

$N(2060) 5/2^-$

$$I(J^P) = \frac{1}{2}(\frac{5}{2}^-) \text{ Status: } ***$$

was $N(2200)$ Before our 2012 *Review*, this state appeared in our Listings as the $N(2200)$.

 $N(2060)$ POLE POSITION**REAL PART**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
2020 to 2130 (\approx 2070) OUR ESTIMATE			
2020 \pm 30	SARANTSEV 25	DPWA	Multichannel
2119 \pm 11 \pm 1	¹ SVARC 14	L+P	$\pi N \rightarrow \pi N$
2100 \pm 60	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
2010	HUNT 19	DPWA	Multichannel
2030 \pm 15	SOKHOYAN 15A	DPWA	Multichannel
2144 \pm 31	BATINIC 10	DPWA	$\pi N \rightarrow N\pi, N\eta$

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

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
350 to 430 (\approx 400) OUR ESTIMATE			
410 \pm 50	SARANTSEV 25	DPWA	Multichannel
370 \pm 20 \pm 5	¹ SVARC 14	L+P	$\pi N \rightarrow \pi N$
360 \pm 80	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
395	HUNT 19	DPWA	Multichannel
400 \pm 35	SOKHOYAN 15A	DPWA	Multichannel
438 \pm 13	BATINIC 10	DPWA	$\pi N \rightarrow N\pi, N\eta$

¹ Fit to the amplitudes of HOEHLER 79.

 $N(2060)$ ELASTIC POLE RESIDUE**MODULUS $|r|$**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
15 to 30 (\approx 20) OUR ESTIMATE			
25 \pm 8	SOKHOYAN 15A	DPWA	Multichannel
19 \pm 1 \pm 1	¹ SVARC 14	L+P	$\pi N \rightarrow \pi N$
20 \pm 10	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
19 \pm 5	ANISOVICH 12A	DPWA	Multichannel
26	BATINIC 10	DPWA	$\pi N \rightarrow N\pi, N\eta$

¹ Fit to the amplitudes of HOEHLER 79.

PHASE θ

<u>VALUE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
–130 to –90 (\approx –110) OUR ESTIMATE			
–130 \pm 20	SOKHOYAN	15A	DPWA Multichannel
–94 \pm 5 \pm 1	¹ SVARC	14	L+P $\pi N \rightarrow \pi N$
–90 \pm 50	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
–125 \pm 20	ANISOVICH	12A	DPWA Multichannel
–71	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
¹ Fit to the amplitudes of HOEHLER 79.			

 $N(2060)$ INELASTIC POLE RESIDUE

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

Normalized residue in $N\pi \rightarrow N(2060) \rightarrow N\eta$

<u>MODULUS</u>	<u>PHASE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.05 \pm 0.03	40 \pm 25	ANISOVICH	12A	DPWA Multichannel

Normalized residue in $N\pi \rightarrow N(2060) \rightarrow \Lambda K$

<u>MODULUS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.01 \pm 0.005	ANISOVICH	12A	DPWA Multichannel

Normalized residue in $N\pi \rightarrow N(2060) \rightarrow \Sigma K$

<u>MODULUS</u>	<u>PHASE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.04 \pm 0.02	–70 \pm 30	ANISOVICH	12A	DPWA Multichannel

Normalized residue in $N\pi \rightarrow N(2060) \rightarrow \Delta(1232)\pi, D\text{-wave}$

<u>MODULUS</u>	<u>PHASE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.06 \pm 0.03	–90 \pm 40	SOKHOYAN	15A	DPWA Multichannel

Normalized residue in $N\pi \rightarrow N(2060) \rightarrow N\sigma$

<u>MODULUS</u>	<u>PHASE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.12 \pm 0.06	80 \pm 40	SOKHOYAN	15A	DPWA Multichannel

Normalized residue in $N\pi \rightarrow N(2060) \rightarrow N(1440)\pi$

<u>MODULUS</u>	<u>PHASE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.17 \pm 0.09	–60 \pm 35	SOKHOYAN	15A	DPWA Multichannel

