

$\Lambda(1520) \ 3/2^-$  $I(J^P) = 0(\frac{3}{2}^-)$  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** 1 (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>
<b>1519.5 ± 1.0</b>				<b>OUR ESTIMATE</b>
<b>1519.54 ± 0.17</b>				<b>OUR AVERAGE</b>
1519.6 ± 0.5		ZHANG	13A	DPWA Multichannel
1520.4 ± 0.6 ± 1.5		QIANG	10	SPEC $e p \rightarrow e' K^+ X$ (fit to X)
1517.3 ± 1.5	300	BARBER	80D	SPEC $\gamma p \rightarrow \Lambda(1520) K^+$
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>
<b>15.6 ± 1.0</b>				<b>OUR ESTIMATE</b>
<b>15.73 ± 0.29</b>				<b>OUR AVERAGE</b> Error includes scale factor of 1.1.
17 ± 1		ZHANG	13A	DPWA Multichannel
18.6 ± 1.9 ± 1.0		QIANG	10	SPEC $e p \rightarrow e' K^+ X$ (fit to X)
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	<sup>1</sup> 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

<sup>1</sup> From the best-resolution sample of  $\Lambda\pi\pi$  events only.

**$\Lambda(1520)$  POLE POSITION****REAL PART**

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1518	ZHANG	13A	DPWA Multichannel
1518.8	QIANG	10	SPEC $ep \rightarrow e'K^+X$ (fit to X)

**-2×IMAGINARY PART**

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
16	ZHANG	13A	DPWA Multichannel
17.2	QIANG	10	SPEC $ep \rightarrow e'K^+X$ (fit to X)

 **$\Lambda(1520)$  DECAY MODES**

Mode	Fraction ( $\Gamma_i/\Gamma$ )
$\Gamma_1$ $N\bar{K}$	(45 ±1 ) %
$\Gamma_2$ $\Sigma\pi$	(42 ±1 ) %
$\Gamma_3$ $\Lambda\pi\pi$	(10 ±1 ) %
$\Gamma_4$ $\Sigma(1385)\pi$	
$\Gamma_5$ $\Sigma(1385)\pi(\rightarrow \Lambda\pi\pi)$	
$\Gamma_6$ $\Lambda(\pi\pi)S\text{-wave}$	
$\Gamma_7$ $\Sigma\pi\pi$	( 0.9 ±0.1 ) %
$\Gamma_8$ $\Lambda\gamma$	( 0.85±0.15 ) %
$\Gamma_9$ $\Sigma^0\gamma$	

**CONSTRAINED FIT INFORMATION**

An overall fit to 9 branching ratios uses 28 measurements and one constraint to determine 6 parameters. The overall fit has a  $\chi^2 = 18.9$  for 23 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	-34			
$x_7$	-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  $\Lambda$  and  $\Sigma$  Resonances.

 **$\Gamma(N\bar{K})/\Gamma_{\text{total}}$   $\Gamma_1/\Gamma$** 

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.45 ± 0.01 OUR ESTIMATE</b>			
<b>0.448 ± 0.007 OUR FIT</b>			Error includes scale factor of 1.2.
<b>0.456 ± 0.010 OUR AVERAGE</b>			
0.47 ± 0.04	ZHANG	13A	DPWA Multichannel
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 $K^- p \rightarrow \bar{K}^0 n$

 **$\Gamma(\Sigma\pi)/\Gamma_{\text{total}}$   $\Gamma_2/\Gamma$** 

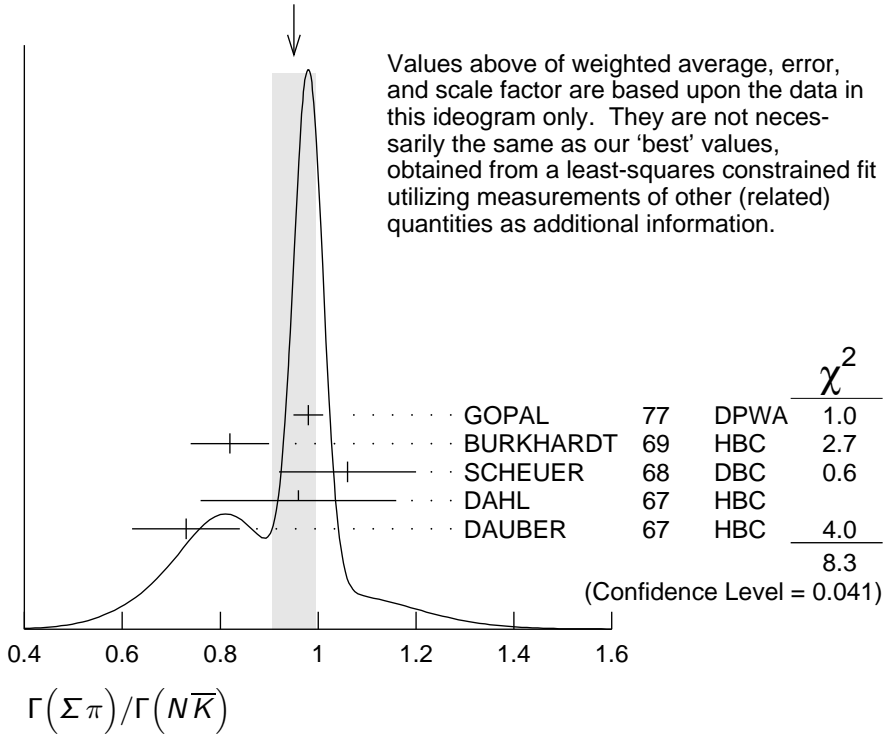
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.42 ± 0.01 OUR ESTIMATE</b>			
<b>0.421 ± 0.007 OUR FIT</b>			Error includes scale factor of 1.2.
<b>0.425 ± 0.011 OUR AVERAGE</b>			
0.47 ± 0.05	ZHANG	13A	DPWA Multichannel
0.426 ± 0.014	CORDEN	75	DBC $K^- d$ 1.4–1.8 GeV/c
0.418 ± 0.017	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

