CHARMED BARYONS
($C = +1$)

$\Lambda_c^+ = u\,d\,c$, $\Sigma_c^{++} = u\,u\,c$, $\Sigma_c^+ = u\,d\,c$, $\Sigma_c^0 = d\,d\,c$,
$\Xi_c^+ = u\,s\,c$, $\Xi_c^0 = d\,s\,c$, $\Omega_c^0 = s\,s\,c$

Λ_c^+

$I(J^P) = 0(\frac{1}{2}^+)$

J is not well measured; $\frac{1}{2}$ is the quark-model prediction.

Mass $m = 2284.9 \pm 0.6$ MeV
Mean life $\tau = (200 \pm 6) \times 10^{-15}$ s (S = 1.6)
$c\tau = 59.9\ \mu$m

Decay asymmetry parameters

$\Lambda\pi^+$	$\alpha = -0.98 \pm 0.19$
$\Sigma^+\pi^0$	$\alpha = -0.45 \pm 0.32$
$\Lambda\ell^+\nu_\ell$	$\alpha = -0.82^{+0.11}_{-0.07}$

Nearly all branching fractions of the Λ_c^+ are measured relative to the $p\,K^-\pi^+$ mode, but there are no model-independent measurements of this branching fraction. We explain how we arrive at our value of B($\Lambda_c^+ \to p\,K^-\pi^+$) in a Note at the beginning of the branching-ratio measurements in the Listings. When this branching fraction is eventually well determined, all the other branching fractions will slide up or down proportionally as the true value differs from the value we use here.

Λ_c^+ DECAY MODES		Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
Hadronic modes with a p: $S = -1$ final states				
$p\,\overline{K}^0$		(2.3 ± 0.6) %		872
$p\,K^-\pi^+$	[a]	(5.0 ± 1.3) %		822
$p\,\overline{K}^*(892)^0$	[b]	(1.6 ± 0.5) %		684
$\Delta(1232)^{++}\,K^-$		(8.6 ± 3.0) $\times 10^{-3}$		709
$\Lambda(1520)\,\pi^+$	[b]	(5.9 ± 2.1) $\times 10^{-3}$		626
$p\,K^-\pi^+$ nonresonant		(2.8 ± 0.8) %		822
$p\,\overline{K}^0\,\pi^0$		(3.3 ± 1.0) %		822
$p\,\overline{K}^0\,\eta$		(1.2 ± 0.4) %		566
$p\,\overline{K}^0\,\pi^+\pi^-$		(2.6 ± 0.7) %		753
$p\,K^-\pi^+\pi^0$		(3.4 ± 1.0) %		758
$p\,K^*(892)^-\,\pi^+$	[b]	(1.1 ± 0.5) %		579

$p(K^-\pi^+)_{\text{nonresonant}}\,\pi^0$		(3.6 ± 1.2) %		758
$\Delta(1232)\overline{K}^*(892)$		seen		417
$p\,K^-\,\pi^+\,\pi^+\,\pi^-$		(1.1 ± 0.8) $\times 10^{-3}$		670
$p\,K^-\,\pi^+\,\pi^0\,\pi^0$		(8 ± 4) $\times 10^{-3}$		676

Hadronic modes with a p: $S = 0$ final states

$p\,\pi^+\,\pi^-$		(3.5 ± 2.0) $\times 10^{-3}$		926
$p\,f_0(980)$	[b]	(2.8 ± 1.9) $\times 10^{-3}$		621
$p\,\pi^+\,\pi^+\,\pi^-\,\pi^-$		(1.8 ± 1.2) $\times 10^{-3}$		851
$p\,K^+\,K^-$		(7.7 ± 3.5) $\times 10^{-4}$		615
$p\,\phi$	[b]	(8.2 ± 2.7) $\times 10^{-4}$		589
$p\,K^+\,K^-$ non-ϕ		(3.5 ± 1.7) $\times 10^{-4}$		615

