$N(1720)\ P_{13}$

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

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(1720) BREIT-WIGNER MASS

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1650 to 1750 (≈ 1720) OUR ESTIMATE				
1717±31	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
1700±50	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1710±20	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1705±10	PENNER	02C	DPWA	Multichannel
1716±112	VRANA	00	DPWA	Multichannel
1713±10	ARNDT	96	IPWA	$\gamma N \to \pi N$
1820	ARNDT	95	DPWA	$\pi N \to N\pi$
1711±26	BATINIC	95	DPWA	$\pi N \to N\pi$, $N\eta$
1720	LI	93	IPWA	$\gamma N \to \pi N$
1785	CRAWFORD	80	DPWA	$\gamma N \to \pi N$
1690	SAXON	80	DPWA	$\pi^- p \to \Lambda K^0$
1710 to 1790	BAKER	78	DPWA	$\pi^- p \to \Lambda K^0$
1809	BARBOUR	78	DPWA	$\gamma N \to \pi N$
1640±10	[1] BAKER	77	IPWA	$\pi^- p \to \Lambda K^0$
1710	[1] BAKER	77	DPWA	$\pi^- p \to \Lambda K^0$
1750	[2] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
1850	KNASEL	75	DPWA	$\pi^- p \to \Lambda K^0$
1720	[3] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

N(1720) BREIT-WIGNER WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
100 to 200 (≈ 150) OUR ESTIMATE				
380±180	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
125±70	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
190±30	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
237±73	PENNER	02C	DPWA	Multichannel
121±39	VRANA	00	DPWA	Multichannel
153±15	ARNDT	96	IPWA	$\gamma N \to \pi N$
354	ARNDT	95	DPWA	$\pi N \to N\pi$
235±51	BATINIC	95	DPWA	$\pi N \to N\pi$, $N\eta$
200	LI	93	IPWA	$\gamma N \to \pi N$
308	CRAWFORD	80	DPWA	$\gamma N \to \pi N$
120	SAXON	80	DPWA	$\pi^- p \to \Lambda K^0$

447	BAKER	79	DPWA	$\pi^- p \to n\eta$
300 to 400	BAKER	78	DPWA	$\pi^- p \to \Lambda K^0$
285	BARBOUR	78	DPWA	$\gamma N \to \pi N$
200± 50	[1] BAKER	77	IPWA	$\pi^- p \to \Lambda K^0$
500	[1] BAKER	77	DPWA	$\pi^- p \to \Lambda K^0$
130	[2] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
327	KNASEL	75	DPWA	$\pi^- p \to \Lambda K^0$
150	[3] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

N(1720) POLE POSITION

REAL PART

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1650 to 1750 (≈ 1700) OUR ESTIMATE				
1717	ARNDT	95	DPWA	$\pi N \to N\pi$
1686	[4] HOEHLER	93	SPED	$\pi N \to \pi N$
1680±30	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1692	VRANA	00	DPWA	Multichannel
1675	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90
1716 or 1716	[5] LONGACRE	78	IPWA	$\pi N \to N\pi\pi$
1745 or 1748	[2] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

−2×IMAGINARY PART

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
110 to 390 (≈ 250) OUR ESTIMATE				
388	ARNDT	95	DPWA	$\pi N \to N\pi$
187	[4] HOEHLER	93	SPED	$\pi N \to \pi N$
120±40	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
94	VRANA	00	DPWA	Multichannel
114	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90
124 or 126	[5] LONGACRE	78	IPWA	$\pi N \to N\pi\pi$
135 or 123	[2] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

N(1720) ELASTIC POLE RESIDUE

MODULUS $|r|$

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
39	ARNDT	95	DPWA	$\pi N \to N\pi$
15	HOEHLER	93	SPED	$\pi N \to \pi N$
8±2	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
11	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90

PHASE θ

VALUE (°)	DOCUMENT ID		TECN	COMMENT
− 70	ARNDT	95	DPWA	$\pi N \to N\pi$
−160±30	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−130	ARNDT	91	DPWA	$\pi N \to \pi N$ Soln SM90

N(1720) DECAY MODES

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	10–20 %
Γ_2	$N\eta$	(4.0±1.0) %
Γ_3	ΛK	1–15 %
Γ_4	ΣK	
Γ_5	$N\pi\pi$	>70 %
Γ_6	$\Delta\pi$	
Γ_7	$\Delta(1232)\pi$, P-wave	
Γ_8	$N\rho$	70–85 %
Γ_9	$N\rho$, S=1/2, P-wave	
Γ_{10}	$N\rho$, S=3/2, P-wave	
Γ_{11}	$N(\pi\pi)^{I=0}_{S\text{-wave}}$	
Γ_{12}	$p\gamma$	0.003–0.10 %
Γ_{13}	$p\gamma$, helicity=1/2	0.003–0.08 %
Γ_{14}	$p\gamma$, helicity=3/2	0.001–0.03 %
Γ_{15}	$n\gamma$	0.002–0.39 %
Γ_{16}	$n\gamma$, helicity=1/2	0.0–0.002 %
Γ_{17}	$n\gamma$, helicity=3/2	0.001–0.39 %

N(1720) BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{total}$ Γ_1/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.10 to 0.20 OUR ESTIMATE				
0.13±0.05	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
0.10±0.04	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
0.14±0.03	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.17±0.02	PENNER	02C	DPWA	Multichannel
0.05±0.05	VRANA	00	DPWA	Multichannel
0.16	ARNDT	95	DPWA	$\pi N \to N\pi$
0.18±0.04	BATINIC	95	DPWA	$\pi N \to N\pi$, $N\eta$

$\Gamma(N\eta)/\Gamma_{total}$ — Γ_2/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.04 ±0.01	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.002±0.002	PENNER	02C	DPWA	Multichannel
0.002±0.01	BATINIC	95	DPWA	$\pi N \to N\pi$, $N\eta$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1720) \to N\eta$ — $(\Gamma_1\Gamma_2)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.08	BAKER	79	DPWA	$\pi^- p \to n\eta$

$\Gamma(\Lambda K)/\Gamma_{total}$ — Γ_3/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.09 ±0.03	PENNER	02C	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1720) \to \Lambda K$ — $(\Gamma_1\Gamma_3)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
−0.14 to −0.06 OUR ESTIMATE				
−0.09	BELL	83	DPWA	$\pi^- p \to \Lambda K^0$
−0.11	SAXON	80	DPWA	$\pi^- p \to \Lambda K^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.09	[6] BAKER	78	DPWA	See SAXON 80
−0.06±0.02	[1] BAKER	77	IPWA	$\pi^- p \to \Lambda K^0$
−0.09	[1] BAKER	77	DPWA	$\pi^- p \to \Lambda K^0$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1720) \to \Sigma K$ — $(\Gamma_1\Gamma_4)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.051 to 0.087	[7] DEANS	75	DPWA	$\pi N \to \Sigma K$

Note: Signs of couplings from $\pi N \to N\pi\pi$ analyses were changed in the 1986 edition to agree with the baryon-first convention; the overall phase ambiguity is resolved by choosing a negative sign for the $\Delta(1620)$ S_{31} coupling to $\Delta(1232)\pi$.

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1720) \to \Delta(1232)\pi$, *P*-wave — $(\Gamma_1\Gamma_7)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
±0.27 to ±0.37 OUR ESTIMATE				
−0.17	[2] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to N(1720) \to N\rho$, S=1/2, *P*-wave — $(\Gamma_1\Gamma_9)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
+0.34±0.05	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$
−0.26	[2] LONGACRE	77	IPWA	$\pi N \to N\pi\pi$
+0.40	[3] LONGACRE	75	IPWA	$\pi N \to N\pi\pi$

$\Gamma(N\rho, S{=}1/2, P\text{-wave})/\Gamma_{total}$ — Γ_9/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.91±0.01	VRANA	00	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \rightarrow N(1720) \rightarrow N\rho$, $S{=}3/2$, P-wave — $(\Gamma_1\Gamma_{10})^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
+0.15	[2] LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \rightarrow N(1720) \rightarrow N(\pi\pi)^{I=0}_{S\text{-wave}}$ — $(\Gamma_1\Gamma_{11})^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
−0.19	[2] LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$

N(1720) PHOTON DECAY AMPLITUDES

$N(1720) \rightarrow p\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
+0.018±0.030 OUR ESTIMATE				
−0.015±0.015	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
0.044±0.066	CRAWFORD	83	IPWA	$\gamma N \rightarrow \pi N$
−0.004±0.007	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
0.051±0.009	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 1)
0.071±0.010	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 2)
0.038±0.050	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.053	PENNER	02D	DPWA	Multichannel
0.012±0.003	LI	93	IPWA	$\gamma N \rightarrow \pi N$
+0.111±0.047	BARBOUR	78	DPWA	$\gamma N \rightarrow \pi N$

$N(1720) \rightarrow p\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.019±0.020 OUR ESTIMATE				
0.007±0.010	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
−0.024±0.006	CRAWFORD	83	IPWA	$\gamma N \rightarrow \pi N$
−0.040±0.016	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
−0.058±0.010	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 1)
−0.011±0.011	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 2)
−0.014±0.040	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.027	PENNER	02D	DPWA	Multichannel
−0.022±0.003	LI	93	IPWA	$\gamma N \rightarrow \pi N$
−0.063±0.032	BARBOUR	78	DPWA	$\gamma N \rightarrow \pi N$

$N(1720) \rightarrow n\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
+0.001±0.015 OUR ESTIMATE				
0.007±0.015	ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
0.002±0.005	AWAJI	81	DPWA	$\gamma N \rightarrow \pi N$
−0.019±0.033	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 1)
0.001±0.038	ARAI	80	DPWA	$\gamma N \rightarrow \pi N$ (fit 2)
−0.003±0.034	CRAWFORD	80	DPWA	$\gamma N \rightarrow \pi N$

