\[ \Delta(1930) \, 5/2^- \]

I\( (J^P) = \frac{3}{2}\left(\frac{5}{2}^-\right) \) Status: ***

Older and obsolete values are listed and referenced in the 2014 edition, Chinese Physics C38 070001 (2014).

### \( \Delta(1930) \) POLE POSITION

#### REAL PART

<table>
<thead>
<tr>
<th>VALUE (MeV)</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1840 to 1920 (≈ 1880) OUR ESTIMATE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1848 ± 9 ± 19</td>
<td>SVARC</td>
<td>14 L+P ( \pi N \rightarrow \pi N )</td>
<td></td>
</tr>
<tr>
<td>1890±50</td>
<td>CUTKOSKY</td>
<td>80 IPWA ( \pi N \rightarrow \pi N )</td>
<td></td>
</tr>
<tr>
<td>• • • We do not use the following data for averages, fits, limits, etc. • • •</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1863</td>
<td>HUNT</td>
<td>19 DPWA Multichannel</td>
<td></td>
</tr>
<tr>
<td>1836</td>
<td>ROENCHEN</td>
<td>15A DPWA Multichannel</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>ARNDT</td>
<td>06 DPWA ( \pi N \rightarrow \pi N, \eta N )</td>
<td></td>
</tr>
<tr>
<td>1883</td>
<td>VRANA</td>
<td>00 DPWA Multichannel</td>
<td></td>
</tr>
<tr>
<td>1850</td>
<td>HOEHLER</td>
<td>93 SPED ( \pi N \rightarrow \pi N )</td>
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</table>

1 Fit to the amplitudes of HOEHLER 79.

#### – 2\(\times\) IMAGINARY PART

<table>
<thead>
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<th>DOCUMENT ID</th>
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<th>COMMENT</th>
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<tr>
<td>230 to 330 (≈ 280) OUR ESTIMATE</td>
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<td></td>
</tr>
<tr>
<td>321 ± 17 ± 7</td>
<td>SVARC</td>
<td>14 L+P ( \pi N \rightarrow \pi N )</td>
<td></td>
</tr>
<tr>
<td>260 ± 60</td>
<td>CUTKOSKY</td>
<td>80 IPWA ( \pi N \rightarrow \pi N )</td>
<td></td>
</tr>
<tr>
<td>• • • We do not use the following data for averages, fits, limits, etc. • • •</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>260</td>
<td>HUNT</td>
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</tr>
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<td>724</td>
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<tr>
<td>250</td>
<td>VRANA</td>
<td>00 DPWA Multichannel</td>
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</tr>
<tr>
<td>180</td>
<td>HOEHLER</td>
<td>93 SPED ( \pi N \rightarrow \pi N )</td>
<td></td>
</tr>
</tbody>
</table>

1 Fit to the amplitudes of HOEHLER 79.

### \( \Delta(1930) \) ELASTIC POLE RESIDUE

#### MODULUS \(|r|\)

<table>
<thead>
<tr>
<th>VALUE (MeV)</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 to 20 (≈ 14) OUR ESTIMATE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 ± 1 ± 1</td>
<td>SVARC</td>
<td>14 L+P ( \pi N \rightarrow \pi N )</td>
<td></td>
</tr>
<tr>
<td>18 ± 6</td>
<td>CUTKOSKY</td>
<td>80 IPWA ( \pi N \rightarrow \pi N )</td>
<td></td>
</tr>
<tr>
<td>• • • We do not use the following data for averages, fits, limits, etc. • • •</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>ROENCHEN</td>
<td>15A DPWA Multichannel</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>ARNDT</td>
<td>06 DPWA ( \pi N \rightarrow \pi N, \eta N )</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>HOEHLER</td>
<td>93 SPED ( \pi N \rightarrow \pi N )</td>
<td></td>
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1 Fit to the amplitudes of HOEHLER 79.
<table>
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<th>PHASE $\theta$</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$- 40$ to $-10$ ($\approx -30$) OUR ESTIMATE</td>
<td>SVARC</td>
<td>14</td>
<td>L+P $\pi N \rightarrow \pi N$</td>
</tr>
<tr>
<td>$- 37 \pm 3 \pm 7$</td>
<td>CUTKOSKY</td>
<td>80</td>
<td>IPWA $\pi N \rightarrow \pi N$</td>
</tr>
<tr>
<td>$- 20 \pm 40$</td>
<td>ROENCHEN</td>
<td>15</td>
<td>DPWA Multichannel</td>
</tr>
<tr>
<td>$- 155$</td>
<td>ARNDT</td>
<td>06</td>
<td>DPWA $\pi N \rightarrow \pi N, \eta N$</td>
</tr>
<tr>
<td>$- 12$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### $\Delta(1930)$ Inelastic Pole Residue