 **$\Gamma(\Sigma\pi)/\Gamma(N\bar{K})$   $\Gamma_2/\Gamma_1$** 

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.940 ± 0.026 OUR FIT</b>			Error includes scale factor of 1.3.
<b>0.95 ± 0.04 OUR AVERAGE</b>			Error includes scale factor of 1.7. See the ideogram below.
0.98 ± 0.03	<sup>2</sup> GOPAL	77	DPWA $\bar{K}N$ 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 $\pi^- p$ 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 $\sigma$
1.72 ± 0.78	MUSGRAVE	65	HBC

<sup>2</sup> The  $\bar{K}N \rightarrow \Sigma\pi$  amplitude at resonance is  $+0.46 \pm 0.01$ .

WEIGHTED AVERAGE  
 $0.95 \pm 0.04$  (Error scaled by 1.7)



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

$\Gamma_3/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
<b>0.10 ± 0.01 OUR ESTIMATE</b>			
<b>0.095 ± 0.005 OUR FIT</b>			Error includes scale factor of 1.2.
<b>0.096 ± 0.008 OUR AVERAGE</b>			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	<sup>3</sup> MAST	73B	IPWA $K^- p \rightarrow \Lambda\pi\pi$
<sup>3</sup> Assumes $\Gamma(N\bar{K})/\Gamma_{\text{total}} = 0.46 \pm 0.02$ .			

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

$\Gamma_3/\Gamma_1$

VALUE	DOCUMENT ID	TECN	COMMENT
<b>0.212 ± 0.012 OUR FIT</b>			Error includes scale factor of 1.2.
<b>0.202 ± 0.021 OUR AVERAGE</b>			
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 $\sigma$
0.2	KIM	71	DPWA K-matrix analysis

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

$\Gamma_2/\Gamma_3$

VALUE	DOCUMENT ID	TECN	COMMENT
<b>4.43 ± 0.25 OUR FIT</b>			Error includes scale factor of 1.2.
<b>3.9 ± 0.6 OUR AVERAGE</b>			
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

$\Gamma(\Sigma(1385)\pi)/\Gamma_{\text{total}}$   $\Gamma_4/\Gamma$ 

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

 $\Gamma(\Sigma(1385)\pi(\rightarrow\Lambda\pi\pi))/\Gamma(\Lambda\pi\pi)$   $\Gamma_5/\Gamma_3$ 

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>CL%</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		<sup>4</sup> MAST	73B IPWA	$K^- p \rightarrow \Lambda\pi\pi$

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

<0.44	90	WIELAND	11 SPHR	$\gamma p \rightarrow K^+ \Lambda(1520)$
0.39±0.10		<sup>5</sup> BURKHARDT	71 HBC	$K^- p \rightarrow (\Lambda\pi\pi)\pi$

<sup>4</sup> Both  $\Sigma(1385)\pi$   $DS_{03}$  and  $\Sigma(\pi\pi)$   $DP_{03}$  contribute.

<sup>5</sup> The central bin (1514–1524 MeV) gives  $0.74 \pm 0.10$ ; other bins are lower by 2-to-5 standard deviations.

 $\Gamma(\Lambda(\pi\pi)_{S\text{-wave}})/\Gamma(\Lambda\pi\pi)$   $\Gamma_6/\Gamma_3$ 

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

 $\Gamma(\Sigma\pi\pi)/\Gamma_{\text{total}}$   $\Gamma_7/\Gamma$ 

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

<sup>6</sup> Much of the  $\Sigma\pi\pi$  decay proceeds via  $\Sigma(1385)\pi$ .

<sup>7</sup> Assumes  $\Gamma(N\bar{K})/\Gamma_{\text{total}} = 0.46$ .

 $\Gamma(\Lambda\gamma)/\Gamma_{\text{total}}$   $\Gamma_8/\Gamma$ 

<u>VALUE (units <math>10^{-3}</math>)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>8.5±1.5 OUR ESTIMATE</b>				
<b>8.8±1.1 OUR FIT</b>				
<b>8.8±1.1 OUR AVERAGE</b>				
10.7±2.9 <sup>+1.5</sup> <sub>-0.4</sub>	32	TAYLOR	05 CLAS	$\gamma p \rightarrow K^+ \Lambda\gamma$
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 $\Gamma(N\bar{K})/\Gamma_{\text{total}} = 0.45$

 $\Gamma(\Sigma^0\gamma)/\Gamma_{\text{total}}$   $\Gamma_9/\Gamma$ 

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.0193±0.0034 OUR FIT</b>			
<b>0.02 ±0.0035</b>	<sup>8</sup> MAST	68B HBC	Not measured; see note

<sup>8</sup> 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**

ZHANG	13A	PR C88 035205	H. Zhang <i>et al.</i>	(KSU)
WIELAND	11	EPJ A47 47	F. Wieland <i>et al.</i>	(ELSA SAPHIR Collab.)
QIANG	10	PL B694 123	Y. Qiang <i>et al.</i>	(DUKE, JEFF, PNPI, GWU+)
TAYLOR	05	PR C71 054609	S. Taylor <i>et al.</i>	(JLab CLAS Collab.)
Also		PR C72 039902 (errat.)	S. Taylor <i>et al.</i>	(JLab CLAS Collab.)
ANTIPOV	04A	PL B604 22	Yu.M. Antipov <i>et al.</i>	(IHEP SPHINX Collab.)
PDG	82	PL 111B 1	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		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		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		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)
SCHEUER	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