Hadronic modes with a hyperon: $S = -1$ final states

$\Lambda\,\pi^+$		(9.0 ± 2.8) $\times 10^{-3}$		863
$\Lambda\,\pi^+\,\pi^0$		(3.6 ± 1.3) %		843
$\Lambda\,\rho^+$		< 5 %	CL=95%	634
$\Lambda\,\pi^+\,\pi^+\,\pi^-$		(3.3 ± 1.0) %		806
$\Lambda\,\pi^+\,\pi^+\,\pi^-\,\pi^0$ total		(1.8 ± 0.8) %		756
$\Lambda\,\pi^+\,\eta$		(1.8 ± 0.6) %		689
$\Sigma(1385)^+\,\eta$	[b]	(8.5 ± 3.3) $\times 10^{-3}$		569
$\Lambda\,\pi^+\,\omega$	[b]	(1.2 ± 0.5) %		515
$\Lambda\,\pi^+\,\pi^+\,\pi^-\,\pi^0$, no η or ω		< 7 $\times 10^{-3}$	CL=90%	756
$\Lambda\,K^+\,\overline{K}^0$		(6.0 ± 2.1) $\times 10^{-3}$		441
$\Xi(1690)^0\,K^+$, $\Xi(1690)^0 \to \Lambda\,\overline{K}^0$		(1.6 ± 0.8) $\times 10^{-3}$		286
$\Sigma^0\,\pi^+$		(9.9 ± 3.2) $\times 10^{-3}$		824
$\Sigma^+\,\pi^0$		(1.00 ± 0.34) %		826
$\Sigma^+\,\eta$		(5.5 ± 2.3) $\times 10^{-3}$		712
$\Sigma^+\,\pi^+\,\pi^-$		(3.6 ± 1.0) %		803
$\Sigma^+\,\rho^0$		< 1.4 %	CL=95%	573
$\Sigma^-\,\pi^+\,\pi^+$		(1.9 ± 0.8) %		798
$\Sigma^0\,\pi^+\,\pi^0$		(1.8 ± 0.8) %		802
$\Sigma^0\,\pi^+\,\pi^+\,\pi^-$		(1.1 ± 0.4) %		762
$\Sigma^+\,\pi^+\,\pi^-\,\pi^0$		—		766
$\Sigma^+\,\omega$	[b]	(2.7 ± 1.0) %		568
$\Sigma^+\,K^+\,K^-$		(2.8 ± 0.8) $\times 10^{-3}$		346
$\Sigma^+\,\phi$	[b]	(3.2 ± 1.0) $\times 10^{-3}$		292
$\Xi(1690)^0\,K^+$, $\Xi(1690)^0 \to \Sigma^+\,K^-$		(8.2 ± 3.1) $\times 10^{-4}$		286
$\Sigma^+\,K^+\,K^-$ nonresonant		< 7 $\times 10^{-4}$	CL=90%	346
$\Xi^0\,K^+$		(3.9 ± 1.4) $\times 10^{-3}$		652
$\Xi^-\,K^+\,\pi^+$		(4.9 ± 1.7) $\times 10^{-3}$		564
$\Xi(1530)^0\,K^+$	[b]	(2.6 ± 1.0) $\times 10^{-3}$		471

Hadronic modes with a hyperon: $S = 0$ final states

ΛK^+		$(6.7 \pm 2.5) \times 10^{-4}$			780
$\Sigma^0 K^+$		$(5.6 \pm 2.4) \times 10^{-4}$			734
$\Sigma^+ K^+ \pi^-$		$(1.7 \pm 0.7) \times 10^{-3}$			668
$\Sigma^+ K^*(892)^0$	[b]	$(2.8 \pm 1.1) \times 10^{-3}$			468
$\Sigma^- K^+ \pi^+$		$< 1.0 \times 10^{-3}$	CL=90%		662