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

#### Normalized residue in $N\pi \rightarrow \Delta(1930) \rightarrow \Sigma K$

<table>
<thead>
<tr>
<th>MODULUS</th>
<th>PHASE (°)</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.043$</td>
<td>$-0.5$</td>
<td>ROENCHEN</td>
<td>15A</td>
<td>DPWA Multichannel</td>
</tr>
</tbody>
</table>

#### Normalized residue in $N\pi \rightarrow \Delta(1930) \rightarrow \Delta \pi, D$-wave

<table>
<thead>
<tr>
<th>MODULUS</th>
<th>PHASE (°)</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.15$</td>
<td>$30$</td>
<td>ROENCHEN</td>
<td>15A</td>
<td>DPWA Multichannel</td>
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#### Normalized residue in $N\pi \rightarrow \Delta(1930) \rightarrow \Delta \pi, G$-wave

<table>
<thead>
<tr>
<th>MODULUS</th>
<th>PHASE (°)</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
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</thead>
<tbody>
<tr>
<td>$0.009$</td>
<td>$121$</td>
<td>ROENCHEN</td>
<td>15A</td>
<td>DPWA Multichannel</td>
</tr>
</tbody>
</table>

### $\Delta(1930)$ 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>1988 $\pm$ 32</td>
<td>1 HUNT</td>
<td>19</td>
<td>DPWA Multichannel</td>
</tr>
<tr>
<td>2233 $\pm$ 53</td>
<td>1 ARNDT</td>
<td>06</td>
<td>DPWA $\pi N \rightarrow \pi N, \eta N$</td>
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<tr>
<td>1940 $\pm$ 30</td>
<td>CUTKOSKY</td>
<td>80</td>
<td>IPWA $\pi N \rightarrow \pi N$</td>
</tr>
<tr>
<td>1901 $\pm$ 15</td>
<td>HOEHLER</td>
<td>79</td>
<td>IPWA $\pi N \rightarrow \pi N$</td>
</tr>
<tr>
<td>$1930 \pm 12$</td>
<td>SHRESTHA</td>
<td>12A</td>
<td>DPWA Multichannel</td>
</tr>
<tr>
<td>$1932 \pm 100$</td>
<td>VRANA</td>
<td>00</td>
<td>DPWA Multichannel</td>
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</tbody>
</table>

| $1$ Statistical error only. |
∆(1930) 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>200 to 400 (≈ 300) OUR ESTIMATE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500±160</td>
<td>1 HUNT 19</td>
<td>DPWA Multichannel</td>
<td></td>
</tr>
<tr>
<td>773±187</td>
<td>ARNDT 06</td>
<td>DPWA π N → π N, η N</td>
<td></td>
</tr>
<tr>
<td>320±60</td>
<td>CUTKOSKY 80</td>
<td>IPWA π N → π N</td>
<td></td>
</tr>
<tr>
<td>195±60</td>
<td>HOEHLER 79</td>
<td>IPWA π N → π N</td>
<td></td>
</tr>
</tbody>
</table>

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

235±39 | 1 SHRESTHA 12A | DPWA Multichannel | |
| 316±237 | VRANA 00 | DPWA Multichannel | |

1 Statistical error only.

∆(1930) DECAY MODES

The following branching fractions are our estimates, not fits or averages.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Fraction (Γ_i/Γ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Γ_1</td>
<td>Nπ</td>
</tr>
<tr>
<td>Γ_2</td>
<td>Nγ</td>
</tr>
<tr>
<td>Γ_3</td>
<td>Nγ, helicity=1/2</td>
</tr>
<tr>
<td>Γ_4</td>
<td>Nγ, helicity=3/2</td>
</tr>
</tbody>
</table>

