

$\Lambda(1520) D_{03}$

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

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

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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	$\bar{K} N \rightarrow \bar{K} N$
1517.8 ± 1.2	5k	BARLAG	79 HBC	$K^- p$ 4.2 GeV/c
1520.0 ± 0.5		ALSTON-...	78 DPWA	$\bar{K} N \rightarrow \bar{K} N$
1519.7 ± 0.3	4k	CAMERON	77 HBC	$K^- p$ 0.96–1.36 GeV/c
1519 ± 1		GOPAL	77 DPWA	$\bar{K} N$ multichannel
1519.4 ± 0.3	2000	CORDEN	75 DBC	$K^- d$ 1.4–1.8 GeV/c

$\Lambda(1520)$ WIDTH

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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	$\bar{K} N \rightarrow \bar{K} N$
14 ± 3	677	¹ BARLAG	79 HBC	$K^- p$ 4.2 GeV/c
15.4 ± 0.5		ALSTON-...	78 DPWA	$\bar{K} N \rightarrow \bar{K} N$
16.3 ± 0.5	4k	CAMERON	77 HBC	$K^- p$ 0.96–1.36 GeV/c
15.0 ± 0.5		GOPAL	77 DPWA	$\bar{K} N$ 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 $N\bar{K}$	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	$\Lambda\gamma$	$0.85 \pm 0.15\%$
Γ_9	$\Sigma^0\gamma$	

CONSTRAINED FIT INFORMATION

An overall fit to 9 branching ratios uses 25 measurements and one constraint to determine 6 parameters. The overall fit has a $\chi^2 = 17.1$ for 20 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients $\langle \delta x_i \delta x_j \rangle / (\delta x_i \delta x_j)$, 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	-8	-7	-3	0	
x_9	-24	-21	-10	-1	-1
	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.

$\Gamma(N\bar{K})/\Gamma_{\text{total}}$ 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 $\bar{K}N \rightarrow \bar{K}N$
0.45 ± 0.03	ALSTON-...	78	DPWA $\bar{K}N \rightarrow \bar{K}N$
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 $K^- p \rightarrow \bar{K}^0 n$

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

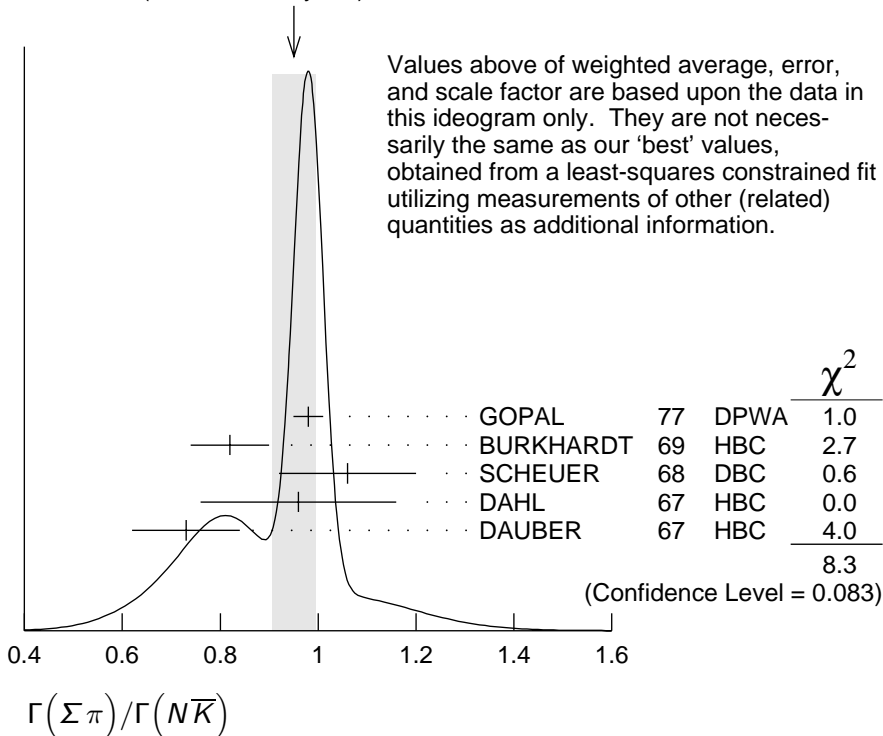
VALUE	DOCUMENT ID	TECN	COMMENT
0.42 ± 0.01 OUR ESTIMATE			
0.421 ± 0.007 OUR FIT			Error includes scale factor of 1.2.
0.423 ± 0.011 OUR AVERAGE			
0.426 ± 0.014	CORDEN	75	DBC $K^- d$ 1.4–1.8 GeV/c
0.418 ± 0.017	BARBARO-...	69B	HBC $K^- p$ 0.28–0.45 GeV/c
• • • We do not use the following data for averages,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

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

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	$\bar{K}N$ multichannel
0.82 ±0.08	BURKHARDT	69 HBC	$K^- p$ 0.8–1.2 GeV/ <i>c</i>
1.06 ±0.14	SCHEUER	68 DBC	$K^- N$ 3 GeV/ <i>c</i>
0.96 ±0.20	DAHL	67 HBC	$\pi^- p$ 1.6–4 GeV/ <i>c</i>
0.73 ±0.11	DAUBER	67 HBC	$K^- p$ 2 GeV/ <i>c</i>
● ● ● 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	

WEIGHTED AVERAGE
0.95±0.04 (Error scaled by 1.7)



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

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/ <i>c</i>
0.11 ±0.01	³ MAST	73B IPWA	$K^- p \rightarrow \Lambda\pi\pi$

$\Gamma(\Lambda\pi\pi)/\Gamma(N\bar{K})$

Γ_3/Γ_1

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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	$\pi^- p$ 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

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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	ARMENTEROS65C	HBC	

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

Γ_4/Γ

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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 $(\Sigma(1385)\pi) / (\Lambda\pi\pi)$ 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.

