

# N(2080) D<sub>13</sub>

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

## 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

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>≈ 2080 OUR ESTIMATE</b>			
1804 ± 55	MANLEY	92	IPWA πN → πN & Nππ
1920	BELL	83	DPWA π <sup>-</sup> p → ΛK <sup>0</sup>
1880 ± 100	<sup>1</sup> CUTKOSKY	80	IPWA πN → πN
2060 ± 80	<sup>1</sup> CUTKOSKY	80	IPWA πN → πN
1900	SAXON	80	DPWA π <sup>-</sup> p → ΛK <sup>0</sup>
2081 ± 20	HOEHLER	79	IPWA πN → πN
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1946 ± 1	PENNER	02C	DPWA Multichannel
1895	MART	00	DPWA γp → ΛK <sup>+</sup>
2003 ± 18	VRANA	00	DPWA Multichannel
1986 ± 75	BATINIC	95	DPWA πN → Nπ, Nη
1880	BAKER	79	DPWA π <sup>-</sup> p → nη

## N(2080) BREIT-WIGNER WIDTH

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
450 ± 185	MANLEY	92	IPWA πN → πN & Nππ
320	BELL	83	DPWA π <sup>-</sup> p → ΛK <sup>0</sup>
180 ± 60	<sup>1</sup> CUTKOSKY	80	IPWA πN → πN (lower m)
300 ± 100	<sup>1</sup> CUTKOSKY	80	IPWA πN → πN (higher m)
240	SAXON	80	DPWA π <sup>-</sup> p → ΛK <sup>0</sup>
265 ± 40	HOEHLER	79	IPWA πN → πN
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
859 ± 7	PENNER	02C	DPWA Multichannel
372	MART	00	DPWA γp → ΛK <sup>+</sup>
1070 ± 858	VRANA	00	DPWA Multichannel
1050 ± 225	BATINIC	95	DPWA πN → Nπ, Nη
87	BAKER	79	DPWA π <sup>-</sup> p → nη

## N(2080) POLE POSITION

### REAL PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1880 ± 100	<sup>1</sup> CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (lower $m$ )
2050 ± 70	<sup>1</sup> CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (higher $m$ )
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1824	VRANA	00	DPWA Multichannel
not seen	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

### −2×IMAGINARY PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
160 ± 80	<sup>1</sup> CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (lower $m$ )
200 ± 80	<sup>1</sup> CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (higher $m$ )
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
614	VRANA	00	DPWA Multichannel
not seen	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

## N(2080) ELASTIC POLE RESIDUE

### MODULUS $|r|$

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
10 ± 5	<sup>1</sup> CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (lower $m$ )
30 ± 20	<sup>1</sup> CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (higher $m$ )

### PHASE $\theta$

<u>VALUE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
100 ± 80	<sup>1</sup> CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (lower $m$ )
0 ± 100	<sup>1</sup> CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (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 ) × 10 <sup>−3</sup>	
$\Gamma_6$ $N\pi\pi$		
$\Gamma_7$ $\Delta(1232)\pi$ , S-wave		
$\Gamma_8$ $\Delta(1232)\pi$ , D-wave		
$\Gamma_9$ $N\rho$ , S=3/2, S-wave		
$\Gamma_{10}$ $N(\pi\pi)_{S\text{-wave}}^{I=0}$		
$\Gamma_{11}$ $p\gamma$ , 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

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

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.23±0.03	MANLEY	92	IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$
0.10±0.04	<sup>1</sup> CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (lower $m$ )
0.14±0.07	<sup>1</sup> CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$ (higher $m$ )
0.06±0.02	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● 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 $\pi N \rightarrow N\pi, N\eta$

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

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.035±0.035 OUR AVERAGE</b>	Error includes scale factor of 2.5.		
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 $\pi N \rightarrow N\pi, N\eta$

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

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.065	BAKER	79	DPWA $\pi^- p \rightarrow n\eta$

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

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.21±0.07</b>	PENNER	02C	DPWA Multichannel

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

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.002±0.002	PENNER	02C	DPWA Multichannel

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

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
+0.04	BELL	83	DPWA $\pi^- p \rightarrow \Lambda K^0$
+0.03	SAXON	80	DPWA $\pi^- p \rightarrow \Lambda K^0$

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

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.007±0.004</b>	PENNER	02C	DPWA Multichannel

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

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.014 to 0.037	<sup>2</sup> DEANS	75	DPWA $\pi N \rightarrow \Sigma K$

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(2080) \rightarrow \Delta(1232)\pi$ , <b>S-wave</b>	$(\Gamma_1 \Gamma_7)^{1/2} / \Gamma$
VALUE	DOCUMENT ID TECN COMMENT
$-0.09 \pm 0.09$	MANLEY 92 IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$

$\Gamma(\Delta(1232)\pi)$ , <b>S-wave</b> / $\Gamma_{\text{total}}$	$\Gamma_7 / \Gamma$
VALUE	DOCUMENT ID TECN COMMENT
$0.40 \pm 0.10$	VRANA 00 DPWA Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(2080) \rightarrow \Delta(1232)\pi$ , <b>D-wave</b>	$(\Gamma_1 \Gamma_8)^{1/2} / \Gamma$
VALUE	DOCUMENT ID TECN COMMENT
$+0.22 \pm 0.07$	MANLEY 92 IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$

