# $\Lambda_c(2595)^+$

$I(J^P) = 0(\frac{1}{2}^-)$ Status: ***

The $\Lambda_c^+\pi^+\pi^-$ mode is largely, and perhaps entirely, $\Sigma_c\pi$, which is just at threshold; since the $\Sigma_c$ has $J^P = 1/2^+$, the $J^P$ here is almost certainly $1/2^-$. This result is in accord with the theoretical expectation that this is the charm counterpart of the strange $\Lambda(1405)$.

## $\Lambda_c(2595)^+$ MASS

The mass is obtained from the $\Lambda_c(2595)^+$–$\Lambda_c^+$ mass-difference measurements below.

| *VALUE* (MeV) | *DOCUMENT ID* |
|---|---|
| **2592.25±0.28 OUR FIT** | |

## $\Lambda_c(2595)^+ - \Lambda_c^+$ MASS DIFFERENCE

| *VALUE* (MeV) | *EVTS* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|
| **305.79±0.24 OUR FIT** | | | | | |
| **305.79±0.14±0.20** | 3.5k | AALTONEN | 11H | CDF | $p\overline{p}$ at 1.96 TeV |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 305.6 ±0.3 | | [1] BLECHMAN | 03 | | Threshold shift |
| 309.7 ±0.9 ±0.4 | 19 | ALBRECHT | 97 | ARG | $e^+e^- \approx$ 10 GeV |
| 309.2 ±0.7 ±0.3 | 14 ± 4.5 | FRABETTI | 96 | E687 | $\gamma$Be, $\overline{E}_\gamma \approx$ 220 GeV |
| 307.5 ±0.4 ±1.0 | 112 ± 17 | EDWARDS | 95 | CLE2 | $e^+e^- \approx$ 10.5 GeV |

[1] BLECHMAN 03 finds that a more sophisticated treatment than a simple Breit-Wigner for the proximity of the threshold of the dominant decay, $\Sigma_c(2455)\pi$, lowers the $\Lambda_c(2595)^+ - \Lambda_c^+$ mass difference by 2 or 3 MeV. The analysis of AALTONEN 11H bears this out.

## $\Lambda_c(2595)^+$ WIDTH

| *VALUE* (MeV) | *EVTS* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|
| **2.59±0.30±0.47** | 3.5k | [2] AALTONEN | 11H | CDF | $p\overline{p}$ at 1.96 TeV |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| $2.9\ ^{+2.9}_{-2.1}\ ^{+1.8}_{-1.4}$ | 19 | ALBRECHT | 97 | ARG | $e^+e^- \approx$ 10 GeV |
| $3.9\ ^{+1.4}_{-1.2}\ ^{+2.0}_{-1.0}$ | 112 ± 17 | EDWARDS | 95 | CLE2 | $e^+e^- \approx$ 10.5 GeV |

[2] AALTONEN 11H treats the three charged modes $\Lambda_c(2595)^+ \to \Sigma_c(2455)^{++}\pi^-$, $\Sigma_c(2455)^+\pi^0$, $\Sigma_c(2455)^0\pi^+$ separately in terms of a common coupling constant $h_2$ and obtains $h_2^2 = 0.36 \pm 0.08$. From this the width is determined.

## $\Lambda_c(2595)^+$ DECAY MODES

$\Lambda_c^+\pi\pi$ and its submode $\Sigma_c(2455)\pi$ — the latter just barely — are the only strong decays allowed to an excited $\Lambda_c^+$ having this mass; and the submode seems to dominate.

| | Mode | Fraction ($\Gamma_i/\Gamma$) |
|---|---|---|
| $\Gamma_1$ | $\Lambda_c^+\pi^+\pi^-$ | [a] — |
| $\Gamma_2$ | $\Sigma_c(2455)^{++}\pi^-$ | 24 ± 7 % |
| $\Gamma_3$ | $\Sigma_c(2455)^0\pi^+$ | 24 ± 7 % |
| $\Gamma_4$ | $\Lambda_c^+\pi^+\pi^-$ 3-body | 18 ± 10 % |
| $\Gamma_5$ | $\Lambda_c^+\pi^0$ | [b] not seen |
| $\Gamma_6$ | $\Lambda_c^+\gamma$ | not seen |