Semileptonic modes

$\Lambda \ell^+ \nu_\ell$	[c]	(2.0 ± 0.6) %		870
$\Lambda e^+ \nu_e$		(2.1 ± 0.6) %		870
$\Lambda \mu^+ \nu_\mu$		(2.0 ± 0.7) %		866

Inclusive modes

e^+ anything		(4.5 ± 1.7) %		–
$p e^+$ anything		(1.8 ± 0.9) %		–
p anything		(50 ± 16) %		–
p anything (no Λ)		(12 ± 19) %		–
n anything		(50 ± 16) %		–
n anything (no Λ)		(29 ± 17) %		–
Λ anything		(35 ± 11) %	S=1.4	–
$\Sigma^\pm$ anything	[d]	(10 ± 5) %		–
3prongs		(24 ± 8) %		–

$\Delta C = 1$ weak neutral current ($C1$) modes, or Lepton number (L) violating modes

$p \mu^+ \mu^-$	$C1$	$< 3.4 \times 10^{-4}$	CL=90%		936
$\Sigma^- \mu^+ \mu^+$	L	$< 7.0 \times 10^{-4}$	CL=90%		811

$\Lambda_c(2593)^+$

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

The spin-parity follows from the fact that $\Sigma_c(2455)\pi$ decays, with little available phase space, are dominant. This assumes that $J^P = 1/2^+$ for the $\Sigma_c(2455)$.

Mass $m = 2593.9 \pm 0.8$ MeV

$m - m_{\Lambda_c^+} = 308.9 \pm 0.6$ MeV (S = 1.1)

Full width $\Gamma = 3.6^{+2.0}_{-1.3}$ MeV

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

$\Lambda_c(2593)^+$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_c^+ \pi^+ \pi^-$	[e] $\approx$ 67 %	124
$\Sigma_c(2455)^{++} \pi^-$	24 $\pm$ 7 %	28
$\Sigma_c(2455)^0 \pi^+$	24 $\pm$ 7 %	28
$\Lambda_c^+ \pi^+ \pi^-$ 3-body	18 $\pm$ 10 %	124
$\Lambda_c^+ \pi^0$	[f] not seen	261
$\Lambda_c^+ \gamma$	not seen	291

$\Lambda_c(2625)^+$

$I(J^P) = 0(\frac{3}{2}^-)$

J^P has not been measured; $\frac{3}{2}^-$ is the quark-model prediction.

Mass $m = 2626.6 \pm 0.8$ MeV (S = 1.2)
$m - m_{\Lambda_c^+} = 341.7 \pm 0.6$ MeV (S = 1.6)
Full width $\Gamma < 1.9$ MeV, CL = 90%

$\Lambda_c^+ \pi\pi$ and its submode $\Sigma(2455)\pi$ are the only strong decays allowed to an excited Λ_c^+ having this mass.

$\Lambda_c(2625)^+$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\Lambda_c^+ \pi^+ \pi^-$	[e] $\approx$ 67%		184
$\Sigma_c(2455)^{++} \pi^-$	<5	90%	102
$\Sigma_c(2455)^0 \pi^+$	<5	90%	102
$\Lambda_c^+ \pi^+ \pi^-$ 3-body	large		184
$\Lambda_c^+ \pi^0$	[f] not seen		293
$\Lambda_c^+ \gamma$	not seen		319

$\Sigma_c(2455)$

$I(J^P) = 1(\frac{1}{2}^+)$

J^P has not been measured; $\frac{1}{2}^+$ is the quark-model prediction.

