$\Lambda(1520)$ D_{03}

$I(J^P) = 0(\frac{3}{2}^-)$ Status: ****

Discovered by FERRO-LUZZI 62; the elaboration in WATSON 63 is the classic paper on the Breit-Wigner analysis of a multichannel resonance.

The measurements of the mass, width, and elasticity published before 1975 are now obsolete and have been omitted. They were last listed in our 1982 edition Physics Letters **111B** (1982).

Production and formation experiments agree quite well, so they are listed together here.

$\Lambda(1520)$ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1519.5 ±1.0 OUR ESTIMATE					
1519.50±0.18 OUR AVERAGE					
1517.3 ±1.5	300	BARBER	80D	SPEC	$\gamma p \rightarrow \Lambda(1520) K^+$
1519 ±1		GOPAL	80	DPWA	$\overline{K} N \rightarrow \overline{K} N$
1517.8 ±1.2	5k	BARLAG	79	HBC	$K^- p$ 4.2 GeV/c
1520.0 ±0.5		ALSTON-...	78	DPWA	$\overline{K} N \rightarrow \overline{K} N$
1519.7 ±0.3	4k	CAMERON	77	HBC	$K^- p$ 0.96–1.36 GeV/c
1519 ±1		GOPAL	77	DPWA	$\overline{K} N$ multichannel
1519.4 ±0.3	2000	CORDEN	75	DBC	$K^- d$ 1.4–1.8 GeV/c

$\Lambda(1520)$ WIDTH

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
15.6 ±1.0 OUR ESTIMATE					
15.59±0.27 OUR AVERAGE					
16.3 ±3.3	300	BARBER	80D	SPEC	$\gamma p \rightarrow \Lambda(1520) K^+$
16 ±1		GOPAL	80	DPWA	$\overline{K} N \rightarrow \overline{K} N$
14 ±3	677	[1] BARLAG	79	HBC	$K^- p$ 4.2 GeV/c
15.4 ±0.5		ALSTON-...	78	DPWA	$\overline{K} N \rightarrow \overline{K} N$
16.3 ±0.5	4k	CAMERON	77	HBC	$K^- p$ 0.96–1.36 GeV/c
15.0 ±0.5		GOPAL	77	DPWA	$\overline{K} N$ multichannel
15.5 ±1.6	2000	CORDEN	75	DBC	$K^- d$ 1.4–1.8 GeV/c

$\Lambda(1520)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\overline{K}$	45 ± 1%
Γ_2	$\Sigma\pi$	42 ± 1%
Γ_3	$\Lambda\pi\pi$	10 ± 1%
Γ_4	$\Sigma(1385)\pi$	

Γ_5	$\Sigma(1385)\pi(\rightarrow \Lambda\pi\pi)$	
Γ_6	$\Lambda(\pi\pi)_{S\text{-wave}}$	
Γ_7	$\Sigma\pi\pi$	$0.9 \pm 0.1\%$
Γ_8	$\Lambda\gamma$	$0.8 \pm 0.2\%$
Γ_9	$\Sigma^0\gamma$	

CONSTRAINED FIT INFORMATION

An overall fit to 9 branching ratios uses 24 measurements and one constraint to determine 6 parameters. The overall fit has a $\chi^2 = 16.5$ for 19 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients $\langle \delta x_i \delta x_j \rangle / (\delta x_i \cdot \delta x_j)$, in percent, from the fit to the branching fractions, $x_i \equiv \Gamma_i/\Gamma_{\text{total}}$. The fit constrains the x_i whose labels appear in this array to sum to one.

x_2	−63				
x_3	−32	−33			
x_7	−4	−3	−1		
x_8	−9	−8	−4	0	
x_9	−24	−21	−10	−1	−2
	x_1	x_2	x_3	x_7	x_8

$\Lambda(1520)$ BRANCHING RATIOS

See "Sign conventions for resonance couplings" in the Note on Λ and Σ Resonances.