[a] See AALTONEN 11H, Fig. 8, for the calculated ratio of $\Lambda_c^+\pi^0\pi^0$ and $\Lambda_c^+\pi^+\pi^-$ partial widths as a function of the $\Lambda_c(2595)^+ - \Lambda_c^+$ mass difference. At our value of the mass difference, the ratio is about 4.

[b] A test that the isospin is indeed 0, so that the particle is indeed a $\Lambda_c^+$.

## $\Lambda_c(2595)^+$ BRANCHING RATIOS

### $\Gamma(\Sigma_c(2455)^{++}\pi^-)/\Gamma(\Lambda_c^+\pi^+\pi^-)$ $\Gamma_2/\Gamma_1$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **0.36±0.10 OUR AVERAGE** | | | | |
| 0.37±0.12±0.13 | ALBRECHT | 97 | ARG | $e^+e^-\approx$ 10 GeV |
| 0.36±0.09±0.09 | EDWARDS | 95 | CLE2 | $e^+e^-\approx$ 10.5 GeV |

### $\Gamma(\Sigma_c(2455)^0\pi^+)/\Gamma(\Lambda_c^+\pi^+\pi^-)$ $\Gamma_3/\Gamma_1$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **0.37±0.10 OUR AVERAGE** | | | | |
| 0.29±0.10±0.11 | ALBRECHT | 97 | ARG | $e^+e^-\approx$ 10 GeV |
| 0.42±0.09±0.09 | EDWARDS | 95 | CLE2 | $e^+e^-\approx$ 10.5 GeV |

### $[\Gamma(\Sigma_c(2455)^{++}\pi^-)+\Gamma(\Sigma_c(2455)^0\pi^+)]/\Gamma(\Lambda_c^+\pi^+\pi^-)$ $(\Gamma_2+\Gamma_3)/\Gamma_1$

| VALUE | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| $0.66^{+0.13}_{-0.16}\pm0.07$ | | ALBRECHT | 97 | ARG | $e^+e^-\approx$ 10 GeV |
| >0.51 | 90 | [3] FRABETTI | 96 | E687 | $\gamma$Be, $\overline{E}_\gamma\approx$ 220 GeV |

[3] The results of FRABETTI 96 are consistent with this ratio being 100%.

### $\Gamma(\Lambda_c^+\pi^0)/\Gamma(\Lambda_c^+\pi^+\pi^-)$ $\Gamma_5/\Gamma_1$

$\Lambda_c^+\pi^0$ decay is forbidden by isospin conservation if this state is in fact a $\Lambda_c$.

| VALUE | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **<3.53** | 90 | EDWARDS | 95 | CLE2 | $e^+e^-\approx$ 10.5 GeV |

### $\Gamma(\Lambda_c^+\gamma)/\Gamma(\Lambda_c^+\pi^+\pi^-)$ $\Gamma_6/\Gamma_1$

| VALUE | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **<0.98** | 90 | EDWARDS | 95 | CLE2 | $e^+e^-\approx$ 10.5 GeV |

## $\Lambda_c(2595)^+$ REFERENCES


| | | | | |
|---|---|---|---|---|
| AALTONEN | 11H | PR D84 012003 | T. Aaltonen *et al.* | (CDF Collab.) |
| BLECHMAN | 03 | PR D67 074033 | A.E. Blechman *et al.* | (JHU, FLOR) |
| ALBRECHT | 97 | PL B402 207 | H. Albrecht *et al.* | (ARGUS Collab.) |
| FRABETTI | 96 | PL B365 461 | P.L. Frabetti *et al.* | (FNAL E687 Collab.) |
| EDWARDS | 95 | PRL 74 3331 | K.W. Edwards *et al.* | (CLEO Collab.) |