# $\Lambda(1520)$ $D_{03}$

$I(J^P) = 0(\frac{3}{2}^-)$ 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 ($\Gamma_i/\Gamma$) |
|---|---|---|
| $\Gamma_1$ | $N\overline{K}$ | 45 ± 1% |
| $\Gamma_2$ | $\Sigma\pi$ | 42 ± 1% |
| $\Gamma_3$ | $\Lambda\pi\pi$ | 10 ± 1% |
| $\Gamma_4$ | $\Sigma(1385)\pi$ | |

| | | |
|---|---|---|
| $\Gamma_5$ | $\Sigma(1385)\pi(\rightarrow \Lambda\pi\pi)$ | |
| $\Gamma_6$ | $\Lambda(\pi\pi)_{S\text{-wave}}$ | |
| $\Gamma_7$ | $\Sigma\pi\pi$ | $0.9 \pm 0.1\%$ |
| $\Gamma_8$ | $\Lambda\gamma$ | $0.8 \pm 0.2\%$ |
| $\Gamma_9$ | $\Sigma^0\gamma$ | |

## 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 $\Lambda$ and $\Sigma$ Resonances.

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

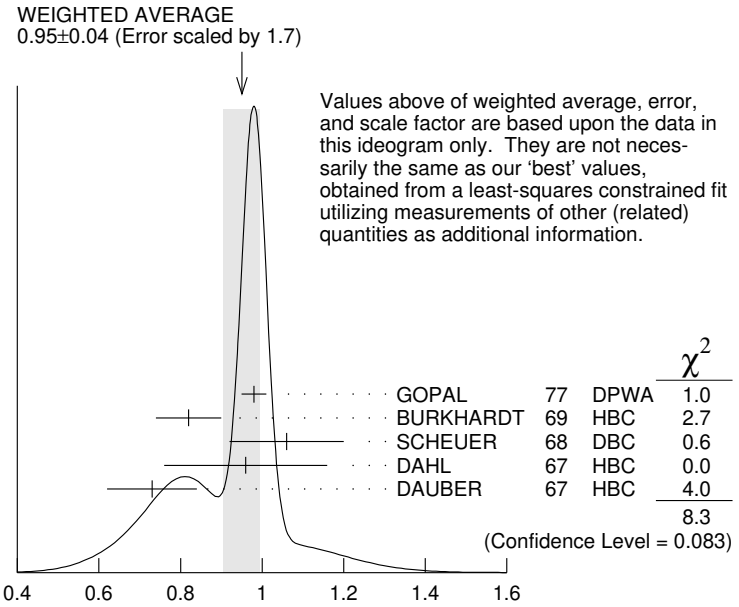
| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **0.45 ±0.01 OUR ESTIMATE** | | | | |
| **0.448±0.007 OUR FIT** Error includes scale factor of 1.2. | | | | |
| **0.455±0.011 OUR AVERAGE** | | | | |
| 0.47 ±0.02 | GOPAL | 80 | DPWA | $\overline{K}N \rightarrow \overline{K}N$ |
| 0.45 ±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 | $K^- p \rightarrow \overline{K}^0 n$ |

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

| 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 |

## $\Gamma(\Sigma\pi)/\Gamma(N\overline{K})$ $\Gamma_2/\Gamma_1$

| 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 | $\pi^-p$ 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 | |




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

## $\Gamma(\Lambda\pi\pi)/\Gamma_{total}$ $\Gamma_3/\Gamma$

| 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 | $K^-p \rightarrow \Lambda\pi\pi$ |

## $\Gamma(\Lambda\pi\pi)/\Gamma(N\overline{K})$ $\Gamma_3/\Gamma_1$

| 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 | $\pi^-p$ 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 |
|---|---|---|---|---|
| **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 | |

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

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

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

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 | $K^-p \rightarrow (\Lambda\pi\pi)\pi$ |

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

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

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

| 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/$c$ |

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

| 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 |

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

| 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 $0.74 \pm 0.10$; 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 | M. Roos *et al.* | (HELS, CIT, CERN) |
| BARBER | 80D | ZPHY C7 17 | D.P. Barber *et al.* | (DARE, LANC, SHEF) |
| GOPAL | 80 | Toronto Conf. 159 | G.P. Gopal | (RHEL) IJP |
| BARLAG | 79 | NP B149 220 | S.J.M. Barlag *et al.* | (AMST, CERN, NIJM+) |
| ALSTON-... | 78 | PR D18 182 | M. Alston-Garnjost *et al.* | (LBL, MTHO+) IJP |
| Also | 77 | PRL 38 1007 | M. Alston-Garnjost *et al.* | (LBL, MTHO+) IJP |
| CAMERON | 77 | NP B131 399 | W. Cameron *et al.* | (RHEL, LOIC) IJP |
| GOPAL | 77 | NP B119 362 | G.P. Gopal *et al.* | (LOIC, RHEL) IJP |
| MAST | 76 | PR D14 13 | T.S. Mast *et al.* | (LBL) |
| CORDEN | 75 | NP B84 306 | M.J. Corden *et al.* | (BIRM) |
| BERTHON | 74 | NC 21A 146 | A. Berthon *et al.* | (CDEF, RHEL, SACL+) |
| MAST | 73 | PR D7 3212 | T.S. Mast *et al.* | (LBL) IJP |
| MAST | 73B | PR D7 5 | T.S. Mast *et al.* | (LBL) IJP |
| CHAN | 72 | PRL 28 256 | S.B. Chan *et al.* | (MASA, YALE) |
| BURKHARDT | 71 | NP B27 64 | E. Burkhardt *et al.* | (HEID, CERN, SACL) |
| KIM | 71 | PRL 27 356 | J.K. Kim | (HARV) IJP |
| Also | 70 | Duke Conf. 161 Hyperon Resonances, 1970 | J.K. Kim | (HARV) IJP |
| BARBARO-... | 69B | Lund Conf. 352 | A. Barbaro-Galtieri *et al.* | (LRL) |
| Also | 70 | Duke Conf. 95 Hyperon Resonances 1970 | R.D. Tripp | (LRL) |
| BURKHARDT | 69 | NP B14 106 | E. Burkhardt *et al.* | (HEID, EFI, CERN+) |
| MAST | 68B | PRL 21 1715 | T.S. Mast *et al.* | (LRL) |
| SCHEUER | 68 | NP B8 503 | J.C. Scheuer *et al.* | (SABRE Collab.) |
| DAHL | 67 | PR 163 1377 | O.I. Dahl *et al.* | (LRL) |
| DAUBER | 67 | PL 24B 525 | P.M. Dauber *et al.* | (UCLA) |
| UHLIG | 67 | PR 155 1448 | R.P. Uhlig *et al.* | (UMD, NRL) |
| BIRMINGHAM | 66 | PR 152 1148 | M. Haque *et al.* | (BIRM, GLAS, LOIC, OXF+) |
| ARMENTEROS | 65C | PL 19 338 | R. Armenteros *et al.* | (CERN, HEID, SACL) |
| MUSGRAVE | 65 | NC 35 735 | B. Musgrave *et al.* | (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 |