

$$\Delta(1930) \ 5/2^-$$

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

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

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

#### REAL PART

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
<b>1820 to 1880 (<math>\approx</math> 1850) OUR ESTIMATE</b>			
1821 $\pm$ 2	ROENCHEN	22	DPWA Multichannel
1848 $\pm$ 9 $\pm$ 19	<sup>1</sup> SVARC	14	L+P $\pi N \rightarrow \pi N$
1890 $\pm$ 50	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1863	HUNT	19	DPWA Multichannel
1836	ROENCHEN	15A	DPWA Multichannel
2001	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1883	VRANA	00	DPWA Multichannel
1850	HOEHLER	93	SPED $\pi N \rightarrow \pi N$

<sup>1</sup> Fit to the amplitudes of HOEHLER 79.

#### -2xIMAGINARY PART

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
<b>300 to 450 (<math>\approx</math> 320) OUR ESTIMATE</b>			
447 $\pm$ 7	ROENCHEN	22	DPWA Multichannel
321 $\pm$ 17 $\pm$ 7	<sup>1</sup> SVARC	14	L+P $\pi N \rightarrow \pi N$
260 $\pm$ 60	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
260	HUNT	19	DPWA Multichannel
724	ROENCHEN	15A	DPWA Multichannel
387	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
250	VRANA	00	DPWA Multichannel
180	HOEHLER	93	SPED $\pi N \rightarrow \pi N$

<sup>1</sup> Fit to the amplitudes of HOEHLER 79.

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

#### MODULUS $|r|$

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
<b>8 to 20 (<math>\approx</math> 14) OUR ESTIMATE</b>			
15 $\pm$ 2	ROENCHEN	22	DPWA Multichannel
9 $\pm$ 1 $\pm$ 1	<sup>1</sup> SVARC	14	L+P $\pi N \rightarrow \pi N$
18 $\pm$ 6	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
34	ROENCHEN	15A	DPWA Multichannel
7	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
20	HOEHLER	93	SPED $\pi N \rightarrow \pi N$

<sup>1</sup> Fit to the amplitudes of HOEHLER 79.

## PHASE $\theta$

VALUE ( $^{\circ}$ )	DOCUMENT ID	TECN	COMMENT
<b>−100 to −10 (<math>\approx</math> −50) OUR ESTIMATE</b>			
−108 ± 5	ROENCHEN	22	DPWA Multichannel
− 37 ± 3 ± 7	<sup>1</sup> SVARC	14	L+P $\pi N \rightarrow \pi N$
− 20 ± 40	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
−155	ROENCHEN	15A	DPWA Multichannel
− 12	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
<sup>1</sup> Fit to the amplitudes of HOEHLER 79.			

## $\Delta(1930)$ INELASTIC POLE RESIDUE

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

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

MODULUS	PHASE ( $^{\circ}$ )	DOCUMENT ID	TECN	COMMENT
<b>0.010 ± 0.001</b>	<b>49 ± 5</b>	ROENCHEN	22	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.043	−0.5	ROENCHEN	15A	DPWA Multichannel

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

MODULUS	PHASE ( $^{\circ}$ )	DOCUMENT ID	TECN	COMMENT
<b>0.12 ± 0.02</b>	<b>64 ± 4</b>	ROENCHEN	22	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.15	30	ROENCHEN	15A	DPWA Multichannel

### Normalized residue in $N\pi \rightarrow \Delta(1930) \rightarrow \Delta\pi, G\text{-wave}$

MODULUS	PHASE ( $^{\circ}$ )	DOCUMENT ID	TECN	COMMENT
<b>0.008 ± 0.001</b>	<b>148 ± 2</b>	ROENCHEN	22	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.009	121	ROENCHEN	15A	DPWA Multichannel

## $\Delta(1930)$ BREIT-WIGNER MASS

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
<b>1900 to 2000 (<math>\approx</math> 1950) OUR ESTIMATE</b>			
1988 ± 32	<sup>1</sup> HUNT	19	DPWA Multichannel
2233 ± 53	<sup>1</sup> ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1940 ± 30	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
1901 ± 15	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
1930 ± 12	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel
1932 ± 100	VRANA	00	DPWA Multichannel
<sup>1</sup> Statistical error only.			