Normalized residue in $N\pi \rightarrow N(2060) \rightarrow N(1520)\pi, P\text{-wave}$

<u>MODULUS</u>	<u>PHASE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.14 \pm 0.06	–45 \pm 15	SOKHOYAN	15A	DPWA Multichannel

 $N(2060)$ BREIT-WIGNER MASS

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
2030 to 2200 (\approx 2100) OUR ESTIMATE			
2040 \pm 30	SARANTSEV	25	DPWA Multichannel
2111 \pm 17	¹ HUNT	19	DPWA Multichannel
2180 \pm 80	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
2228 \pm 30	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$

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

2045 ± 15	SOKHOYAN	15A	DPWA	Multichannel
2116 ± 21	¹ SHRESTHA	12A	DPWA	Multichannel
2217 ± 27	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$

¹Statistical error only.

N(2060) BREIT-WIGNER WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
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300 to 450 (≈ 400) OUR ESTIMATE

420 ± 50	SARANTSEV	25	DPWA	Multichannel
499 ± 70	¹ HUNT	19	DPWA	Multichannel
400 ± 100	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
310 ± 50	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$

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

420 ± 30	SOKHOYAN	15A	DPWA	Multichannel
307 ± 112	¹ SHRESTHA	12A	DPWA	Multichannel
481 ± 17	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$

¹Statistical error only.

N(2060) DECAY MODES

Mode	Fraction (Γ_i/Γ)
Γ_1 $N\pi$	7–12 %
Γ_2 $N\eta$	2–38 %
Γ_3 $N\omega$	1–7 %
Γ_4 ΛK	10–20 %
Γ_5 ΣK	1–5 %
Γ_6 $N\pi\pi$	12–52 %
Γ_7 $\Delta(1232)\pi$	(12.0 ± 3.0) %
Γ_8 $\Delta(1232)\pi, D\text{-wave}$	4–10 %
Γ_9 $N\rho$	5–33 %
Γ_{10} $N\rho, S=1/2$	
Γ_{11} $N\rho, S=3/2, D\text{-wave}$	5–23 %
Γ_{12} $N\sigma$	3–9 %
Γ_{13} $N(1440)\pi$	4–14 %
Γ_{14} $N(1520)\pi, P\text{-wave}$	9–21 %
Γ_{15} $N(1680)\pi, S\text{-wave}$	8–22 %
Γ_{16} $\Lambda K^*(892)$	0.3–1.3 %
Γ_{17} $p\gamma$	0.03–0.19 %
Γ_{18} $p\gamma, \text{helicity}=1/2$	0.02–0.08 %
Γ_{19} $p\gamma, \text{helicity}=3/2$	0.01–0.10 %
Γ_{20} $n\gamma$	0.003–0.07 %
Γ_{21} $n\gamma, \text{helicity}=1/2$	0.001–0.02 %
Γ_{22} $n\gamma, \text{helicity}=3/2$	0.002–0.05 %

$N(2060)$ BRANCHING RATIOS **$\Gamma(N\pi)/\Gamma_{\text{total}}$ Γ_1/Γ**

VALUE (%)	DOCUMENT ID	TECN	COMMENT
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7 to 12 (≈ 10) OUR ESTIMATE

11 ± 2	SEIFEN	25	DPWA	Multichannel
5.3 \pm 1.4	¹ HUNT	19	DPWA	Multichannel
10 ± 3	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
7 ± 2	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
11 ± 2	SOKHOYAN	15A	DPWA	Multichannel
9 ± 2	¹ SHRESTHA	12A	DPWA	Multichannel
13 ± 4	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$

¹Statistical error only. **$\Gamma(N\eta)/\Gamma_{\text{total}}$ Γ_2/Γ**

VALUE (%)	DOCUMENT ID	TECN	COMMENT
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2–38 % OUR ESTIMATE

6 ± 2	MUELLER	20	DPWA	Multichannel
30 ± 8	¹ HUNT	19	DPWA	Multichannel
4 ± 2	ANISOVICH	12A	DPWA	Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
< 1	¹ SHRESTHA	12A	DPWA	Multichannel
0.2 \pm 1.0	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$