$\Sigma_c(2455)^{++}$ mass $m = 2452.5 \pm 0.6$ MeV
$\Sigma_c(2455)^{+}$ mass $m = 2451.3 \pm 0.7$ MeV
$\Sigma_c(2455)^{0}$ mass $m = 2452.2 \pm 0.6$ MeV
$m_{\Sigma_c^{++}} - m_{\Lambda_c^+} = 167.58 \pm 0.12$ MeV
$m_{\Sigma_c^{+}} - m_{\Lambda_c^+} = 166.4 \pm 0.4$ MeV
$m_{\Sigma_c^{0}} - m_{\Lambda_c^+} = 167.32 \pm 0.12$ MeV
$m_{\Sigma_c^{++}} - m_{\Sigma_c^0} = 0.26 \pm 0.11$ MeV
$m_{\Sigma_c^{+}} - m_{\Sigma_c^0} = -0.9 \pm 0.4$ MeV
$\Sigma_c(2455)^{++}$ full width $\Gamma = 2.23 \pm 0.30$ MeV
$\Sigma_c(2455)^{+}$ full width $\Gamma < 4.6$ MeV, CL = 90%
$\Sigma_c(2455)^{0}$ full width $\Gamma = 2.2 \pm 0.4$ MeV (S = 1.4)

$\Lambda_c^+ \pi$ is the only strong decay allowed to a Σ_c having this mass.

$\Sigma_c(2455)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_c^+ \pi$	≈ 100 %	94

$\Sigma_c(2520)$

$I(J^P) = 1(\frac{3}{2}^+)$

J^P has not been measured; $\frac{3}{2}^+$ is the quark-model prediction.

$\Sigma_c(2520)^{++}$ mass $m = 2519.4 \pm 1.5$ MeV
$\Sigma_c(2520)^{+}$ mass $m = 2515.9 \pm 2.4$ MeV
$\Sigma_c(2520)^{0}$ mass $m = 2517.5 \pm 1.4$ MeV
$m_{\Sigma_c(2520)^{++}} - m_{\Lambda_c^+} = 234.5 \pm 1.4$ MeV
$m_{\Sigma_c(2520)^{+}} - m_{\Lambda_c^+} = 231.0 \pm 2.3$ MeV
$m_{\Sigma_c(2520)^{0}} - m_{\Lambda_c^+} = 232.6 \pm 1.3$ MeV
$m_{\Sigma_c(2520)^{++}} - m_{\Sigma_c(2520)^0} = 1.9 \pm 1.7$ MeV
$\Sigma_c(2520)^{++}$ full width $\Gamma = 18 \pm 5$ MeV
$\Sigma_c(2520)^{+}$ full width $\Gamma < 17$ MeV, CL = 90%
$\Sigma_c(2520)^{0}$ full width $\Gamma = 13 \pm 5$ MeV

$\Lambda_c^+ \pi$ is the only strong decay allowed to a Σ_c having this mass.

$\Sigma_c(2520)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_c^+ \pi$	≈ 100 %	180

Ξ_c^+

$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$

J^P has not been measured; $\frac{1}{2}^+$ is the quark-model prediction.

Mass $m = 2466.3 \pm 1.4$ MeV

Mean life $\tau = (442 \pm 26) \times 10^{-15}$ s (S = 1.3)