**$\Delta(1930)$  BREIT-WIGNER WIDTH**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>200 to 400 (<math>\approx 300</math>) OUR ESTIMATE</b>			
$500 \pm 160$	<sup>1</sup> HUNT	19	DPWA Multichannel
$773 \pm 187$	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
$320 \pm 60$	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
$195 \pm 60$	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$235 \pm 39$	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel
$316 \pm 237$	VRANA	00	DPWA Multichannel

<sup>1</sup>Statistical error only. **$\Delta(1930)$  DECAY MODES**

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

Mode	Fraction ( $\Gamma_j/\Gamma$ )
$\Gamma_1$ $N\pi$	5–15 %
$\Gamma_2$ $N\gamma$	0.0–0.01 %
$\Gamma_3$ $N\gamma$ , helicity=1/2	0.0–0.005 %
$\Gamma_4$ $N\gamma$ , helicity=3/2	0.0–0.004 %

 **$\Delta(1930)$  BRANCHING RATIOS**

<u><math>\Gamma(N\pi)/\Gamma_{\text{total}}</math></u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	<u><math>\Gamma_1/\Gamma</math></u>
<b>5 to 15 (<math>\approx 10</math>) OUR ESTIMATE</b>				
$9.5 \pm 0.1$	<sup>1</sup> HUNT	19	DPWA Multichannel	
$8.1 \pm 1.2$	<sup>1</sup> ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$	
$14 \pm 4$	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$	
$4 \pm 3$	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$7.9 \pm 0.4$	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel	
$9 \pm 8$	VRANA	00	DPWA Multichannel	

<sup>1</sup>Statistical error only. **$\Delta(1930)$  PHOTON DECAY AMPLITUDES AT THE POLE** **$\Delta(1930) \rightarrow N\gamma$ , helicity-1/2 amplitude  $A_{1/2}$** 

<u>MODULUS (<math>\text{GeV}^{-1/2}</math>)</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$0.104 \pm 0.009$	$129 \pm 8$	ROENCHEN	22	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$-0.270$	33	ROENCHEN	15A	DPWA Multichannel

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

<u>MODULUS (<math>\text{GeV}^{-1/2}</math>)</u>	<u>PHASE (<math>^\circ</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$0.322 \pm 0.022$	$142 \pm 4$	ROENCHEN	22	DPWA Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.153	81	ROENCHEN	15A	DPWA Multichannel

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

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

<u>VALUE (<math>\text{GeV}^{-1/2}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$-0.043 \pm 0.008$	<sup>1</sup> HUNT	19	DPWA Multichannel
$-0.007 \pm 0.010$	<sup>1</sup> ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$0.011 \pm 0.003$	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel

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

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

<u>VALUE (<math>\text{GeV}^{-1/2}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
$-0.020 \pm 0.017$	<sup>1</sup> HUNT	19	DPWA Multichannel
$0.005 \pm 0.010$	<sup>1</sup> ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$0.002 \pm 0.002$	<sup>1</sup> SHRESTHA	12A	DPWA Multichannel

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

### $\Delta(1930)$ REFERENCES

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

ROENCHEN	22	EPJ A58 229	D. Roenchen <i>et al.</i>	(JULI, GWU, BONN+)
HUNT	19	PR C99 055205	B.C. Hunt, D.M. Manley	
ROENCHEN	15A	EPJ A51 70	D. Roenchen <i>et al.</i>	
PDG	14	CP C38 070001	K. Olive <i>et al.</i>	(PDG Collab.)
SVARC	14	PR C89 045205	A. Svarc <i>et al.</i>	(RBI Zagreb, UNI Tuzla)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
ARNDT	06	PR C74 045205	R.A. Arndt <i>et al.</i>	(GWU)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman, T.-S.H. Lee	(PITT, ANL)
ARNDT	96	PR C53 430	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI)
HOEHLER	93	$\pi N$ Newsletter 9 1	G. Hohler	(KARL)
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
HOEHLER	79	PDAT 12-1	G. Hohler <i>et al.</i>	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP