

$\Lambda_c(2593)^+$  $I(J^P) = 0(\frac{1}{2}^-)$  Status: \*\*\*

Seen in  $\Lambda_c^+ \pi^+ \pi^-$  but not in  $\Lambda_c^+ \pi^0$ , so this is indeed an excited  $\Lambda_c^+$  rather than a  $\Sigma_c^+$ . The  $\Lambda_c^+ \pi^+ \pi^-$  mode is largely, and perhaps entirely,  $\Sigma_c \pi$ , which is just at threshold; thus (assuming, as has not yet been proven, that 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  $\Lambda(1405)$ .

### $\Lambda_c(2593)^+$ MASS

The mass is obtained from the  $\Lambda_c(2593)^+ - \Lambda_c^+$  mass-difference measurements below. But the mass may be 2 or 3 MeV lower: see the footnote to BLECHMAN 03 in the next data block.

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>
<b>2595.4 ± 0.6 OUR FIT</b>	Error includes scale factor of 1.1.

### $\Lambda_c(2593)^+ - \Lambda_c^+$ MASS DIFFERENCE

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>308.9 ± 0.6 OUR FIT</b>	Error includes scale factor of 1.1.			
<b>308.9 ± 0.6 OUR AVERAGE</b>	Error includes scale factor of 1.1.			
309.7 ± 0.9 ± 0.4	19	ALBRECHT	97 ARG	$e^+ e^- \approx 10$ GeV
309.2 ± 0.7 ± 0.3	14	<sup>1</sup> FRABETTI	96 E687	$\gamma$ Be, $\bar{E}_\gamma \approx 220$ GeV
307.5 ± 0.4 ± 1.0	112	<sup>2</sup> EDWARDS	95 CLE2	$e^+ e^- \approx 10.5$ GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •				
305.6 ± 0.3		<sup>3</sup> BLECHMAN	03	Threshold shift

<sup>1</sup>FRABETTI 96 claims a signal of  $13.9 \pm 4.5$  events.

<sup>2</sup>EDWARDS 95 claims a signal of  $112.5 \pm 16.5$  events in  $\Lambda_c^+ \pi^+ \pi^-$ .

<sup>3</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  $\Lambda_c(2593)^+ - \Lambda_c^+$  mass difference by 2 or 3 MeV.

### $\Lambda_c(2593)^+$ WIDTH

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>3.6<sup>+2.0</sup><sub>-1.3</sub> OUR AVERAGE</b>				
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	EDWARDS	95 CLE2	$e^+ e^- \approx 10.5$ GeV

**$\Lambda_c(2593)^+$  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] $\approx 67\%$
$\Gamma_2$ $\Sigma_c(2455)^{++} \pi^-$	$24 \pm 7\%$
$\Gamma_3$ $\Sigma_c(2455)^0 \pi^+$	$24 \pm 7\%$
$\Gamma_4$ $\Lambda_c^+ \pi^+ \pi^-$ 3-body	$18 \pm 10\%$
$\Gamma_5$ $\Lambda_c^+ \pi^0$	[b] not seen
$\Gamma_6$ $\Lambda_c^+ \gamma$	not seen

[a] Assuming isospin conservation, so that the other third is  $\Lambda_c^+ \pi^0 \pi^0$ .

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

 **$\Lambda_c(2593)^+$  BRANCHING RATIOS**

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

VALUE	DOCUMENT ID	TECN	COMMENT
<b><math>0.36 \pm 0.10</math> OUR AVERAGE</b>			
$0.37 \pm 0.12 \pm 0.13$	ALBRECHT	97 ARG	$e^+ e^- \approx 10$ GeV
$0.36 \pm 0.09 \pm 0.09$	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
<b><math>0.37 \pm 0.10</math> OUR AVERAGE</b>			
$0.29 \pm 0.10 \pm 0.11$	ALBRECHT	97 ARG	$e^+ e^- \approx 10$ GeV
$0.42 \pm 0.09 \pm 0.09$	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. • • •				
$0.66^{+0.13}_{-0.16} \pm 0.07$		ALBRECHT	97 ARG	$e^+ e^- \approx 10$ GeV
$> 0.51$	90	<sup>4</sup> FRABETTI	96 E687	$\gamma$ Be, $\bar{E}_\gamma \approx 220$ GeV

<sup>4</sup> The results of FRABETTI 96 are consistent with this ratio being 100%.

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

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

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b><math>&lt; 3.53</math></b>	90	EDWARDS	95 CLE2	$e^+ e^- \approx 10.5$ GeV

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

### $\Lambda_c(2593)^+$ REFERENCES

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.)