$\Lambda_c(2595)^+$

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

The $\Lambda_c^+\pi^+\pi^-$ mode is largely, and perhaps entirely, $\Sigma_c\pi$, which is just at threshold; since the Σ_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 $\Lambda_c(2595)^+$–Λ_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	γBe, $\overline{E}_\gamma \approx$ 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	[1] 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

[1] 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 for an excited Λ_c^+ having this mass; and the submode seems to dominate.

	Mode		Fraction (Γ_i/Γ)	Confidence level
Γ_1	$\Lambda_c^+\pi^+\pi^-$	[a]	(40±14) %	
Γ_2	$\Sigma_c(2455)^{++}\pi^-$		(15± 6) %	
Γ_3	$\Sigma_c(2455)^0\pi^+$		(15± 6) %	
Γ_4	$\Lambda_c^+\pi^+\pi^-$ 3-body			
Γ_5	$\Lambda_c^+\pi^0\pi^0$	[a]	(60±14) %	
Γ_6	$\Lambda_c^+\pi^0$	[b]	< 140 %	90%
Γ_7	$\Lambda_c^+\gamma$		< 40 %	90%

[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 predicted ratio is about 4. Using the measured value of $\Lambda_c^+\pi^0\pi^0$ branching fraction and assuming the $\Lambda_c\pi\pi$ branching fractions sum to unity, we derive the $\Lambda_c\pi^+\pi^-$ branching fraction. The derived ratio of the $\Lambda_c\pi^0\pi^0$ to $\Lambda_c\pi^+\pi^-$ partial widths is correspondingly 1.5 ± 0.2.

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

CONSTRAINED FIT INFORMATION

An overall fit to a branching ratio uses 1 measurements and one constraint to determine 2 parameters. The overall fit has a $\chi^2 = 0.0$ for 0 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_5 | -100

x_1

$\Lambda_c(2595)^+$ BRANCHING RATIOS

$\Gamma(\Lambda_c^+\pi^+\pi^-)/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
0.41±0.14 OUR FIT				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<0.85	90	ABLIKIM	24BC BES3	e^+e^- at 4.918 , 4.950 GeV

$\Gamma(\Sigma_c(2455)^{++}\pi^-)/\Gamma(\Lambda_c^+\pi^+\pi^-)$ Γ_2/Γ_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

$\Gamma(\Sigma_c(2455)^0\pi^+)/\Gamma(\Lambda_c^+\pi^+\pi^-)$ Γ_3/Γ_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	[1] FRABETTI	96	E687	γBe, $\overline{E}_\gamma\approx$ 220 GeV

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

$\Gamma(\Lambda_c^+\pi^0\pi^0)/\Gamma_{\text{total}}$ Γ_5/Γ

VALUE (%)	EVTS	DOCUMENT ID		TECN	COMMENT
59 ±14 OUR FIT					
59.5±11.1±7.9	95	ABLIKIM	25BJ	BES3	e^+e^- at 4.918, 4.951 GeV

$\Gamma(\Lambda_c^+\pi^0)/\Gamma(\Lambda_c^+\pi^+\pi^-)$ Γ_6/Γ_1

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

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

$\Gamma(\Lambda_c^+\gamma)/\Gamma(\Lambda_c^+\pi^+\pi^-)$ Γ_7/Γ_1

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

$\Lambda_c(2595)^+$ REFERENCES

ABLIKIM	25BJ	JHEP 2508 065	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	24BC	PR D109 112007	M. Ablikim *et al.*	(BESIII Collab.)
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.)