# $N(2080)$ $D_{13}$

$I(J^P) = \frac{1}{2}(\frac{3}{2}^-)$ Status: **

OMITTED FROM SUMMARY TABLE

There is some evidence for two resonances in this wave between 1800 and 2200 MeV (see CUTKOSKY 80). However, the solution of HOEHLER 79 is quite different.

Most of the results published before 1975 are now obsolete and have been omitted. They may be found in our 1982 edition, Physics Letters **111B** (1982).

## $N(2080)$ BREIT-WIGNER MASS

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **≈ 2080 OUR ESTIMATE** | | | | |
| 1804± 55 | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |
| 1920 | BELL | 83 | DPWA | $\pi^- p \to \Lambda K^0$ |
| 1880±100 | [1] CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ |
| 2060± 80 | [1] CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ |
| 1900 | SAXON | 80 | DPWA | $\pi^- p \to \Lambda K^0$ |
| 2081± 20 | HOEHLER | 79 | IPWA | $\pi N \to \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 1946± 1 | PENNER | 02C | DPWA | Multichannel |
| 1895 | MART | 00 | DPWA | $\gamma p \to \Lambda K^+$ |
| 2003± 18 | VRANA | 00 | DPWA | Multichannel |
| 1986± 75 | BATINIC | 95 | DPWA | $\pi N \to N\pi$, $N\eta$ |
| 1880 | BAKER | 79 | DPWA | $\pi^- p \to n\eta$ |

## $N(2080)$ BREIT-WIGNER WIDTH

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| 450±185 | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |
| 320 | BELL | 83 | DPWA | $\pi^- p \to \Lambda K^0$ |
| 180± 60 | [1] CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ (lower $m$) |
| 300±100 | [1] CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ (higher $m$) |
| 240 | SAXON | 80 | DPWA | $\pi^- p \to \Lambda K^0$ |
| 265± 40 | HOEHLER | 79 | IPWA | $\pi N \to \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 859± 7 | PENNER | 02C | DPWA | Multichannel |
| 372 | MART | 00 | DPWA | $\gamma p \to \Lambda K^+$ |
| 1070±858 | VRANA | 00 | DPWA | Multichannel |
| 1050±225 | BATINIC | 95 | DPWA | $\pi N \to N\pi$, $N\eta$ |
| 87 | BAKER | 79 | DPWA | $\pi^- p \to n\eta$ |

## *N*(2080) POLE POSITION

### REAL PART

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| 1880±100 | [1] CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ (lower $m$) |
| 2050± 70 | [1] CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ (higher $m$) |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 1824 | VRANA | 00 | DPWA | Multichannel |
| not seen | ARNDT | 91 | DPWA | $\pi N \to \pi N$ Soln SM90 |

### −2×IMAGINARY PART

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| 160±80 | [1] CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ (lower $m$) |
| 200±80 | [1] CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ (higher $m$) |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 614 | VRANA | 00 | DPWA | Multichannel |
| not seen | ARNDT | 91 | DPWA | $\pi N \to \pi N$ Soln SM90 |

## *N*(2080) ELASTIC POLE RESIDUE

### MODULUS $|r|$

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| 10± 5 | [1] CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ (lower $m$) |
| 30±20 | [1] CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ (higher $m$) |

### PHASE $\theta$

| *VALUE* (°) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| 100± 80 | [1] CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ (lower $m$) |
| 0±100 | [1] CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ (higher $m$) |

## *N*(2080) DECAY MODES

| | Mode | Fraction ($\Gamma_i/\Gamma$) | Scale factor |
|---|---|---|---|
| $\Gamma_1$ | $N\pi$ | | |
| $\Gamma_2$ | $N\eta$ | ( 3.5±3.5) % | 2.5 |
| $\Gamma_3$ | $N\omega$ | (21 ±7 ) % | |
| $\Gamma_4$ | $\Lambda K$ | | |
| $\Gamma_5$ | $\Sigma K$ | ( 7 ±4 ) $\times 10^{-3}$ | |
| $\Gamma_6$ | $N\pi\pi$ | | |
| $\Gamma_7$ | $\Delta(1232)\pi$, $S$-wave | | |
| $\Gamma_8$ | $\Delta(1232)\pi$, $D$-wave | | |
| $\Gamma_9$ | $N\rho$, $S$=3/2, $S$-wave | | |
| $\Gamma_{10}$ | $N(\pi\pi)^{I=0}_{S\text{-wave}}$ | | |
| $\Gamma_{11}$ | $p\gamma$, helicity=1/2 | | |
| $\Gamma_{12}$ | $p\gamma$, helicity=3/2 | | |
| $\Gamma_{13}$ | $n\gamma$, helicity=1/2 | | |
| $\Gamma_{14}$ | $n\gamma$, helicity=3/2 | | |
| $\Gamma_{15}$ | $p\gamma$ | | |

## $N(2080)$ BRANCHING RATIOS

### $\Gamma(N\pi)/\Gamma_{total}$ $\Gamma_1/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| 0.23±0.03 | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |
| 0.10±0.04 | [1] CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ (lower $m$) |
| 0.14±0.07 | [1] CUTKOSKY | 80 | IPWA | $\pi N \to \pi N$ (higher $m$) |
| 0.06±0.02 | HOEHLER | 79 | IPWA | $\pi N \to \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 0.12±0.02 | PENNER | 02C | DPWA | Multichannel |
| 0.13±0.03 | VRANA | 00 | DPWA | Multichannel |
| 0.09±0.02 | BATINIC | 95 | DPWA | $\pi N \to N\pi$, $N\eta$ |

### $\Gamma(N\eta)/\Gamma_{total}$ $\Gamma_2/\Gamma$

| VALUE | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|
| **0.035±0.035 OUR NEW AVERAGE** Error includes scale factor of 2.5. [0.000 ± 0.020 OUR 2002 AVERAGE] | | | |
| 0.07 ±0.02 | PENNER | 02C | DPWA Multichannel |
| 0.00 ±0.02 | VRANA | 00 | DPWA Multichannel |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | |
| 0.07 ±0.04 | BATINIC | 95 | DPWA $\pi N \to N\pi$, $N\eta$ |

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(2080) \to N\eta$ $(\Gamma_1\Gamma_2)^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|
| 0.065 | BAKER | 79 | DPWA $\pi^- p \to n\eta$ |

### $\Gamma(N\omega)/\Gamma_{total}$ $\Gamma_3/\Gamma$

| VALUE | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|
| **0.21±0.07** | PENNER | 02C | DPWA Multichannel |

### $\Gamma(\Lambda K)/\Gamma_{total}$ $\Gamma_4/\Gamma$

| VALUE | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | |
| 0.002±0.002 | PENNER | 02C | DPWA Multichannel |

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(2080) \to \Lambda K$ $(\Gamma_1\Gamma_4)^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|
| +0.04 | BELL | 83 | DPWA $\pi^- p \to \Lambda K^0$ |
| +0.03 | SAXON | 80 | DPWA $\pi^- p \to \Lambda K^0$ |

### $\Gamma(\Sigma K)/\Gamma_{total}$ $\Gamma_5/\Gamma$

| VALUE | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|
| **0.007±0.004** | PENNER | 02C | DPWA Multichannel |

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(2080) \to \Sigma K$ $(\Gamma_1\Gamma_5)^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| 0.014 to 0.037 | [2] DEANS | 75 | DPWA | $\pi N \to \Sigma K$ |

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(2080) \to \Delta(1232)\pi$, S-wave $(\Gamma_1\Gamma_7)^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $-0.09\pm0.09$ | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |

### $\Gamma(\Delta(1232)\pi$, S-wave$)/\Gamma_{total}$ $\Gamma_7/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $0.40\pm0.10$ | VRANA | 00 | DPWA | Multichannel |

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(2080) \to \Delta(1232)\pi$, D-wave $(\Gamma_1\Gamma_8)^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $+0.22\pm0.07$ | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |

### $\Gamma(\Delta(1232)\pi$, D-wave$)/\Gamma_{total}$ $\Gamma_8/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $0.17\pm0.10$ | VRANA | 00 | DPWA | Multichannel |

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(2080) \to N\rho$, S=3/2, S-wave $(\Gamma_1\Gamma_9)^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $-0.24\pm0.06$ | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |

### $\Gamma(N\rho$, S=3/2, S-wave$)/\Gamma_{total}$ $\Gamma_9/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $0.06\pm0.06$ | VRANA | 00 | DPWA | Multichannel |

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(2080) \to N(\pi\pi)^{I=0}_{S\text{-wave}}$ $(\Gamma_1\Gamma_{10})^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $+0.25\pm0.06$ | MANLEY | 92 | IPWA | $\pi N \to \pi N$ & $N\pi\pi$ |

### $\Gamma(N(\pi\pi)^{I=0}_{S\text{-wave}})/\Gamma_{total}$ $\Gamma_{10}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $0.24\pm0.24$ | VRANA | 00 | DPWA | Multichannel |

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $p\gamma \to N(2080) \to N\eta$ $(\Gamma_{15}\Gamma_2)^{1/2}/\Gamma$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| 0.0037 | HICKS | 73 | MPWA | $\gamma p \to p\eta$ |

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## N(2080) PHOTON DECAY AMPLITUDES

### N(2080) → pγ, helicity-1/2 amplitude $A_{1/2}$

| VALUE ($GeV^{-1/2}$) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $-0.020\pm0.008$ | AWAJI | 81 | DPWA | $\gamma N \to \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 0.012 | PENNER | 02D | DPWA | Multichannel |
| $0.026\pm0.052$ | DEVENISH | 74 | DPWA | $\gamma N \to \pi N$ |

### $N(2080) \rightarrow p\gamma$, helicity-3/2 amplitude $A_{3/2}$

| VALUE ($GeV^{-1/2}$) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $0.017 \pm 0.011$ | AWAJI | 81 | DPWA | $\gamma N \rightarrow \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| $-0.010$ | PENNER | 02D | DPWA | Multichannel |
| $0.128 \pm 0.057$ | DEVENISH | 74 | DPWA | $\gamma N \rightarrow \pi N$ |

### $N(2080) \rightarrow n\gamma$, helicity-1/2 amplitude $A_{1/2}$

| VALUE ($GeV^{-1/2}$) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $0.007 \pm 0.013$ | AWAJI | 81 | DPWA | $\gamma N \rightarrow \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 0.023 | PENNER | 02D | DPWA | Multichannel |
| $0.053 \pm 0.083$ | DEVENISH | 74 | DPWA | $\gamma N \rightarrow \pi N$ |

### $N(2080) \rightarrow n\gamma$, helicity-3/2 amplitude $A_{3/2}$

| VALUE ($GeV^{-1/2}$) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| $-0.053 \pm 0.034$ | AWAJI | 81 | DPWA | $\gamma N \rightarrow \pi N$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| $-0.009$ | PENNER | 02D | DPWA | Multichannel |
| $0.100 \pm 0.141$ | DEVENISH | 74 | DPWA | $\gamma N \rightarrow \pi N$ |

## $N(2080)$ $\gamma p \rightarrow \Lambda K^+$ AMPLITUDES

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $p\gamma \rightarrow N(2080) \rightarrow \Lambda K^+$ ($E_{2-}$ amplitude)

| VALUE (units $10^{-3}$) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| $2.29^{+0.7}_{-0.2}$ | MART | 00 | DPWA | $\gamma p \rightarrow \Lambda K^+$ |
| $5.5 \pm 0.3$ | WORKMAN | 90 | DPWA | |
| 4.09 | TANABE | 89 | DPWA | |

### $p\gamma \rightarrow N(2080) \rightarrow \Lambda K^+$ phase angle $\theta$ ($E_{2-}$ amplitude)

| VALUE (degrees) | DOCUMENT ID | | TECN |
|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | |
| $-48 \pm 5$ | WORKMAN | 90 | DPWA |
| $-35.9$ | TANABE | 89 | DPWA |

### $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $p\gamma \rightarrow N(2080) \rightarrow \Lambda K^+$ ($M_{2-}$ amplitude)

| VALUE (units $10^{-3}$) | DOCUMENT ID | | TECN |
|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | |
| $-6.7 \pm 0.2$ | WORKMAN | 90 | DPWA |
| $-4.09$ | TANABE | 89 | DPWA |

## *N*(2080) FOOTNOTES

[1] CUTKOSKY 80 finds a lower mass $D_{13}$ resonance, as well as one in this region. Both are listed here.

[2] The range given for DEANS 75 is from the four best solutions. Disagrees with $\pi^+ p \rightarrow \Sigma^+ K^+$ data of WINNIK 77 around 1920 MeV.

## *N*(2080) REFERENCES

For early references, see Physics Letters **111B** 70 (1982).


| | | | | |
|---|---|---|---|---|
| PENNER | 02C | PR C66 055211 | G. Penner, U. Mosel | (GIES) |
| PENNER | 02D | PR C66 055212 | G. Penner, U. Mosel | (GIES) |
| MART | 00 | PR C61 012201 | T. Mart, C. Bennhold | |
| VRANA | 00 | PRPL 328 181 | T.P. Vrana, S.A. Dytman,, T.-S.H. Lee | (PITT+) |
| BATINIC | 95 | PR C51 2310 | M. Batinic *et al.* | (BOSK, UCLA) |
| Also | 98 | PR C57 1004 (erratum) | M. Batinic *et al.* | |
| MANLEY | 92 | PR D45 4002 | D.M. Manley, E.M. Saleski | (KENT) IJP |
| Also | 84 | PR D30 904 | D.M. Manley *et al.* | (VPI) |
| ARNDT | 91 | PR D43 2131 | R.A. Arndt *et al.* | (VPI, TELE) IJP |
| WORKMAN | 90 | PR C42 781 | R.L. Workman | (VPI) |
| TANABE | 89 | PR C39 741 | H. Tanabe, M. Kohno, C. Bennhold | (MANZ) |
| Also | 89 | NC 102A 193 | M. Kohno, H. Tanabe, C. Bennhold | (MANZ) |
| BELL | 83 | NP B222 389 | K.W. Bell *et al.* | (RL) IJP |
| PDG | 82 | PL 111B | M. Roos *et al.* | (HELS, CIT, CERN) |
| AWAJI | 81 | Bonn Conf. 352 | N. Awaji, R. Kajikawa | (NAGO) |
| Also | 82 | NP B197 365 | K. Fujii *et al.* | (NAGO) |
| CUTKOSKY | 80 | Toronto Conf. 19 | R.E. Cutkosky *et al.* | (CMU, LBL) IJP |
| Also | 79 | PR D20 2839 | R.E. Cutkosky *et al.* | (CMU, LBL) IJP |
| SAXON | 80 | NP B162 522 | D.H. Saxon *et al.* | (RHEL, BRIS) IJP |
| BAKER | 79 | NP B156 93 | R.D. Baker *et al.* | (RHEL) IJP |
| HOEHLER | 79 | PDAT 12-1 | G. Hohler *et al.* | (KARLT) IJP |
| Also | 80 | Toronto Conf. 3 | R. Koch | (KARLT) IJP |
| WINNIK | 77 | NP B128 66 | M. Winnik *et al.* | (HAIF) I |
| DEANS | 75 | NP B96 90 | S.R. Deans *et al.* | (SFLA, ALAH) IJP |
| DEVENISH | 74 | PL 52B 227 | R.C.E. Devenish, D.H. Lyth, W.A. Rankin | (DESY+) IJP |
| HICKS | 73 | PR D7 2614 | H.R. Hicks *et al.* | (CMU, ORNL, SFLA) IJP |