

$$N(2220) \ 9/2^+$$

$$I(J^P) = \frac{1}{2}(\frac{9}{2}^+) \text{ Status: } ****$$

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

***N*(2220) POLE POSITION**

**REAL PART**

| VALUE (MeV)                                                                   | DOCUMENT ID        | TECN | COMMENT                                |
|-------------------------------------------------------------------------------|--------------------|------|----------------------------------------|
| <b>2130 to 2200 (<math>\approx</math> 2150) OUR ESTIMATE</b>                  |                    |      |                                        |
| 2131 $\pm$ 6                                                                  | ROENCHEN           | 22   | DPWA Multichannel                      |
| 2127 $\pm$ 3 $\pm$ 24                                                         | <sup>1</sup> SVARC | 14   | L+P $\pi N \rightarrow \pi N$          |
| 2150 $\pm$ 35                                                                 | ANISOVICH          | 12A  | DPWA Multichannel                      |
| 2160 $\pm$ 80                                                                 | CUTKOSKY           | 80   | IPWA $\pi N \rightarrow \pi N$         |
| • • • We do not use the following data for averages, fits, limits, etc. • • • |                    |      |                                        |
| 2171                                                                          | ROENCHEN           | 15A  | DPWA Multichannel                      |
| 2199                                                                          | ARNDT              | 06   | DPWA $\pi N \rightarrow \pi N, \eta N$ |
| 2135                                                                          | HOEHLER            | 93   | ARGD $\pi N \rightarrow \pi N$         |

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

**–2xIMAGINARY PART**

| VALUE (MeV)                                                                   | DOCUMENT ID        | TECN | COMMENT                                |
|-------------------------------------------------------------------------------|--------------------|------|----------------------------------------|
| <b>360 to 480 (<math>\approx</math> 400) OUR ESTIMATE</b>                     |                    |      |                                        |
| 388 $\pm$ 6                                                                   | ROENCHEN           | 22   | DPWA Multichannel                      |
| 380 $\pm$ 7 $\pm$ 22                                                          | <sup>1</sup> SVARC | 14   | L+P $\pi N \rightarrow \pi N$          |
| 440 $\pm$ 40                                                                  | ANISOVICH          | 12A  | DPWA Multichannel                      |
| 480 $\pm$ 100                                                                 | CUTKOSKY           | 80   | IPWA $\pi N \rightarrow \pi N$         |
| • • • We do not use the following data for averages, fits, limits, etc. • • • |                    |      |                                        |
| 593                                                                           | ROENCHEN           | 15A  | DPWA Multichannel                      |
| 372                                                                           | ARNDT              | 06   | DPWA $\pi N \rightarrow \pi N, \eta N$ |
| 400                                                                           | HOEHLER            | 93   | ARGD $\pi N \rightarrow \pi N$         |

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

***N*(2220) ELASTIC POLE RESIDUE**

**MODULUS  $|r|$**

| VALUE (MeV)                                                                   | DOCUMENT ID        | TECN | COMMENT                                |
|-------------------------------------------------------------------------------|--------------------|------|----------------------------------------|
| <b>35 to 60 (<math>\approx</math> 45) OUR ESTIMATE</b>                        |                    |      |                                        |
| 48 $\pm$ 5                                                                    | ROENCHEN           | 22   | DPWA Multichannel                      |
| 38 $\pm$ 1 $\pm$ 5                                                            | <sup>1</sup> SVARC | 14   | L+P $\pi N \rightarrow \pi N$          |
| 60 $\pm$ 12                                                                   | ANISOVICH          | 12A  | DPWA Multichannel                      |
| 45 $\pm$ 20                                                                   | CUTKOSKY           | 80   | IPWA $\pi N \rightarrow \pi N$         |
| • • • We do not use the following data for averages, fits, limits, etc. • • • |                    |      |                                        |
| 62                                                                            | ROENCHEN           | 15A  | DPWA Multichannel                      |
| 33                                                                            | ARNDT              | 06   | DPWA $\pi N \rightarrow \pi N, \eta N$ |
| 40                                                                            | HOEHLER            | 93   | ARGD $\pi N \rightarrow \pi N$         |