$\Gamma(\Delta(1232)\pi)$ , <b>D-wave</b> / $\Gamma_{\text{total}}$	$\Gamma_8 / \Gamma$
VALUE	DOCUMENT ID TECN COMMENT
$0.17 \pm 0.10$	VRANA 00 DPWA Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(2080) \rightarrow N\rho$ , <b>S=3/2, S-wave</b>	$(\Gamma_1 \Gamma_9)^{1/2} / \Gamma$
VALUE	DOCUMENT ID TECN COMMENT
$-0.24 \pm 0.06$	MANLEY 92 IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$

$\Gamma(N\rho, S=3/2)$ , <b>S-wave</b> / $\Gamma_{\text{total}}$	$\Gamma_9 / \Gamma$
VALUE	DOCUMENT ID TECN COMMENT
$0.06 \pm 0.06$	VRANA 00 DPWA Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $N\pi \rightarrow N(2080) \rightarrow N(\pi\pi)_{S=0}^{I=0}$ , <b>S-wave</b>	$(\Gamma_1 \Gamma_{10})^{1/2} / \Gamma$
VALUE	DOCUMENT ID TECN COMMENT
$+0.25 \pm 0.06$	MANLEY 92 IPWA $\pi N \rightarrow \pi N$ & $N\pi\pi$

$\Gamma(N(\pi\pi)_{S=0}^{I=0})$ / $\Gamma_{\text{total}}$	$\Gamma_{10} / \Gamma$
VALUE	DOCUMENT ID TECN COMMENT
$0.24 \pm 0.24$	VRANA 00 DPWA Multichannel

$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$ in $p\gamma \rightarrow N(2080) \rightarrow N\eta$	$(\Gamma_{15} \Gamma_2)^{1/2} / \Gamma$
VALUE	DOCUMENT ID TECN COMMENT
0.0037	HICKS 73 MPWA $\gamma p \rightarrow p\eta$

## N(2080) PHOTON DECAY AMPLITUDES

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

VALUE ( $\text{GeV}^{-1/2}$ )	DOCUMENT ID	TECN	COMMENT
$-0.020 \pm 0.008$	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
• • •	We do not use the following data for averages, fits, limits, etc. • • •		
0.012	PENNER	02D	DPWA Multichannel
$0.026 \pm 0.052$	DEVENISH	74	DPWA $\gamma N \rightarrow \pi N$

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

<u>VALUE (GeV<sup>-1/2</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.017 ± 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 ± 0.057	DEVENISH	74	DPWA $\gamma N \rightarrow \pi N$

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

<u>VALUE (GeV<sup>-1/2</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.007 ± 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 ± 0.083	DEVENISH	74	DPWA $\gamma N \rightarrow \pi N$

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

<u>VALUE (GeV<sup>-1/2</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.053 ± 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 ± 0.141	DEVENISH	74	DPWA $\gamma N \rightarrow \pi N$

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

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

<u>VALUE (units 10<sup>-3</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
2.29 <sup>+0.7</sup> <sub>-0.2</sub>	MART	00	DPWA $\gamma p \rightarrow \Lambda K^+$
5.5 ± 0.3	WORKMAN	90	DPWA
4.09	TANABE	89	DPWA

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

<u>VALUE (degrees)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
-48 ± 5	WORKMAN	90	DPWA
-35.9	TANABE	89	DPWA

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

<u>VALUE (units 10<sup>-3</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
-6.7 ± 0.2	WORKMAN	90	DPWA
-4.09	TANABE	89	DPWA

## N(2080) FOOTNOTES

- <sup>1</sup> CUTKOSKY 80 finds a lower mass  $D_{13}$  resonance, as well as one in this region. Both are listed here.
- <sup>2</sup> 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.

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## 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 <i>et al.</i>	(BOSK, UCLA)
Also	98	PR C57 1004 (erratum)	M. Batinic <i>et al.</i>	
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KENT) IJP
Also	84	PR D30 904	D.M. Manley <i>et al.</i>	(VPI)
ARNDT	91	PR D43 2131	R.A. Arndt <i>et al.</i>	(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 <i>et al.</i>	(RL) IJP
PDG	82	PL 111B	M. Roos <i>et al.</i>	(HELS, CIT, CERN)
AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)
Also	82	NP B197 365	K. Fujii <i>et al.</i>	(NAGO)
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
Also	79	PR D20 2839	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
SAXON	80	NP B162 522	D.H. Saxon <i>et al.</i>	(RHEL, BRIS) IJP
BAKER	79	NP B156 93	R.D. Baker <i>et al.</i>	(RHEL) IJP
HOEHLER	79	PDAT 12-1	G. Hohler <i>et al.</i>	(KARLT) IJP
Also	80	Toronto Conf. 3	R. Koch	(KARLT) IJP
WINNIK	77	NP B128 66	M. Winnik <i>et al.</i>	(HAIF) I
DEANS	75	NP B96 90	S.R. Deans <i>et al.</i>	(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 <i>et al.</i>	(CMU, ORNL, SFLA) IJP

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