N BARYONS
($S = 0$, $I = 1/2$)

p, $N^+ = uud$; n, $N^0 = udd$

p

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

Mass $m = 1.00727646681 \pm 0.00000000009$ u
Mass $m = 938.272046 \pm 0.000021$ MeV [a]
$|m_p - m_{\overline{p}}|/m_p < 7 \times 10^{-10}$, CL = 90% [b]
$|\frac{q_{\overline{p}}}{m_{\overline{p}}}|/(\frac{q_p}{m_p}) = 0.99999999991 \pm 0.00000000009$
$|q_p + q_{\overline{p}}|/e < 7 \times 10^{-10}$, CL = 90% [b]
$|q_p + q_e|/e < 1 \times 10^{-21}$ [c]
Magnetic moment $\mu = 2.792847356 \pm 0.000000023\ \mu_N$
$(\mu_p + \mu_{\overline{p}}) / \mu_p = (0 \pm 5) \times 10^{-6}$
Electric dipole moment $d < 0.54 \times 10^{-23}$ e cm
Electric polarizability $\alpha = (11.2 \pm 0.4) \times 10^{-4}$ fm^3
Magnetic polarizability $\beta = (2.5 \pm 0.4) \times 10^{-4}$ fm^3 (S = 1.2)
Charge radius, μp Lamb shift $= 0.84087 \pm 0.00039$ fm [d]
Charge radius, $e p$ CODATA value $= 0.8775 \pm 0.0051$ fm [d]
Magnetic radius $= 0.777 \pm 0.016$ fm
Mean life $\tau > 2.1 \times 10^{29}$ years, CL = 90% [e] ($p \to$ invisible mode)
Mean life $\tau > 10^{31}$ to 10^{33} years [e] (mode dependent)

See the "Note on Nucleon Decay" in our 1994 edition (Phys. Rev. **D50**, 1173) for a short review.

The "partial mean life" limits tabulated here are the limits on τ/B_i, where τ is the total mean life and B_i is the branching fraction for the mode in question. For N decays, p and n indicate proton and neutron partial lifetimes.

p DECAY MODES	Partial mean life (10^{30} years)	Confidence level	p (MeV/c)
Antilepton + meson			
$N \to e^+\pi$	> 2000 (n), > 8200 (p)	90%	459
$N \to \mu^+\pi$	> 1000 (n), > 6600 (p)	90%	453
$N \to \nu\pi$	> 112 (n), > 16 (p)	90%	459
$p \to e^+\eta$	> 4200	90%	309
$p \to \mu^+\eta$	> 1300	90%	297
$n \to \nu\eta$	> 158	90%	310
$N \to e^+\rho$	> 217 (n), > 710 (p)	90%	149
$N \to \mu^+\rho$	> 228 (n), > 160 (p)	90%	113
$N \to \nu\rho$	> 19 (n), > 162 (p)	90%	149
$p \to e^+\omega$	> 320	90%	143
$p \to \mu^+\omega$	> 780	90%	105
$n \to \nu\omega$	> 108	90%	144
$N \to e^+K$	> 17 (n), > 1000 (p)	90%	339
$N \to \mu^+K$	> 26 (n), > 1600 (p)	90%	329
$N \to \nu K$	> 86 (n), > 2300 (p)	90%	339
$n \to \nu K^0_S$	> 260	90%	338
$p \to e^+K^*(892)^0$	> 84	90%	45
$N \to \nu K^*(892)$	> 78 (n), > 51 (p)	90%	45

Antilepton + mesons			
$p \to e^+ \pi^+ \pi^-$	> 82	90%	448
$p \to e^+ \pi^0 \pi^0$	> 147	90%	449
$n \to e^+ \pi^- \pi^0$	> 52	90%	449
$p \to \mu^+ \pi^+ \pi^-$	> 133	90%	425
$p \to \mu^+ \pi^0 \pi^0$	> 101	90%	427
$n \to \mu^+ \pi^- \pi^0$	> 74	90%	427
$n \to e^+ K^0 \pi^-$	> 18	90%	319
Lepton + meson			
$n \to e^- \pi^+$	> 65	90%	459
$n \to \mu^- \pi^+$	> 49	90%	453
$n \to e^- \rho^+$	> 62	90%	150
$n \to \mu^- \rho^+$	> 7	90%	115
$n \to e^- K^+$	> 32	90%	340
$n \to \mu^- K^+$	> 57	90%	330
Lepton + mesons			
$p \to e^- \pi^+ \pi^+$	> 30	90%	448
$n \to e^- \pi^+ \pi^0$	> 29	90%	449
$p \to \mu^- \pi^+ \pi^+$	> 17	90%	425
$n \to \mu^- \pi^+ \pi^0$	> 34	90%	427
$p \to e^- \pi^+ K^+$	> 75	90%	320
$p \to \mu^- \pi^+ K^+$	> 245	90%	279
Antilepton + photon(s)			
$p \to e^+ \gamma$	> 670	90%	469
$p \to \mu^+ \gamma$	> 478	90%	463
$n \to \nu \gamma$	> 28	90%	470
$p \to e^+ \gamma \gamma$	> 100	90%	469
$n \to \nu \gamma \gamma$	> 219	90%	470
Three (or more) leptons			
$p \to e^+ e^+ e^-$	> 793	90%	469
$p \to e^+ \mu^+ \mu^-$	> 359	90%	457
$p \to e^+ \nu \nu$	> 17	90%	469
$n \to e^+ e^- \nu$	> 257	90%	470
$n \to \mu^+ e^- \nu$	> 83	90%	464
$n \to \mu^+ \mu^- \nu$	> 79	90%	458
$p \to \mu^+ e^+ e^-$	> 529	90%	463
$p \to \mu^+ \mu^+ \mu^-$	> 675	90%	439
$p \to \mu^+ \nu \nu$	> 21	90%	463
$p \to e^- \mu^+ \mu^+$	> 6	90%	457
$n \to 3\nu$	> 0.0005	90%	470
Inclusive modes			
$N \to e^+$ anything	> 0.6 (n, p)	90%	–
$N \to \mu^+$ anything	> 12 (n, p)	90%	–
$N \to e^+ \pi^0$ anything	> 0.6 (n, p)	90%	–
$\Delta B = 2$ dinucleon modes			
The following are lifetime limits per iron nucleus.			
$pp \to \pi^+ \pi^+$	> 0.7	90%	–
$pn \to \pi^+ \pi^0$	> 2	90%	–
$nn \to \pi^+ \pi^-$	> 0.7	90%	–
$nn \to \pi^0 \pi^0$	> 3.4	90%	–
$pp \to e^+ e^+$	> 5.8	90%	–