¹Statistical error only. **$\Gamma(N\omega)/\Gamma_{\text{total}}$ Γ_3/Γ**

VALUE (%)	DOCUMENT ID	TECN	COMMENT
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4 \pm 3	DENISENKO	16	DPWA	Multichannel
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 $\Gamma(\Lambda K)/\Gamma_{\text{total}}$ Γ_4/Γ

VALUE (%)	DOCUMENT ID	TECN	COMMENT
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10–20 % OUR ESTIMATE

15 \pm 5	¹ HUNT	19	DPWA	Multichannel
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¹Statistical error only. **$\Gamma(\Sigma K)/\Gamma_{\text{total}}$ Γ_5/Γ**

VALUE (%)	DOCUMENT ID	TECN	COMMENT
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3 \pm 2	ANISOVICH	12A	DPWA	Multichannel
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 $\Gamma(\Delta(1232)\pi)/\Gamma_{\text{total}}$ Γ_7/Γ

VALUE (%)	DOCUMENT ID	TECN	COMMENT
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12 \pm 3	SARANTSEV	25	DPWA	Multichannel
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 $\Gamma(\Delta(1232)\pi, D\text{-wave})/\Gamma_{\text{total}}$ Γ_8/Γ

VALUE (%)	DOCUMENT ID	TECN	COMMENT
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4–10 % OUR ESTIMATE

12 \pm 3	SARANTSEV	25	DPWA	Multichannel
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9 ± 3	SEIFEN	25	DPWA	Multichannel
15 ± 6	¹ HUNT	19	DPWA	Multichannel
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
7 ± 3	SOKHOYAN	15A	DPWA	Multichannel
40 ± 13	¹ SHRESTHA	12A	DPWA	Multichannel
¹ Statistical error only.				

$\Gamma(N\rho)/\Gamma_{\text{total}}$					Γ_9/Γ
<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>		
28 ± 11	SARANTSEV	25	DPWA	Multichannel	

$\Gamma(N\rho, S=1/2)/\Gamma_{\text{total}}$					Γ_{10}/Γ
<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>		
24 ± 10	SARANTSEV	25	DPWA	Multichannel	
<10	¹ HUNT	19	DPWA	Multichannel	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
21 ± 15	¹ SHRESTHA	12A	DPWA	Multichannel	
¹ Statistical error only.					

$\Gamma(N\rho, S=3/2, D\text{-wave})/\Gamma_{\text{total}}$					Γ_{11}/Γ
<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>		
5-23 % OUR ESTIMATE					
4 ± 4	SARANTSEV	25	DPWA	Multichannel	
14 ± 9	¹ HUNT	19	DPWA	Multichannel	
¹ Statistical error only.					

$\Gamma(N\sigma)/\Gamma_{\text{total}}$					Γ_{12}/Γ
<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>		
3 ± 2	SARANTSEV	25	DPWA	Multichannel	
5 ± 3	SEIFEN	25	DPWA	Multichannel	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
6 ± 3	SOKHOYAN	15A	DPWA	Multichannel	

$\Gamma(N(1440)\pi)/\Gamma_{\text{total}}$					Γ_{13}/Γ
<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>		
8 ± 5	SEIFEN	25	DPWA	Multichannel	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
9 ± 5	SOKHOYAN	15A	DPWA	Multichannel	

$\Gamma(N(1520)\pi, P\text{-wave})/\Gamma_{\text{total}}$					Γ_{14}/Γ
<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>		
13 ± 7	SEIFEN	25	DPWA	Multichannel	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
15 ± 6	SOKHOYAN	15A	DPWA	Multichannel	

$\Gamma(N(1680)\pi, S\text{-wave})/\Gamma_{\text{total}}$					Γ_{15}/Γ
<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>		
14 ± 5	SEIFEN	25	DPWA	Multichannel	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
15 ± 7	SOKHOYAN	15A	DPWA	Multichannel	