∆(1930) BRANCHING RATIOS

<table>
<thead>
<tr>
<th>Γ(Nπ)/Γ_{total}</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 to 15 (≈ 10) OUR ESTIMATE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.5±0.1</td>
<td>1 HUNT 19</td>
<td>DPWA Multichannel</td>
<td></td>
</tr>
<tr>
<td>8.1±1.2</td>
<td>ARNDT 06</td>
<td>DPWA π N → π N, η N</td>
<td></td>
</tr>
<tr>
<td>14±4</td>
<td>CUTKOSKY 80</td>
<td>IPWA π N → π N</td>
<td></td>
</tr>
<tr>
<td>4±3</td>
<td>HOEHLER 79</td>
<td>IPWA π N → π N</td>
<td></td>
</tr>
</tbody>
</table>

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

7.9±0.4 | 1 SHRESTHA 12A | DPWA Multichannel | |
| 9±8 | VRANA 00 | DPWA Multichannel | |

1 Statistical error only.

∆(1930) PHOTON DECAY AMPLITUDES AT THE POLE

∆(1930) → Nγ, helicity-1/2 amplitude A_{1/2}

<table>
<thead>
<tr>
<th>MODULUS (GeV^{-1/2})</th>
<th>PHASE (°)</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.130±0.073 ±0.096</td>
<td>−50±77−26</td>
<td>ROENCHEN 14</td>
<td>DPWA</td>
<td></td>
</tr>
</tbody>
</table>

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

−0.270 | 33 | ROENCHEN 15A | DPWA Multichannel | |

HTTP://PDG.LBL.GOV Page 3 Created: 6/1/2020 08:30
### $\Delta(1930) \to N\gamma$, helicity-3/2 amplitude $A_{3/2}$

<table>
<thead>
<tr>
<th>MODULUS (GeV$^{-1/2}$)</th>
<th>PHASE (°)</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$-0.056 \pm 0.003^{+0.151}_{-0.191}$</td>
<td>$168 \pm 72_{-76}$</td>
<td>ROENCHEN 14</td>
<td>DPWA</td>
<td></td>
</tr>
</tbody>
</table>

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

### $\Delta(1930)$ BREIT-WIGNER PHOTON DECAY AMPLITUDES

#### $\Delta(1930) \to N\gamma$, helicity-1/2 amplitude $A_{1/2}$

<table>
<thead>
<tr>
<th>VALUE (GeV$^{-1/2}$)</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$-0.043 \pm 0.008$</td>
<td>1 HUNT 19</td>
<td>DPWA</td>
<td>Multichannel</td>
</tr>
<tr>
<td>$-0.007 \pm 0.010$</td>
<td>1 ARNDT 96</td>
<td>IPWA</td>
<td>$\gamma N \to \pi N$</td>
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</tbody>
</table>

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

#### $\Delta(1930) \to N\gamma$, helicity-3/2 amplitude $A_{3/2}$

<table>
<thead>
<tr>
<th>VALUE (GeV$^{-1/2}$)</th>
<th>DOCUMENT ID</th>
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<td>DPWA</td>
<td>Multichannel</td>
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<tr>
<td>$0.005 \pm 0.010$</td>
<td>1 ARNDT 96</td>
<td>IPWA</td>
<td>$\gamma N \to \pi N$</td>
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</tbody>
</table>

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

1 Statistical error only.

### $\Delta(1930)$ REFERENCES

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

<table>
<thead>
<tr>
<th>HUNT 19 PR C99 055205</th>
<th>B.C. Hunt, D.M. Manley</th>
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<tr>
<td>ROENCHEN 15A EPJ A51 70</td>
<td>D. Roenchen et al.</td>
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<td>K. Olive et al.</td>
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<td>ROENCHEN 14 EPJ A50 101</td>
<td>D. Roenchen et al.</td>
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<td>Also EPJ A51 63 (errat.)</td>
<td>D. Roenchen et al.</td>
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<td>SVARC 14 PR C99 045205</td>
<td>A. Svarc et al.</td>
</tr>
<tr>
<td>SHRESTHA 12A PR C86 055203</td>
<td>M. Shrestha, D.M. Manley</td>
</tr>
<tr>
<td>ARNDT 06 PR C74 045205</td>
<td>R.A. Arndt et al.</td>
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<td>VRANA 00 PRPL 328 181</td>
<td>T.P. Vrana, S.A. Dytman, T.-S.H. Lee</td>
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<td>ARNDT 96 CR C23 430</td>
<td>R.A. Arndt, I.L. Strakovsky, R.L. Workman</td>
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<td>HOEHLER 93 Pr C4 11</td>
<td>G. Hohler</td>
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<td>R.E. Cutkosky et al.</td>
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<td>R. Koch</td>
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1 Statistical error only.