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

**PHASE  $\theta$** 

| VALUE ( $^{\circ}$ )                                                          | DOCUMENT ID        | TECN | COMMENT                                |
|-------------------------------------------------------------------------------|--------------------|------|----------------------------------------|
| <b>−60 to −10 (<math>\approx</math> −40) OUR ESTIMATE</b>                     |                    |      |                                        |
| −13 $\pm$ 2                                                                   | ROENCHEN           | 22   | DPWA Multichannel                      |
| −52 $\pm$ 1 $\pm$ 14                                                          | <sup>1</sup> SVARC | 14   | L+P $\pi N \rightarrow \pi N$          |
| −58 $\pm$ 12                                                                  | ANISOVICH          | 12A  | DPWA Multichannel                      |
| −45 $\pm$ 25                                                                  | CUTKOSKY           | 80   | IPWA $\pi N \rightarrow \pi N$         |
| • • • We do not use the following data for averages, fits, limits, etc. • • • |                    |      |                                        |
| −59                                                                           | ROENCHEN           | 15A  | DPWA Multichannel                      |
| −33                                                                           | ARNDT              | 06   | DPWA $\pi N \rightarrow \pi N, \eta N$ |
| −50                                                                           | HOEHLER            | 93   | ARGD $\pi N \rightarrow \pi N$         |
| <sup>1</sup> Fit to the amplitudes of HOEHLER 79.                             |                    |      |                                        |

 **$N(2220)$  INELASTIC POLE RESIDUE**

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

**Normalized residue in  $N\pi \rightarrow N(2220) \rightarrow N\eta$** 

| MODULUS                                                                       | PHASE ( $^{\circ}$ ) | DOCUMENT ID | TECN | COMMENT           |
|-------------------------------------------------------------------------------|----------------------|-------------|------|-------------------|
| 0.042 $\pm$ 0.006                                                             | −48 $\pm$ 2          | ROENCHEN    | 22   | DPWA Multichannel |
| • • • We do not use the following data for averages, fits, limits, etc. • • • |                      |             |      |                   |
| 0.004                                                                         | −101                 | ROENCHEN    | 15A  | DPWA Multichannel |

**Normalized residue in  $N\pi \rightarrow N(2220) \rightarrow \Lambda K$** 

| MODULUS                                                                       | PHASE ( $^{\circ}$ ) | DOCUMENT ID | TECN | COMMENT           |
|-------------------------------------------------------------------------------|----------------------|-------------|------|-------------------|
| 0.020 $\pm$ 0.003                                                             | −60 $\pm$ 2          | ROENCHEN    | 22   | DPWA Multichannel |
| • • • We do not use the following data for averages, fits, limits, etc. • • • |                      |             |      |                   |
| 0.007                                                                         | 62                   | ROENCHEN    | 15A  | DPWA Multichannel |

**Normalized residue in  $N\pi \rightarrow N(2220) \rightarrow \Sigma K$** 

| MODULUS                                                                       | PHASE ( $^{\circ}$ ) | DOCUMENT ID | TECN | COMMENT           |
|-------------------------------------------------------------------------------|----------------------|-------------|------|-------------------|
| 0.003 $\pm$ 0.008                                                             | −70 $\pm$ 2          | ROENCHEN    | 22   | DPWA Multichannel |
| • • • We do not use the following data for averages, fits, limits, etc. • • • |                      |             |      |                   |
| 0.009                                                                         | −128                 | ROENCHEN    | 15A  | DPWA Multichannel |

 **$N(2220)$  BREIT-WIGNER MASS**

| VALUE (MeV)                                                  | DOCUMENT ID        | TECN | COMMENT                                |
|--------------------------------------------------------------|--------------------|------|----------------------------------------|
| <b>2200 to 2300 (<math>\approx</math> 2250) OUR ESTIMATE</b> |                    |      |                                        |
| 2316.3 $\pm$ 2.9                                             | <sup>1</sup> ARNDT | 06   | DPWA $\pi N \rightarrow \pi N, \eta N$ |
| 2230 $\pm$ 80                                                | CUTKOSKY           | 80   | IPWA $\pi N \rightarrow \pi N$         |
| 2205 $\pm$ 10                                                | HOEHLER            | 79   | IPWA $\pi N \rightarrow \pi N$         |
| <sup>1</sup> Statistical error only.                         |                    |      |                                        |