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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

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

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

Γ_7/Γ

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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

$\Gamma(\Lambda\gamma)/\Gamma_{\text{total}}$					Γ_8/Γ
VALUE (units 10^{-3})	EVTS	DOCUMENT ID	TECN	COMMENT	
8.5±1.5 OUR ESTIMATE					
8.4±1.2 OUR FIT					
8.5±1.2 OUR AVERAGE					

10.2±2.1±1.5	290	ANTIPOV	04A SPNX	$pN(C) \rightarrow \Lambda(1520)K^+N(C)$	
8.0±1.4	238	MAST	68B HBC	Using $\Gamma(N\bar{K})/\Gamma_{\text{total}} = 0.45$	

$\Gamma(\Sigma^0\gamma)/\Gamma_{\text{total}}$					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 $\bar{K}N \rightarrow \Sigma\pi$ amplitude at resonance is $+0.46 \pm 0.01$.
- ³ Assumes $\Gamma(N\bar{K})/\Gamma_{\text{total}} = 0.46 \pm 0.02$.
- 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 $\Gamma(N\bar{K})/\Gamma_{\text{total}} = 0.46$.
- ⁸ Calculated from $\Gamma(\Lambda\gamma)/\Gamma_{\text{total}}$, assuming SU(3). Needed to constrain the sum of all the branching ratios to be unity.

$\Lambda(1520)$ REFERENCES

ANTIPOV	04A	PL B604 22	Yu.M. Antipov <i>et al.</i>	(IHEP SPHINX Collab.)
PDG	82	PL 111B	M. Roos <i>et al.</i>	(HEL5, CIT, CERN)
BARBER	80D	ZPHY C7 17	D.P. Barber <i>et al.</i>	(DARE, LANC, SHEF)
GOPAL	80	Toronto Conf. 159	G.P. Gopal	(RHEL) IJP
BARLAG	79	NP B149 220	S.J.M. Barlag <i>et al.</i>	(AMST, CERN, NIJM+)
ALSTON-...	78	PR D18 182	M. Alston-Garnjost <i>et al.</i>	(LBL, MTHO+) IJP
Also	77	PRL 38 1007	M. Alston-Garnjost <i>et al.</i>	(LBL, MTHO+) IJP
CAMERON	77	NP B131 399	W. Cameron <i>et al.</i>	(RHEL, LOIC) IJP
GOPAL	77	NP B119 362	G.P. Gopal <i>et al.</i>	(LOIC, RHEL) IJP
MAST	76	PR D14 13	T.S. Mast <i>et al.</i>	(LBL)
CORDEN	75	NP B84 306	M.J. Corden <i>et al.</i>	(BIRM)
BERTHON	74	NC 21A 146	A. Berthon <i>et al.</i>	(CDEF, RHEL, SACL+)
MAST	73	PR D7 3212	T.S. Mast <i>et al.</i>	(LBL) IJP
MAST	73B	PR D7 5	T.S. Mast <i>et al.</i>	(LBL) IJP
CHAN	72	PRL 28 256	S.B. Chan <i>et al.</i>	(MASA, YALE)
BURKHARDT	71	NP B27 64	E. Burkhardt <i>et al.</i>	(HEID, CERN, SACL)
KIM	71	PRL 27 356	J.K. Kim	(HARV) IJP
Also	70	Duke Conf. 161	J.K. Kim	(HARV) IJP
Hyperon Resonances, 1970				
BARBARO-...	69B	Lund Conf. 352	A. Barbaro-Galtieri <i>et al.</i>	(LRL)
Also	70	Duke Conf. 95	R.D. Tripp	(LRL)
Hyperon Resonances 1970				
BURKHARDT	69	NP B14 106	E. Burkhardt <i>et al.</i>	(HEID, EFI, CERN+)
MAST	68B	PRL 21 1715	T.S. Mast <i>et al.</i>	(LRL)
SCHUEER	68	NP B8 503	J.C. Scheuer <i>et al.</i>	(SABRE Collab.)
DAHL	67	PR 163 1377	O.I. Dahl <i>et al.</i>	(LRL)
DAUBER	67	PL 24B 525	P.M. Dauber <i>et al.</i>	(UCLA)
UHLIG	67	PR 155 1448	R.P. Uhlig <i>et al.</i>	(UMD, NRL)
BIRMINGHAM	66	PR 152 1148	M. Haque <i>et al.</i>	(BIRM, GLAS, LOIC, OXF+)
ARMENTEROS	65C	PL 19 338	R. Armenteros <i>et al.</i>	(CERN, HEID, SACL)
MUSGRAVE	65	NC 35 735	B. Musgrave <i>et al.</i>	(BIRM, CERN, EPOL+)
WATSON	63	PR 131 2248	M.B. Watson, M. Ferro-Luzzi, R.D. Tripp	(LRL) IJP
FERRO-LUZZI	62	PRL 8 28	M. Ferro-Luzzi, R.D. Tripp, M.B. Watson	(LRL) IJP