

# $\Lambda_c(2595)^+$

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

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.

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>
<b>2592.25 ± 0.28 OUR FIT</b>	

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

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>305.79 ± 0.24 OUR FIT</b>				
<b>305.79 ± 0.14 ± 0.20</b>	3.5k	AALTONEN	11H CDF	$p\bar{p}$ at 1.96 TeV
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
305.6 ± 0.3		<sup>1</sup> 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, $\bar{E}_\gamma \approx 220$ GeV
307.5 ± 0.4 ± 1.0	112 ± 17	EDWARDS	95 CLE2	$e^+ e^- \approx 10.5$ GeV

<sup>1</sup> 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

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

<sup>2</sup> AALTONEN 11H treats the three charged modes  $\Lambda_c(2595)^+ \rightarrow \Sigma_c(2455)^{++} \pi^-$ ,  $\Sigma_c(2455)^+ \pi^0$ ,  $\Sigma_c(2455)^0 \pi^+$  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] —
$\Gamma_2$ $\Sigma_c(2455)^{++} \pi^-$	$24 \pm 7 \%$
$\Gamma_3$ $\Sigma_c(2455)^0 \pi^+$	$24 \pm 7 \%$
$\Gamma_4$ $\Lambda_c^+ \pi^+ \pi^-$ 3-body	$18 \pm 10 \%$
$\Gamma_5$ $\Lambda_c^+ \pi^0$	[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

$\Gamma(\Sigma_c(2455)^{++} \pi^-)/\Gamma(\Lambda_c^+ \pi^+ \pi^-)$					$\Gamma_2/\Gamma_1$
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>		
<b>0.36±0.10 OUR AVERAGE</b>					
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	

$\Gamma(\Sigma_c(2455)^0 \pi^+)/\Gamma(\Lambda_c^+ \pi^+ \pi^-)$					$\Gamma_3/\Gamma_1$
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>		
<b>0.37±0.10 OUR AVERAGE</b>					
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	

$[\Gamma(\Sigma_c(2455)^{++} \pi^-) + \Gamma(\Sigma_c(2455)^0 \pi^+)]/\Gamma(\Lambda_c^+ \pi^+ \pi^-)$					$(\Gamma_2+\Gamma_3)/\Gamma_1$
<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	

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

$0.66^{+0.13}_{-0.16} \pm 0.07$		ALBRECHT	97	ARG	$e^+ e^- \approx 10$ GeV
>0.51	90	<sup>3</sup> FRABETTI	96	E687	$\gamma$ Be, $\bar{E}_\gamma \approx 220$ GeV

<sup>3</sup>The results of FRABETTI 96 are consistent with this ratio being 100%.

$\Gamma(\Lambda_c^+ \pi^0)/\Gamma(\Lambda_c^+ \pi^+ \pi^-)$					$\Gamma_5/\Gamma_1$
<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&lt;3.53</b>	90	EDWARDS	95	CLE2	$e^+ e^- \approx 10.5$ GeV

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

$\Gamma(\Lambda_c^+ \gamma) / \Gamma(\Lambda_c^+ \pi^+ \pi^-)$					$\Gamma_6 / \Gamma_1$
<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
<b>&lt;0.98</b>	90	EDWARDS	95	CLE2	$e^+ e^- \approx 10.5$ GeV

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

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