$\Gamma(N\overline{K})/\Gamma_{\text{total}}$ Γ_1/Γ

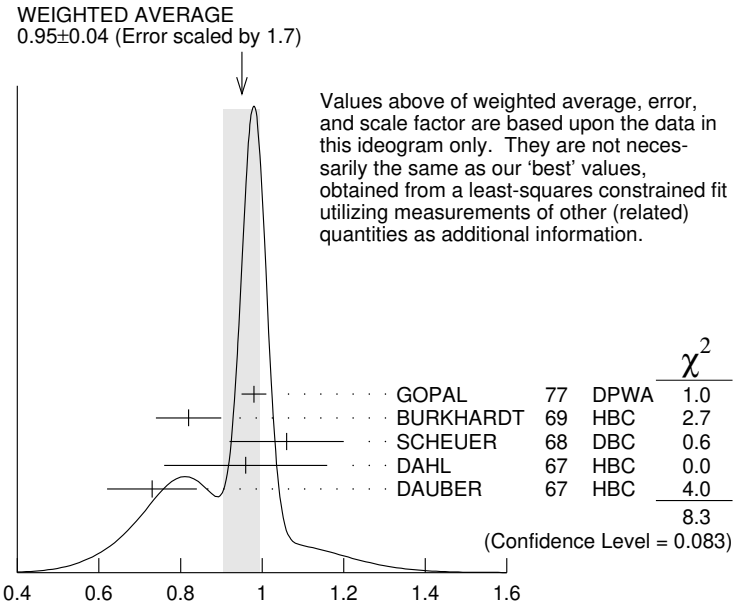
VALUE	DOCUMENT ID		TECN	COMMENT
0.45 ±0.01 OUR ESTIMATE				
0.448±0.007 OUR FIT Error includes scale factor of 1.2.				
0.455±0.011 OUR AVERAGE				
0.47 ±0.02	GOPAL	80	DPWA	$\overline{K}N \rightarrow \overline{K}N$
0.45 ±0.03	ALSTON-...	78	DPWA	$\overline{K}N \rightarrow \overline{K}N$
0.448±0.014	CORDEN	75	DBC	K^-d 1.4–1.8 GeV/c
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.47 ±0.01	GOPAL	77	DPWA	See GOPAL 80
0.42	MAST	76	HBC	$K^-p \rightarrow \overline{K}^0 n$

$\Gamma(\Sigma\pi)/\Gamma_{\text{total}}$ Γ_2/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.42 ±0.01 OUR ESTIMATE				
0.421±0.007 OUR FIT Error includes scale factor of 1.2.				
0.423±0.011 OUR AVERAGE				
0.426±0.014	CORDEN	75	DBC	K^-d 1.4–1.8 GeV/c
0.418±0.017	BARBARO-...	69B	HBC	K^-p 0.28–0.45 GeV/c
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.46	KIM	71	DPWA	K-matrix analysis

$\Gamma(\Sigma\pi)/\Gamma(N\overline{K})$ Γ_2/Γ_1

VALUE	DOCUMENT ID		TECN	COMMENT
0.940±0.026 OUR FIT Error includes scale factor of 1.3.				
0.95 ±0.04 OUR AVERAGE Error includes scale factor of 1.7. See the ideogram below.				
0.98 ±0.03	[2] GOPAL	77	DPWA	$\overline{K}N$ multichannel
0.82 ±0.08	BURKHARDT	69	HBC	K^-p 0.8–1.2 GeV/c
1.06 ±0.14	SCHEUER	68	DBC	K^-N 3 GeV/c
0.96 ±0.20	DAHL	67	HBC	π^-p 1.6–4 GeV/c
0.73 ±0.11	DAUBER	67	HBC	K^-p 2 GeV/c
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.06 ±0.12	BERTHON	74	HBC	Quasi-2-body σ
1.72 ±0.78	MUSGRAVE	65	HBC	



$\Gamma(\Sigma\pi)/\Gamma(N\overline{K})$

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.10 ±0.01 OUR ESTIMATE				
0.095±0.005 OUR FIT Error includes scale factor of 1.2.				
0.096±0.008 OUR AVERAGE Error includes scale factor of 1.6.				
0.091±0.006	CORDEN	75	DBC	K^-d 1.4–1.8 GeV/c
0.11 ±0.01	[3] MAST	73B	IPWA	$K^-p \rightarrow \Lambda\pi\pi$