$\Gamma(\Lambda K^*(892))/\Gamma_{\text{total}}$	Γ_{16}/Γ		
VALUE (%)	DOCUMENT ID	TECN	COMMENT
0.3–1.3 % OUR ESTIMATE			
0.8±0.5	ANISOVICH	17B	DPWA Multichannel

$N(2060)$ PHOTON DECAY AMPLITUDES AT THE POLE

$N(2060) \rightarrow p\gamma$, helicity-1/2 amplitude $A_{1/2}$

MODULUS ($\text{GeV}^{-1/2}$)	PHASE ($^\circ$)	DOCUMENT ID	TECN	COMMENT
0.065±0.015	20 ± 10	SARANTSEV	25	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.064±0.010	12 ± 8	SOKHOYAN	15A	DPWA Multichannel

$N(2060) \rightarrow p\gamma$, helicity-3/2 amplitude $A_{3/2}$

MODULUS ($\text{GeV}^{-1/2}$)	PHASE ($^\circ$)	DOCUMENT ID	TECN	COMMENT
0.030±0.020	160 ± 30	SARANTSEV	25	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.060±0.020	13 ± 10	SOKHOYAN	15A	DPWA Multichannel

$N(2060) \rightarrow n\gamma$, helicity-1/2 amplitude $A_{1/2}$

MODULUS ($\text{GeV}^{-1/2}$)	PHASE ($^\circ$)	DOCUMENT ID	TECN	COMMENT
0.052±0.025	−5 ± 20	ANISOVICH	17E	DPWA Multichannel

$N(2060) \rightarrow n\gamma$, helicity-3/2 amplitude $A_{3/2}$

MODULUS ($\text{GeV}^{-1/2}$)	PHASE ($^\circ$)	DOCUMENT ID	TECN	COMMENT
0.012±0.007	−40 ± 35	ANISOVICH	17E	DPWA Multichannel

$N(2060)$ BREIT-WIGNER PHOTON DECAY AMPLITUDES

$N(2060) \rightarrow p\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
0.065±0.015	SARANTSEV	25	DPWA Multichannel
−0.019±0.005	¹ HUNT	19	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.062±0.010	SOKHOYAN	15A	DPWA Multichannel
0.018±0.004	¹ SHRESTHA	12A	DPWA Multichannel

¹Statistical error only.

$N(2060) \rightarrow p\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
−0.030±0.020	SARANTSEV	25	DPWA Multichannel
0.039±0.005	¹ HUNT	19	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.062±0.020	SOKHOYAN	15A	DPWA Multichannel
0.010±0.004	¹ SHRESTHA	12A	DPWA Multichannel

¹Statistical error only.

$N(2060) \rightarrow n\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
0.069 ± 0.017	¹ HUNT	19	DPWA Multichannel
0.052 ± 0.024	ANISOVICH	17E	DPWA Multichannel

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

0.025 ± 0.011	ANISOVICH	13B	DPWA Multichannel
-0.012 ± 0.017	¹ SHRESTHA	12A	DPWA Multichannel

¹Statistical error only.

 $N(2060) \rightarrow n\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE ($\text{GeV}^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
-0.023 ± 0.020	¹ HUNT	19	DPWA Multichannel
0.012 ± 0.007	ANISOVICH	17E	DPWA Multichannel

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

-0.037 ± 0.017	ANISOVICH	13B	DPWA Multichannel
-0.023 ± 0.023	¹ SHRESTHA	12A	DPWA Multichannel

¹Statistical error only.

 $N(2060)$ 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.)
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>	
ANISOVICH	17E	PR C96 055202	A.V. Anisovich <i>et al.</i>	(BONN, PNPI, JLAB+)
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.)
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)
BATINIC	10	PR C82 038203	M. Batinic <i>et al.</i>	(ZAGR)
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)
HOEHLER	79	PDAT 12-1	G. Hohler <i>et al.</i>	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP