$N(1860)\, 5/2^+$

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

OMITTED FROM SUMMARY TABLE

Before the 2012 Review, all the evidence for a $J^P = 5/2^+$ state with a mass above 1800 MeV was filed under a two-star $N(2000)$. There is now some evidence from ANISOVICH 12A for two $5/2^+$ states in this region, so we have split the older data (according to mass) between two two-star $5/2^+$ states, an $N(1860)$ and an $N(2000)$.

$N(1860)$ BREIT-WIGNER MASS

<table>
<thead>
<tr>
<th>VALUE (MeV)</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1820 to 1960 (≈ 1860) OUR ESTIMATE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1860 $^{+120}_{-60}$</td>
<td>ANISOVICH 12A</td>
<td>DPWA Multichannel</td>
<td></td>
</tr>
<tr>
<td>1817.7</td>
<td>ARNDT 06</td>
<td>DPWA $\pi N \rightarrow \pi N, \eta N$</td>
<td></td>
</tr>
<tr>
<td>1882 $^{±10}_{-10}$</td>
<td>HOEHLER 79</td>
<td>IPWA $\pi N \rightarrow \pi N$</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>VALUE (MeV)</th>
<th>DOCUMENT ID</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1900 $^{±7}_{-10}$</td>
<td>SHRESTHA 12A</td>
<td>DPWA Multichannel</td>
<td></td>
</tr>
<tr>
<td>1814</td>
<td>ARNDT 95</td>
<td>DPWA $\pi N \rightarrow N\pi$</td>
<td></td>
</tr>
<tr>
<td>1903 $^{±87}_{-87}$</td>
<td>MANLEY 92</td>
<td>IPWA $\pi N \rightarrow \pi N &amp; N\pi\pi$</td>
<td></td>
</tr>
</tbody>
</table>

$N(1860)$ BREIT-WIGNER WIDTH

<table>
<thead>
<tr>
<th>VALUE (MeV)</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>270 $^{+140}_{-50}$</td>
<td>ANISOVICH 12A</td>
<td>DPWA Multichannel</td>
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</tr>
<tr>
<td>117.6</td>
<td>ARNDT 06</td>
<td>DPWA $\pi N \rightarrow \pi N, \eta N$</td>
<td></td>
</tr>
<tr>
<td>95 $^{±20}_{-20}$</td>
<td>HOEHLER 79</td>
<td>IPWA $\pi N \rightarrow \pi N$</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>VALUE (MeV)</th>
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<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>219 $^{±23}_{-23}$</td>
<td>SHRESTHA 12A</td>
<td>DPWA Multichannel</td>
<td></td>
</tr>
<tr>
<td>176</td>
<td>ARNDT 95</td>
<td>DPWA $\pi N \rightarrow N\pi$</td>
<td></td>
</tr>
<tr>
<td>490 $^{±310}_{-310}$</td>
<td>MANLEY 92</td>
<td>IPWA $\pi N \rightarrow \pi N &amp; N\pi\pi$</td>
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</tbody>
</table>

$N(1860)$ POLE POSITION

<table>
<thead>
<tr>
<th>VALUE (MeV)</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1830 $^{+120}_{-60}$</td>
<td>ANISOVICH 12A</td>
<td>DPWA Multichannel</td>
<td></td>
</tr>
<tr>
<td>1807</td>
<td>ARNDT 06</td>
<td>DPWA $\pi N \rightarrow \pi N, \eta N$</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>VALUE (MeV)</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1863</td>
<td>SHRESTHA 12A</td>
<td>DPWA Multichannel</td>
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</table>

HTTP://PDG.LBL.GOV Page 1 Created: 8/21/2014 12:54
\[ -2 \times \text{IMAGINARY PART} \]

<table>
<thead>
<tr>
<th>VALUE (MeV)</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 ± 150</td>
<td>ANISOVICH</td>
<td>12A</td>
<td>DPWA Multichannel</td>
</tr>
<tr>
<td>109</td>
<td>ARNDT</td>
<td>06</td>
<td>DPWA (\pi N \rightarrow \pi N, \eta N)</td>
</tr>
</tbody>
</table>

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

\[ \text{VALUE} (\text{MeV}) \]

| MODULUS \(|r|\) | DOCUMENT ID | TECN | COMMENT |
|-----------------|-------------|------|---------|
| 50 ± 20         | ANISOVICH | 12A  | DPWA Multichannel |
| 60              | ARNDT | 06   | DPWA \(\pi N \rightarrow \pi N, \eta N\) |

<table>
<thead>
<tr>
<th>PHASE (\theta)</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>(-80 ± 40)</td>
<td>ANISOVICH</td>
<td>12A</td>
<td>DPWA Multichannel</td>
</tr>
<tr>
<td>(-67)</td>
<td>ARNDT</td>
<td>06</td>
<td>DPWA (\pi N \rightarrow \pi N, \eta N)</td>
</tr>
</tbody>
</table>

\[ \text{N(1860) ELASTIC POLE RESIDUE} \]

\[ \text{N(1860) DECAY MODES} \]

\[ \text{Mode} \]

\[ \Gamma_1 \quad N\pi \]
\[ \Gamma_2 \quad N\eta \]
\[ \Gamma_3 \quad \Lambda K \]
\[ \Gamma_4 \quad N\pi\pi \]
\[ \Gamma_5 \quad \Delta(1232)\pi, P\text{-wave} \]
\[ \Gamma_6 \quad \Delta(1232)\pi, F\text{-wave} \]
\[ \Gamma_7 \quad N\rho, S=3/2, P\text{-wave} \]
\[ \Gamma_8 \quad N\rho, S=3/2, F\text{-wave} \]
\[ \Gamma_9 \quad N(\pi\pi)^{I=0}_{S=wave} \]
\[ \Gamma_{10} \quad p\gamma \]
\[ \Gamma_{11} \quad p\gamma, \text{helicity}=1/2 \]
\[ \Gamma_{12} \quad p\gamma, \text{helicity}=3/2 \]
\[ \Gamma_{13} \quad n\gamma \]
\[ \Gamma_{14} \quad n\gamma, \text{helicity}=1/2 \]
\[ \Gamma_{15} \quad n\gamma, \text{helicity}=3/2 \]

\[ \text{N(1860) BRANCHING RATIOS} \]

\[ \Gamma(N\pi)/\Gamma_{\text{total}} \]

<table>
<thead>
<tr>
<th>VALUE (% )</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 ± 6</td>
<td>ANISOVICH</td>
<td>12A</td>
<td>DPWA Multichannel</td>
</tr>
<tr>
<td>12.7</td>
<td>ARNDT</td>
<td>06</td>
<td>DPWA (\pi N \rightarrow \pi N, \eta N)</td>
</tr>
<tr>
<td>4 ± 2</td>
<td>HOEHLER</td>
<td>79</td>
<td>IPWA (\pi N \rightarrow \pi N)</td>
</tr>
<tr>
<td>( (\Gamma_i \Gamma_f)^{1/2}/(\Gamma_{\text{total}} \text{ in } N\pi \rightarrow N(1860) \rightarrow \Delta(1232)\pi, P\text{-wave}) )</td>
<td>( (\Gamma_1 \Gamma_5)^{1/2}/\Gamma )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Gamma_{\text{2}/\Gamma} )</td>
<td>( \Gamma_{\text{3}/\Gamma} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Gamma_{\text{6}/\Gamma} )</td>
<td>( \Gamma_{\text{7}/\Gamma} )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| \( \Gamma(N\pi)/\Gamma_{\text{total}} \) | \( \Gamma_2/\Gamma \) |
| \( \Gamma(\Lambda K)/\Gamma_{\text{total}} \) | \( \Gamma_{\text{3}/\Gamma} \) |
| \( \Gamma(N(1860)/N\pi) \) | \( \Gamma_6/\Gamma \) |
| \( \Gamma(\Delta(1232)\pi, F\text{-wave})/\Gamma_{\text{total}} \) | \( \Gamma_{\text{7}/\Gamma} \) |
| \( \Gamma(N(\pi))_S=0/F\text{-wave})/\Gamma_{\text{total}} \) | \( \Gamma_9/\Gamma \) |

| \( \Gamma(N(\pi))_S=0/F\text{-wave})/\Gamma_{\text{total}} \) | \( \Gamma_9/\Gamma \) |

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| \( \Gamma_{\text{2}/\Gamma} \) | \( \Gamma_{\text{3}/\Gamma} \) |
| \( \Gamma_{\text{6}/\Gamma} \) | \( \Gamma_{\text{7}/\Gamma} \) |

| \( \Gamma(N\pi)/\Gamma_{\text{total}} \) | \( \Gamma_2/\Gamma \) |
| \( \Gamma(\Lambda K)/\Gamma_{\text{total}} \) | \( \Gamma_{\text{3}/\Gamma} \) |
| \( \Gamma(N(1860)/N\pi) \) | \( \Gamma_6/\Gamma \) |
| \( \Gamma(\Delta(1232)\pi, F\text{-wave})/\Gamma_{\text{total}} \) | \( \Gamma_{\text{7}/\Gamma} \) |
| \( \Gamma(N(\pi))_S=0/F\text{-wave})/\Gamma_{\text{total}} \) | \( \Gamma_9/\Gamma \) |

| \( \Gamma(N(\pi))_S=0/F\text{-wave})/\Gamma_{\text{total}} \) | \( \Gamma_9/\Gamma \) |

| \( \Gamma(N\pi)/\Gamma_{\text{total}} \) | \( \Gamma_2/\Gamma \) |
| \( \Gamma(\Lambda K)/\Gamma_{\text{total}} \) | \( \Gamma_{\text{3}/\Gamma} \) |
| \( \Gamma(N(1860)/N\pi) \) | \( \Gamma_6/\Gamma \) |
| \( \Gamma(\Delta(1232)\pi, F\text{-wave})/\Gamma_{\text{total}} \) | \( \Gamma_{\text{7}/\Gamma} \) |
| \( \Gamma(N(\pi))_S=0/F\text{-wave})/\Gamma_{\text{total}} \) | \( \Gamma_9/\Gamma \) |

| \( \Gamma(N\pi)/\Gamma_{\text{total}} \) | \( \Gamma_2/\Gamma \) |
| \( \Gamma(\Lambda K)/\Gamma_{\text{total}} \) | \( \Gamma_{\text{3}/\Gamma} \) |
| \( \Gamma(N(1860)/N\pi) \) | \( \Gamma_6/\Gamma \) |
| \( \Gamma(\Delta(1232)\pi, F\text{-wave})/\Gamma_{\text{total}} \) | \( \Gamma_{\text{7}/\Gamma} \) |
| \( \Gamma(N(\pi))_S=0/F\text{-wave})/\Gamma_{\text{total}} \) | \( \Gamma_9/\Gamma \) |
$N(1860)$ PHOTON DECAY AMPLITUDES

$N(1860) \to p\gamma$, helicity-1/2 amplitude $A_{1/2}$

<table>
<thead>
<tr>
<th>VALUE ($\text{GeV}^{-1/2}$)</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.020±0.012</td>
<td>1 ANISOVICH</td>
<td>12A</td>
<td>DPWA Phase = (120 ± 50)$^\circ$</td>
</tr>
<tr>
<td>−0.017±0.003</td>
<td>SHRESTHA</td>
<td>12A</td>
<td>DPWA Multichannel</td>
</tr>
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$N(1860) \to p\gamma$, helicity-3/2 amplitude $A_{3/2}$

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<th>VALUE ($\text{GeV}^{-1/2}$)</th>
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<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.050±0.020</td>
<td>1 ANISOVICH</td>
<td>12A</td>
<td>DPWA Phase = (−80 ± 60)$^\circ$</td>
</tr>
<tr>
<td>0.029±0.004</td>
<td>SHRESTHA</td>
<td>12A</td>
<td>DPWA Multichannel</td>
</tr>
</tbody>
</table>

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$N(1860) \to n\gamma$, helicity-1/2 amplitude $A_{1/2}$

<table>
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<th>VALUE ($\text{GeV}^{-1/2}$)</th>
<th>DOCUMENT ID</th>
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<tbody>
<tr>
<td>0.010±0.005</td>
<td>SHRESTHA</td>
<td>12A</td>
<td>DPWA Multichannel</td>
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$N(1860) \to n\gamma$, helicity-3/2 amplitude $A_{3/2}$

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<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>−0.009±0.005</td>
<td>SHRESTHA</td>
<td>12A</td>
<td>DPWA Multichannel</td>
</tr>
</tbody>
</table>

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$N(1860)$ FOOTNOTES

1 This ANISOVICH 12A value is the complex helicity amplitude at the pole position.

$N(1860)$ REFERENCES

| ANISOVICH | 12A | EPJ A48 15 | A.V. Anisovich et al. |
| SHRESTHA  | 12A | PR C86 055203 | M. Shrestha, D.M. Manley |
| ARNDT     | 06  | PR C74 045205 | R.A. Arndt et al. |
| MANLEY    | 92  | PR D45 4002 | D.M. Manley, E.M. Saleski |
| HOEHLER   | 79  | PDAT 12-1 | G. Hohler et al. |

BONN, PNPI
(KSU)
(GWU)
(VPI, BRCO)
(KSA)
(VPI)
(KARLT)