$\Gamma(\Lambda\pi\pi)/\Gamma(N\overline{K})$ Γ_3/Γ_1

VALUE	DOCUMENT ID		TECN	COMMENT
0.213±0.012 OUR FIT Error includes scale factor of 1.2.				
0.202±0.021 OUR AVERAGE				
0.22 ±0.03	BURKHARDT	69	HBC	K^-p 0.8–1.2 GeV/c
0.19 ±0.04	SCHEUER	68	DBC	K^-N 3 GeV/c
0.17 ±0.05	DAHL	67	HBC	π^-p 1.6–4 GeV/c
0.21 ±0.18	DAUBER	67	HBC	K^-p 2 GeV/c
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.27 ±0.13	BERTHON	74	HBC	Quasi-2-body σ
0.2	KIM	71	DPWA	K-matrix analysis

$\Gamma(\Sigma\pi)/\Gamma(\Lambda\pi\pi)$ Γ_2/Γ_3

VALUE	DOCUMENT ID		TECN	COMMENT
4.42±0.25 OUR FIT Error includes scale factor of 1.2.				
3.9 ±0.6 OUR AVERAGE				
3.9 ±1.0	UHLIG	67	HBC	K^-p 0.9–1.0 GeV/c
3.3 ±1.1	BIRMINGHAM	66	HBC	K^-p 3.5 GeV/c
4.5 ±1.0	ARMENTEROS	65C	HBC	

$\Gamma(\Sigma(1385)\pi)/\Gamma_{total}$ Γ_4/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.041±0.005	CHAN	72	HBC	$K^-p \rightarrow \Lambda\pi\pi$

$\Gamma(\Sigma(1385)\pi(\rightarrow\Lambda\pi\pi))/\Gamma(\Lambda\pi\pi)$ Γ_5/Γ_3

The $\Lambda\pi\pi$ mode is largely due to $\Sigma(1385)\pi$. Only the values of $(\Sigma(1385)\pi)$ / $(\Lambda 2\pi)$ given by MAST 73B and CORDEN 75 are based on real 3-body partial-wave analyses. The discrepancy between the two results is essentially due to the different hypotheses made concerning the shape of the $(\pi\pi)_{S\text{-wave}}$ state.

VALUE	DOCUMENT ID		TECN	COMMENT
0.58±0.22	CORDEN	75	DBC	K^-d 1.4–1.8 GeV/c
0.82±0.10	[4] MAST	73B	IPWA	$K^-p \rightarrow \Lambda\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.39±0.10	[5] BURKHARDT	71	HBC	$K^-p \rightarrow (\Lambda\pi\pi)\pi$

$\Gamma(\Lambda(\pi\pi)_{S\text{-wave}})/\Gamma(\Lambda\pi\pi)$ Γ_6/Γ_3

VALUE	DOCUMENT ID		TECN	COMMENT
0.20±0.08	CORDEN	75	DBC	K^-d 1.4–1.8 GeV/c

$\Gamma(\Sigma\pi\pi)/\Gamma_{total}$ Γ_7/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.009 ±0.001 OUR ESTIMATE				
0.0086±0.0005 OUR FIT				
0.0086±0.0005 OUR AVERAGE				
0.007 ±0.002	[6] CORDEN	75	DBC	K^-d 1.4–1.8 GeV/c
0.0085±0.0006	[7] MAST	73	MPWA	$K^-p \rightarrow \Sigma\pi\pi$
0.010 ±0.0015	BARBARO-...	69B	HBC	K^-p 0.28–0.45 GeV/c

$\Gamma(\Lambda\gamma)/\Gamma_{total}$ Γ_8/Γ

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
0.008 ±0.002 OUR ESTIMATE				
0.0079±0.0014 OUR FIT				
0.0080±0.0014	238	MAST	68B HBC	Using $\Gamma(N\overline{K})/\Gamma_{total}$ = 0.45

$\Gamma(\Sigma^0\gamma)/\Gamma_{total}$ Γ_9/Γ

VALUE	DOCUMENT ID	TECN	COMMENT
0.0195±0.0034 OUR FIT			
0.02 ±0.0035	[8] MAST	68B HBC	Not measured; see note