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

−0.004	PENNER	02D	DPWA	Multichannel
0.050±0.004	LI	93	IPWA	$\gamma N \to \pi N$
+0.007±0.020	BARBOUR	78	DPWA	$\gamma N \to \pi N$

$N(1720) \to n\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.029±0.061 OUR ESTIMATE				
−0.005±0.025	ARNDT	96	IPWA	$\gamma N \to \pi N$
−0.015±0.019	AWAJI	81	DPWA	$\gamma N \to \pi N$
−0.139±0.039	ARAI	80	DPWA	$\gamma N \to \pi N$ (fit 1)
−0.134±0.044	ARAI	80	DPWA	$\gamma N \to \pi N$ (fit 2)
0.018±0.028	CRAWFORD	80	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.003	PENNER	02D	DPWA	Multichannel
−0.017±0.004	LI	93	IPWA	$\gamma N \to \pi N$
+0.051±0.051	BARBOUR	78	DPWA	$\gamma N \to \pi N$

$N(1720)$ $\gamma p \to \Lambda K^+$ AMPLITUDES

$(\Gamma_i \Gamma_f)^{1/2}/\Gamma_{total}$ in $p\gamma \to N(1720) \to \Lambda K^+$ (E_{1+} amplitude)

VALUE (units 10^{-3})	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •			
10.2 ±0.2	WORKMAN	90	DPWA
9.52	TANABE	89	DPWA

$p\gamma \to N(1720) \to \Lambda K^+$ phase angle θ (E_{1+} amplitude)

VALUE (degrees)	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •			
−124 ±2	WORKMAN	90	DPWA
−103.4	TANABE	89	DPWA

$(\Gamma_i \Gamma_f)^{1/2}/\Gamma_{total}$ in $p\gamma \to N(1720) \to \Lambda K^+$ (M_{1+} amplitude)

VALUE (units 10^{-3})	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •			
−4.5 ±0.2	WORKMAN	90	DPWA
3.18	TANABE	89	DPWA

$N(1720)$ FOOTNOTES

[1] The two BAKER 77 entries are from an IPWA using the Barrelet-zero method and from a conventional energy-dependent analysis.

[2] LONGACRE 77 pole positions are from a search for poles in the unitarized T-matrix; the first (second) value uses, in addition to $\pi N \to N\pi\pi$ data, elastic amplitudes from a Saclay (CERN) partial-wave analysis. The other LONGACRE 77 values are from eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.

[3] From method II of LONGACRE 75: eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.

[4] See HOEHLER 93 for a detailed discussion of the evidence for and the pole parameters of N and Δ resonances as determined from Argand diagrams of πN elastic partial-wave amplitudes and from plots of the speeds with which the amplitudes traverse the diagrams.

[5] LONGACRE 78 values are from a search for poles in the unitarized T-matrix. The first (second) value uses, in addition to $\pi N \to N\pi\pi$ data, elastic amplitudes from a Saclay (CERN) partial-wave analysis.

[6] The overall phase of BAKER 78 copulings has been changed to agree with previous conventions.

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

N(1720) 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)	
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman,, T.-S.H. Lee	(PITT+)	
ARNDT	96	PR C53 430	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI)	
ARNDT	95	PR C52 2120	R.A. Arndt *et al.*	(VPI, BRCO)	
BATINIC	95	PR C51 2310	M. Batinic *et al.*	(BOSK, UCLA)	
Also	98	PR C57 1004 (erratum)	M. Batinic *et al.*		
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)	
LI	93	PR C47 2759	Z.J. Li *et al.*	(VPI)	
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
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)	
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)	
ARAI	80	Toronto Conf. 93	I. Arai	(INUS)	
Also	82	NP B194 251	I. Arai, H. Fujii	(INUS)	
CRAWFORD	80	Toronto Conf. 107	R.L. Crawford	(GLAS)	
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
BAKER	78	NP B141 29	R.D. Baker *et al.*	(RL, CAVE)	IJP
BARBOUR	78	NP B141 253	I.M. Barbour, R.L. Crawford, N.H. Parsons	(GLAS)	
LONGACRE	78	PR D17 1795	R.S. Longacre *et al.*	(LBL, SLAC)	
BAKER	77	NP B126 365	R.D. Baker *et al.*	(RHEL)	IJP
LONGACRE	77	NP B122 493	R.S. Longacre, J. Dolbeau	(SACL)	IJP
Also	76	NP B108 365	J. Dolbeau *et al.*	(SACL)	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
KNASEL	75	PR D11 1	T.M. Knasel *et al.*	(CHIC, WUSL, OSU+)	IJP
LONGACRE	75	PL 55B 415	R.S. Longacre *et al.*	(LBL, SLAC)	IJP