\Gamma(N\pi)/\Gamma_{\text{total}}$				$\Gamma_1/\Gamma$
VALUE (%)	DOCUMENT ID	TECN	COMMENT	
<b>5 to 15 (<math>\approx 10</math>) OUR ESTIMATE</b>				
$19 \pm 2$	<sup>1</sup> HUNT	19	DPWA Multichannel	
$5 \pm 3$	SOKHOYAN	15A	DPWA Multichannel	
$14 \pm 7$	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (higher $m$ )	
$6 \pm 2$	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$	

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

$5 \pm 3$  GUTZ 14 DPWA Multichannel  
 $6 \pm 2$  ANISOVICH 12A DPWA Multichannel

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

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$3.1 \pm 2.4$	<sup>1</sup> HUNT	19	DPWA Multichannel

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

**$\Gamma(N\eta')/\Gamma_{\text{total}}$   $\Gamma_3/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$0.04 \pm 0.02$	ANISOVICH	17C	DPWA Multichannel

**$\Gamma(N\omega)/\Gamma_{\text{total}}$   $\Gamma_4/\Gamma$**

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$12 \pm 8$	DENISENKO	16	DPWA Multichannel

**$\Gamma(\Lambda K)/\Gamma_{\text{total}}$   $\Gamma_5/\Gamma$**

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$8.5 \pm 2.5$	<sup>1</sup> HUNT	19	DPWA Multichannel

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

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$25 \pm 11$	<sup>1</sup> HUNT	19	DPWA Multichannel
$50 \pm 20$	SOKHOYAN	15A	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>
$34 \pm 11$	<sup>1</sup> HUNT	19	DPWA Multichannel
$20 \pm 12$	SOKHOYAN	15A	DPWA Multichannel

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

**$\Gamma(N\rho, S=3/2, S\text{-wave})/\Gamma_{\text{total}}$   $\Gamma_{11}/\Gamma$**

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$< 3$	<sup>1</sup> HUNT	19	DPWA Multichannel

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

**$\Gamma(\Lambda K^*(892))/\Gamma_{\text{total}}$   $\Gamma_{12}/\Gamma$**

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

$\Gamma(N\sigma)/\Gamma_{\text{total}}$					$\Gamma_{13}/\Gamma$
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
$9 \pm 5$	<sup>1</sup> HUNT	19	DPWA	Multichannel	
$11 \pm 4$	SOKHOYAN	15A	DPWA	Multichannel	

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

$\Gamma(N(1535)\pi)/\Gamma_{\text{total}}$					$\Gamma_{14}/\Gamma$
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
$15 \pm 8$	GUTZ	14	DPWA	Multichannel	

 **$N(2120)$  PHOTON DECAY AMPLITUDES AT THE POLE** **$N(2120) \rightarrow p\gamma$ , helicity-1/2 amplitude  $A_{1/2}$** 

MODULUS ( $\text{GeV}^{-1/2}$ )	PHASE ( $^\circ$ )	DOCUMENT ID	TECN	COMMENT
$0.130 \pm 0.045$	$-40 \pm 25$	SOKHOYAN	15A	DPWA Multichannel

 **$N(2120) \rightarrow p\gamma$ , helicity-3/2 amplitude  $A_{3/2}$** 

MODULUS ( $\text{GeV}^{-1/2}$ )	PHASE ( $^\circ$ )	DOCUMENT ID	TECN	COMMENT
$0.160 \pm 0.060$	$-30 \pm 15$	SOKHOYAN	15A	DPWA Multichannel

 **$N(2120)$  BREIT-WIGNER PHOTON DECAY AMPLITUDES** **$N(2120) \rightarrow p\gamma$ , helicity-1/2 amplitude  $A_{1/2}$** 

VALUE ( $\text{GeV}^{-1/2}$ )	DOCUMENT ID	TECN	COMMENT
$0.047 \pm 0.009$	<sup>1</sup> HUNT	19	DPWA Multichannel
$0.130 \pm 0.050$	SOKHOYAN	15A	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$0.130 \pm 0.050$	GUTZ	14	DPWA Multichannel

<sup>1</sup>Statistical error only. **$N(2120) \rightarrow p\gamma$ , helicity-3/2 amplitude  $A_{3/2}$** 

VALUE ( $\text{GeV}^{-1/2}$ )	DOCUMENT ID	TECN	COMMENT
$0.001 \pm 0.007$	<sup>1</sup> HUNT	19	DPWA Multichannel
$0.160 \pm 0.065$	SOKHOYAN	15A	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$0.160 \pm 0.065$	GUTZ	14	DPWA Multichannel

<sup>1</sup>Statistical error only. **$N(2120) \rightarrow n\gamma$ , helicity-1/2 amplitude  $A_{1/2}$** 

VALUE ( $\text{GeV}^{-1/2}$ )	DOCUMENT ID	TECN	COMMENT
$-0.020 \pm 0.013$	<sup>1</sup> HUNT	19	DPWA Multichannel
$0.110 \pm 0.045$	ANISOVICH	13B	DPWA Multichannel

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

**$N(2120) \rightarrow n\gamma$ , helicity-3/2 amplitude  $A_{3/2}$** 

<u>VALUE (GeV<sup>-1/2</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.00 ± 0.02	<sup>1</sup> HUNT	19	DPWA Multichannel
0.040 ± 0.030	ANISOVICH	13B	DPWA Multichannel

<sup>1</sup>Statistical error only. **$N(2120)$  REFERENCES**

HUNT	19	PR C99 055205	B.C. Hunt, D.M. Manley	
ANISOVICH	17B	PL B771 142	A.V. Anisovich <i>et al.</i>	
ANISOVICH	17C	PL B772 247	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.)
GUTZ	14	EPJ A50 74	E. Gutz <i>et al.</i>	(CBELSA/TAPS Collab.)
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)
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky <i>et al.</i>	(CMU, LBL)
HOEHLER	79	PDAT 12-1	G. Hohler <i>et al.</i>	(KARLT)