$\Lambda(1520)$ FOOTNOTES

[1] From the best-resolution sample of $\Lambda\pi\pi$ events only.
[2] The $\overline{K}N \rightarrow \Sigma\pi$ amplitude at resonance is $+0.46 \pm 0.01$.
[3] Assumes $\Gamma(N\overline{K})/\Gamma_{total} = 0.46 \pm 0.02$.
[4] Both $\Sigma(1385)\pi$ DS_{03} and $\Sigma(\pi\pi)$ DP_{03} contribute.
[5] The central bin (1514–1524 MeV) gives 0.74 ± 0.10; other bins are lower by 2-to-5 standard deviations.
[6] Much of the $\Sigma\pi\pi$ decay proceeds via $\Sigma(1385)\pi$.
[7] Assumes $\Gamma(N\overline{K})/\Gamma_{total} = 0.46$.
[8] Calculated from $\Gamma(\Lambda\gamma)/\Gamma_{total}$, assuming SU(3). Needed to constrain the sum of all the branching ratios to be unity.

$\Lambda(1520)$ REFERENCES

PDG	82	PL 111B	Roos, Porter, Aguilar-Benitez+	(HELS, CIT, CERN)
BARBER	80D	ZPHY C7 17	+Dainton, Lee, Marshall+	(DARE, LANC, SHEF)
GOPAL	80	Toronto Conf. 159		(RHEL) IJP
BARLAG	79	NP B149 220	+Blokzijl, Jongejans+	(AMST, CERN, NIJM, OXF)
ALSTON-...	78	PR D18 182	Alston-Garnjost, Kenney+	(LBL, MTHO, CERN) IJP
Also	77	PRL 38 1007	Alston-Garnjost, Kenney+	(LBL, MTHO, CERN) IJP
CAMERON	77	NP B131 399	+Franek, Gopal, Kalmus, McPherson+	(RHEL, LOIC) IJP
GOPAL	77	NP B119 362	+Ross, VanHorn, McPherson+	(LOIC, RHEL) IJP
MAST	76	PR D14 13	+Alston-Garnjost, Bangerter+	(LBL)
CORDEN	75	NP B84 306	+Cox, Dartnell, Kenyon, O'Neale+	(BIRM)
BERTHON	74	NC 21A 146	+Tristram+	(CDEF, RHEL, SACL, STRB)
MAST	73	PR D7 3212	+Bangerter, Alston-Garnjost+	(LBL) IJP
MAST	73B	PR D7 5	+Bangerter, Alston-Garnjost+	(LBL) IJP
CHAN	72	PRL 28 256	+Button-Shafer, Hertzbach, Kofler+	(MASA, YALE)
BURKHARDT	71	NP B27 64	+Filthuth, Kluge+	(HEID, CERN, SACL)
KIM	71	PRL 27 356		(HARV) IJP
Also	70	Duke Conf. 161	Kim	(HARV) IJP
BARBARO-...	69B	Lund Conf. 352	Barbaro-Galtieri, Bangerter, Mast, Tripp	(LRL)
Also	70	Duke Conf. 95	Tripp	(LRL)
BURKHARDT	69	NP B14 106	+Filthuth, Kluge+	(HEID, EFI, CERN, SACL)
MAST	68B	PRL 21 1715	+Alston-Garnjost, Bangerter, Galtieri+	(LRL)
SCHEUER	68	NP B8 503	+Merrill, Verglas, DeWitt+	(SABRE Collab.)
DAHL	67	PR 163 1377	+Hardy, Hess, Kirz, Miller	(LRL)
DAUBER	67	PL 24B 525	+Malamud, Schlein, Slater, Stork	(UCLA)
UHLIG	67	PR 155 1448	+Charlton, Condon, Glasser, Yodh+	(UMD, NRL)
BIRMINGHAM	66	PR 152 1148		(BIRM, GLAS, LOIC, OXF, RHEL)
ARMENTEROS	65C	PL 19 338	+Ferro-Luzzi+	(CERN, HEID, SACL)
MUSGRAVE	65	NC 35 735	+Petmezas+	(BIRM, CERN, EPOL, LOIC, SACL)
WATSON	63	PR 131 2248	+Ferro-Luzzi, Tripp	(LRL) IJP
FERRO-LUZZI	62	PRL 8 28	+Tripp, Watson	(LRL) IJP