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

$I(J^P) = 0(\frac{3}{2}^-)$ 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** 1 (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 | $\gamma p \to \Lambda(1520) K^+$ |
| 1519 ±1 | | GOPAL | 80 | DPWA | $\overline{K}N \to \overline{K}N$ |
| 1517.8 ±1.2 | 5k | BARLAG | 79 | HBC | $K^- p$ 4.2 GeV/$c$ |
| 1520.0 ±0.5 | | ALSTON-... | 78 | DPWA | $\overline{K}N \to \overline{K}N$ |
| 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 | $\gamma p \to \Lambda(1520) K^+$ |
| 16 ±1 | | GOPAL | 80 | DPWA | $\overline{K}N \to \overline{K}N$ |
| 14 ±3 | 677 | [1] BARLAG | 79 | HBC | $K^- p$ 4.2 GeV/$c$ |
| 15.4 ±0.5 | | ALSTON-... | 78 | DPWA | $\overline{K}N \to \overline{K}N$ |
| 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% |
| $\Gamma_4$ | $\Sigma(1385)\pi$ | |

| | | |
|---|---|---|
| $\Gamma_5$ | $\Sigma(1385)\pi(\rightarrow \Lambda\pi\pi)$ | |
| $\Gamma_6$ | $\Lambda(\pi\pi)_{S\text{-wave}}$ | |
| $\Gamma_7$ | $\Sigma\pi\pi$ | $0.9 \pm 0.1\%$ |
| $\Gamma_8$ | $\Lambda\gamma$ | $0.85 \pm 0.15\%$ |
| $\Gamma_9$ | $\Sigma^0\gamma$ | |

## CONSTRAINED FIT INFORMATION

An overall fit to 9 branching ratios uses 26 measurements and one constraint to determine 6 parameters. The overall fit has a $\chi^2 =$ 17.6 for 21 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients $\left\langle\delta x_i \delta x_j\right\rangle/(\delta x_i \cdot \delta x_j)$, 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.

| | | | | | |
|---|---|---|---|---|---|
| $x_2$ | −64 | | | | |
| $x_3$ | −32 | −34 | | | |
| $x_7$ | −4 | −3 | −1 | | |
| $x_8$ | −8 | −7 | −3 | 0 | |
| $x_9$ | −24 | −21 | −10 | −1 | −1 |
| | $x_1$ | $x_2$ | $x_3$ | $x_7$ | $x_8$ |

## Λ(1520) BRANCHING RATIOS

See "Sign conventions for resonance couplings" in the Note on $\Lambda$ and $\Sigma$ Resonances.

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

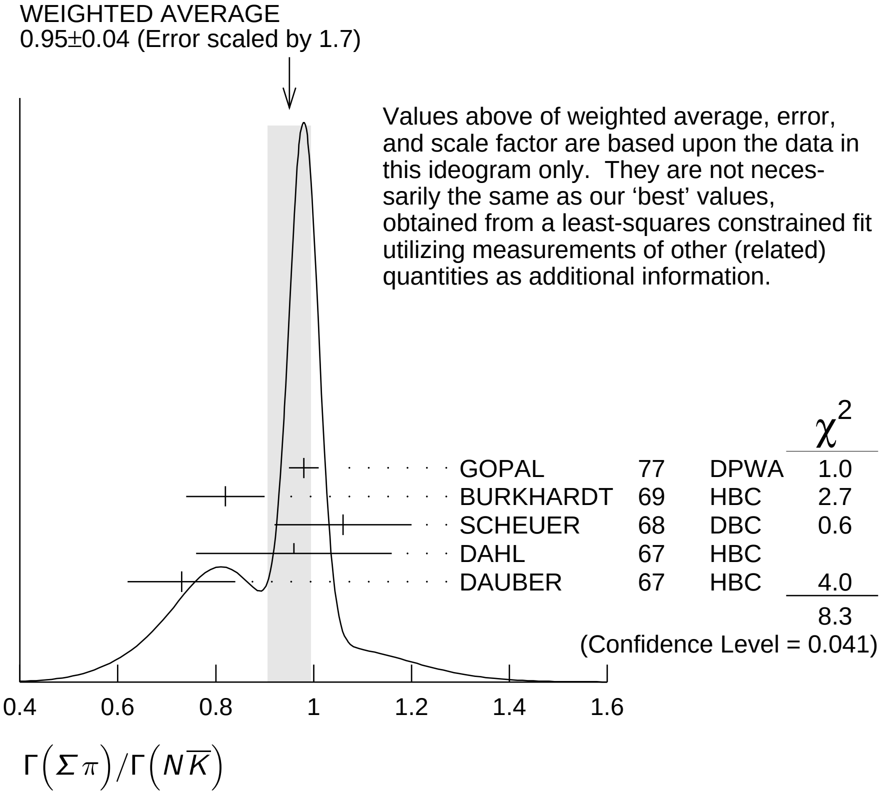
| *VALUE* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **0.45 ±0.01 OUR ESTIMATE** | | | | |
| **0.447±0.007 OUR FIT** Error includes scale factor of 1.2. | | | | |
| **0.455±0.011 OUR AVERAGE** | | | | |
| 0.47 ±0.02 | GOPAL | 80 | DPWA | $\overline{K}N \rightarrow \overline{K}N$ |
| 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** | | | | |
| **0.420±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 | |



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

| *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 | |

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

| *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/$c$ |

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

| *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/$c$ |

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

| *VALUE* (units $10^{-3}$) | *EVTS* | *DOCUMENT ID* | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **8.5±1.5 OUR ESTIMATE** | | | | |
| **8.8±1.1 OUR FIT** | | | | |
| **8.8±1.1 OUR AVERAGE** | | | | |
| $10.7\pm2.9^{+1.5}_{-0.4}$ | 32 | TAYLOR 05 | CLAS | $\gamma p \rightarrow K^+\Lambda\gamma$ |
| $10.2\pm2.1\pm1.5$ | 290 | ANTIPOV 04A | SPNX | $pN(\text{C}) \rightarrow \Lambda(1520)K^+N(\text{C})$ |
| $8.0\pm1.4$ | 238 | MAST 68B | HBC | Using $\Gamma(N\overline{K})/\Gamma_{\text{total}} = 0.45$ |

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

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

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## $\Lambda$(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 $\Gamma(N\overline{K})/\Gamma_{\text{total}} = 0.46 \pm 0.02$.

[4] Both $\Sigma(1385)\pi$ $DS_{03}$ and $\Sigma(\pi\pi)$ $DP_{03}$ contribute.

[5] The central bin (1514–1524 MeV) gives $0.74 \pm 0.10$; 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 $\Gamma(N\overline{K})/\Gamma_{\text{total}} = 0.46$.

[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.

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## $\Lambda$(1520) REFERENCES

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