**$N(2220)$  BREIT-WIGNER WIDTH**

| VALUE (MeV)                                               | DOCUMENT ID        | TECN | COMMENT                                |
|-----------------------------------------------------------|--------------------|------|----------------------------------------|
| <b>350 to 500 (<math>\approx 400</math>) OUR ESTIMATE</b> |                    |      |                                        |
| $633 \pm 17$                                              | <sup>1</sup> ARNDT | 06   | DPWA $\pi N \rightarrow \pi N, \eta N$ |
| $500 \pm 150$                                             | CUTKOSKY           | 80   | IPWA $\pi N \rightarrow \pi N$         |
| $365 \pm 30$                                              | HOEHLER            | 79   | IPWA $\pi N \rightarrow \pi N$         |
| <sup>1</sup> Statistical error only.                      |                    |      |                                        |

**$N(2220)$  DECAY MODES**

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

| Mode                  | Fraction ( $\Gamma_i/\Gamma$ ) |
|-----------------------|--------------------------------|
| $\Gamma_1 \quad N\pi$ | 15–30 %                        |

**$N(2220)$  BRANCHING RATIOS**

| $\Gamma(N\pi)/\Gamma_{\text{total}}$                   | DOCUMENT ID        | TECN | COMMENT | $\Gamma_1/\Gamma$                 |
|--------------------------------------------------------|--------------------|------|---------|-----------------------------------|
| VALUE (%)                                              |                    |      |         |                                   |
| <b>15 to 30 (<math>\approx 25</math>) OUR ESTIMATE</b> |                    |      |         |                                   |
| $24 \pm 5$                                             | ANISOVICH          | 12A  | DPWA    | Multichannel                      |
| $24.6 \pm 0.1$                                         | <sup>1</sup> ARNDT | 06   | DPWA    | $\pi N \rightarrow \pi N, \eta N$ |
| $15 \pm 3$                                             | CUTKOSKY           | 80   | IPWA    | $\pi N \rightarrow \pi N$         |
| $18.0 \pm 1.5$                                         | HOEHLER            | 79   | IPWA    | $\pi N \rightarrow \pi N$         |
| <sup>1</sup> Statistical error only.                   |                    |      |         |                                   |

**$N(2220)$  PHOTON DECAY AMPLITUDES AT THE POLE**

**$N(2220) \rightarrow p\gamma$ , helicity-1/2 amplitude  $A_{1/2}$**

| MODULUS ( $\text{GeV}^{-1/2}$ )                                               | PHASE ( $^\circ$ ) | DOCUMENT ID | TECN | COMMENT           |
|-------------------------------------------------------------------------------|--------------------|-------------|------|-------------------|
| $0.357 \pm 0.020$                                                             | $-91 \pm 4$        | ROENCHEN    | 22   | DPWA Multichannel |
| • • • We do not use the following data for averages, fits, limits, etc. • • • |                    |             |      |                   |
| 0.135                                                                         | 114                | ROENCHEN    | 15A  | DPWA Multichannel |

**$N(2220) \rightarrow p\gamma$ , helicity-3/2 amplitude  $A_{3/2}$**

| MODULUS ( $\text{GeV}^{-1/2}$ )                                               | PHASE ( $^\circ$ ) | DOCUMENT ID | TECN | COMMENT           |
|-------------------------------------------------------------------------------|--------------------|-------------|------|-------------------|
| $-0.273 \pm 0.025$                                                            | $-102 \pm 3$       | ROENCHEN    | 22   | DPWA Multichannel |
| • • • We do not use the following data for averages, fits, limits, etc. • • • |                    |             |      |                   |
| 0.082                                                                         | -41                | ROENCHEN    | 15A  | DPWA Multichannel |

## ***N*(2220) REFERENCES**

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

|           |     |                        |                              |                         |
|-----------|-----|------------------------|------------------------------|-------------------------|
| ROENCHEN  | 22  | EPJ A58 229            | D. Roenchen <i>et al.</i>    | (JULI, GWU, BONN+)      |
| 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) |
| ANISOVICH | 12A | EPJ A48 15             | A.V. Anisovich <i>et al.</i> | (BONN, PNPI)            |
| ARNDT     | 06  | PR C74 045205          | R.A. Arndt <i>et al.</i>     | (GWU)                   |
| 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             |

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