$c\tau = 132$ μm

Ξ_c^+ DECAY MODES		Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
No absolute branching fractions have been measured. The following are branching *ratios* relative to $\Xi^- \pi^+ \pi^+$.				
Cabibbo-favored ($S = -2$) decays				
$\Lambda \overline{K}^0 \pi^+$		—		851
$\Sigma(1385)^+ \overline{K}^0$	[b,g]	1.0 $\pm$0.5		745
$\Lambda K^- \pi^+ \pi^+$	[g]	0.34$\pm$0.12		785
$\Lambda \overline{K}^*(892)^0 \pi^+$	[b,g]	<0.2	90%	607
$\Sigma(1385)^+ K^- \pi^+$	[b,g]	<0.3	90%	677
$\Sigma^+ K^- \pi^+$	[g]	0.94$\pm$0.11		809
$\Sigma^+ \overline{K}^*(892)^0$	[b,g]	0.81$\pm$0.15		657
$\Sigma^0 K^- \pi^+ \pi^+$	[g]	0.29$\pm$0.16		734
$\Xi^0 \pi^+$	[g]	0.55$\pm$0.16		876
$\Xi^- \pi^+ \pi^+$	[g]	DEFINED AS 1		850
$\Xi(1530)^0 \pi^+$	[b,g]	<0.1	90%	748
$\Xi^0 \pi^+ \pi^0$	[g]	2.34$\pm$0.68		855
$\Xi^0 \pi^+ \pi^+ \pi^-$	[g]	1.74$\pm$0.50		817
$\Xi^0 e^+ \nu_e$	[g]	$2.3\ ^{+0.7}_{-0.9}$		883
$\Omega^- K^+ \pi^+$	[g]	0.07$\pm$0.04		397
Cabibbo-suppressed decays				
$p K^- \pi^+$	[g]	0.21$\pm$0.03		943
$p \overline{K}^*(892)^0$	[b,g]	0.12$\pm$0.02		827
$\Sigma^+ K^+ K^-$	[g]	0.15$\pm$0.07		578
$\Sigma^+ \phi$	[b,g]	<0.11	90%	547
$\Xi(1690)^0 K^+$ $\times$B($\Xi(1690)^0 \rightarrow \Sigma^+ K^-$)	[g]	<0.05	90%	501

Ξ_c^0

$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$

J^P has not been measured; $\frac{1}{2}^+$ is the quark-model prediction.

Mass $m = 2471.8 \pm 1.4$ MeV

$m_{\Xi_c^0} - m_{\Xi_c^+} = 5.5 \pm 1.8$ MeV

Mean life $\tau = (112^{+13}_{-10}) \times 10^{-15}$ s

$c\tau = 33.6\ \mu$m

Decay asymmetry parameters

$\Xi^- \pi^+$ $\alpha = -0.6 \pm 0.4$

Ξ_c^0 DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda \overline{K}^0$	seen	907
$\Lambda \overline{K}^0 \pi^+ \pi^-$	seen	788
$\Lambda K^- \pi^+ \pi^+ \pi^-$	seen	704
$\Xi^- \pi^+$	seen	876
$\Xi^- \pi^+ \pi^+ \pi^-$	seen	817
$p K^- \overline{K}^*(892)^0$	seen	414
$\Omega^- K^+$	seen	523
$\Xi^- e^+ \nu_e$	seen	883
$\Xi^- \ell^+$ anything	seen	–

$\Xi_c'^+$

$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$

J^P has not been measured; $\frac{1}{2}^+$ is the quark-model prediction.

Mass $m = 2574.1 \pm 3.3$ MeV

$m_{\Xi_c'^+} - m_{\Xi_c^+} = 107.8 \pm 3.0$ MeV

The $\Xi_c'^+$–Ξ_c^+ mass difference is too small for any strong decay to occur.

$\Xi_c'^+$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_c^+ \gamma$	seen	106

$\Xi_c'^0$

$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$

J^P has not been measured; $\frac{1}{2}^+$ is the quark-model prediction.

Mass $m = 2578.8 \pm 3.2$ MeV

$m_{\Xi_c'^0} - m_{\Xi_c^0} = 107.0 \pm 2.9$ MeV

The $\Xi_c'^0 - \Xi_c^0$ mass difference is too small for any strong decay to occur.

$\Xi_c'^0$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_c^0 \gamma$	seen	105

$\Xi_c(2645)$

$I(J^P) = \frac{1}{2}(\frac{3}{2}^+)$

J^P has not been measured; $\frac{3}{2}^+$ is the quark-model prediction.

$\Xi_c(2645)^+$ mass $m = 2647.4 \pm 2.0$ MeV (S = 1.2)
$\Xi_c(2645)^0$ mass $m = 2644.5 \pm 1.8$ MeV
$m_{\Xi_c(2645)^+} - m_{\Xi_c^0} = 175.6 \pm 1.4$ MeV (S = 1.7)
$m_{\Xi_c(2645)^0} - m_{\Xi_c^+} = 178.2 \pm 1.1$ MeV
$\Xi_c(2645)^+$ full width $\Gamma < 3.1$ MeV, CL = 90%
$\Xi_c(2645)^0$ full width $\Gamma < 5.5$ MeV, CL = 90%

$\Xi_c \pi$ is the only strong decay allowed to a Ξ_c resonance having this mass.

$\Xi_c(2645)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_c^0 \pi^+$	seen	98
$\Xi_c^+ \pi^-$	seen	107

$\Xi_c(2790)$

$I(J^P) = \frac{1}{2}(\frac{1}{2}^-)$

J^P has not been measured; $\frac{1}{2}^-$ is the quark-model prediction.

$\Xi_c(2790)^+$ mass $= 2790.0 \pm 3.5$ MeV
$\Xi_c(2790)^0$ mass $= 2790 \pm 4$ MeV
$m_{\Xi_c(2790)^+} - m_{\Xi_c^0} = 318.2 \pm 3.2$ MeV
$m_{\Xi_c(2790)^0} - m_{\Xi_c^+} = 324.0 \pm 3.3$ MeV
$\Xi_c(2790)^+$ width < 15 MeV, CL = 90%
$\Xi_c(2790)^0$ width < 12 MeV, CL = 90%

$\Xi_c(2790)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_c' \pi$	seen	162

$\Xi_c(2815)$

$I(J^P) = \frac{1}{2}(\frac{3}{2}^-)$

J^P has not been measured; $\frac{3}{2}^-$ is the quark-model prediction.

$\Xi_c(2815)^+$ mass $m = 2814.9 \pm 1.8$ MeV
$\Xi_c(2815)^0$ mass $m = 2819.0 \pm 2.5$ MeV
$m_{\Xi_c(2815)^+} - m_{\Xi_c^+} = 348.6 \pm 1.2$ MeV
$m_{\Xi_c(2815)^0} - m_{\Xi_c^0} = 347.2 \pm 2.1$ MeV
$\Xi_c(2815)^+$ full width $\Gamma < 3.5$ MeV, CL = 90%
$\Xi_c(2815)^0$ full width $\Gamma < 6.5$ MeV, CL = 90%

The $\Xi_c \pi\pi$ modes are consistent with being entirely via $\Xi_c(2645)\pi$.

$\Xi_c(2815)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_c^+ \pi^+ \pi^-$	seen	196
$\Xi_c^0 \pi^+ \pi^-$	seen	187

Ω_c^0

$I(J^P) = 0(\frac{1}{2}^+)$

J^P has not been measured; $\frac{1}{2}^+$ is the quark-model prediction.

Mass $m = 2697.5 \pm 2.6$ MeV (S = 1.2)
Mean life $\tau = (69 \pm 12) \times 10^{-15}$ s
$c\tau = 21\ \mu$m

No absolute branching fractions have been measured.

Ω_c^0 DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Sigma^+ K^- K^- \pi^+$	seen	691
$\Xi^0 K^- \pi^+$	seen	903
$\Xi^- K^- \pi^+ \pi^+$	seen	832
$\Omega^- e^+ \nu_e$	seen	830
$\Omega^- \pi^+$	seen	822
$\Omega^- \pi^+ \pi^0$	seen	798
$\Omega^- \pi^- \pi^+ \pi^+$	seen	754

NOTES

[*a*] See the note on "Λ_c^+ Branching Fractions" in the Λ_c^+ Particle Listings.

[*b*] This branching fraction includes all the decay modes of the final-state resonance.

[*c*] An ℓ indicates an e or a μ mode, not a sum over these modes.

[*d*] The value is for the sum of the charge states or particle/antiparticle states indicated.

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

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

[*g*] No absolute branching fractions have been measured. The following are branching *ratios* relative to $\Xi^- \pi^+ \pi^+$.