$pp \to e^+ \mu^+$	> 3.6	90%	–
$pp \to \mu^+ \mu^+$	> 1.7	90%	–
$pn \to e^+ \overline{\nu}$	> 2.8	90%	–
$pn \to \mu^+ \overline{\nu}$	> 1.6	90%	–
$nn \to \nu_e \overline{\nu}_e$	> 1.4	90%	–
$nn \to \nu_\mu \overline{\nu}_\mu$	> 1.4	90%	–
$pn \to$ invisible	> 0.000021	90%	–
$pp \to$ invisible	> 0.00005	90%	–

$\overline{p}$ DECAY MODES

Mode	Partial mean life (years)	Confidence level	p (MeV/c)
$\overline{p} \to e^- \gamma$	$> 7 \times 10^5$	90%	469
$\overline{p} \to \mu^- \gamma$	$> 5 \times 10^4$	90%	463
$\overline{p} \to e^- \pi^0$	$> 4 \times 10^5$	90%	459
$\overline{p} \to \mu^- \pi^0$	$> 5 \times 10^4$	90%	453
$\overline{p} \to e^- \eta$	$> 2 \times 10^4$	90%	309
$\overline{p} \to \mu^- \eta$	$> 8 \times 10^3$	90%	297
$\overline{p} \to e^- K^0_S$	> 900	90%	337
$\overline{p} \to \mu^- K^0_S$	$> 4 \times 10^3$	90%	326
$\overline{p} \to e^- K^0_L$	$> 9 \times 10^3$	90%	337
$\overline{p} \to \mu^- K^0_L$	$> 7 \times 10^3$	90%	326
$\overline{p} \to e^- \gamma\gamma$	$> 2 \times 10^4$	90%	469
$\overline{p} \to \mu^- \gamma\gamma$	$> 2 \times 10^4$	90%	463
$\overline{p} \to e^- \omega$	> 200	90%	143

n

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

Mass $m = 1.0086649160 \pm 0.0000000004$ u

Mass $m = 939.565379 \pm 0.000021$ MeV [a]

$(m_n - m_{\overline{n}})/\ m_n = (9 \pm 6) \times 10^{-5}$

$m_n - m_p = 1.2933322 \pm 0.0000004$ MeV

$= 0.00138844919(45)$ u

Mean life $\tau = 880.3 \pm 1.1$ s (S = 1.9)

$c\tau = 2.6391 \times 10^8$ km

Magnetic moment $\mu = -1.9130427 \pm 0.0000005\ \mu_N$

Electric dipole moment $d < 0.29 \times 10^{-25}$ e cm, CL = 90%

Mean-square charge radius $\langle r^2_n \rangle = -0.1161 \pm 0.0022$ fm^2 (S = 1.3)

Magnetic radius $\sqrt{\langle r^2_M \rangle} = 0.862^{+0.009}_{-0.008}$ fm

Electric polarizability $\alpha = (11.6 \pm 1.5) \times 10^{-4}$ fm^3

Magnetic polarizability $\beta = (3.7 \pm 2.0) \times 10^{-4}$ fm^3

Charge $q = (-0.2 \pm 0.8) \times 10^{-21}$ e

Mean $n\overline{n}$-oscillation time $> 8.6 \times 10^7$ s, CL = 90% (free n)

Mean $n\overline{n}$-oscillation time $> 1.3 \times 10^8$ s, CL = 90% [f] (bound n)

Mean nn'-oscillation time > 414 s, CL = 90% [g]

$pe^-\nu_e$ decay parameters [h]

$\lambda \equiv g_A / g_V = -1.2723 \pm 0.0023$ (S = 2.2)
$A = -0.1184 \pm 0.0010$ (S = 2.4)
$B = 0.9807 \pm 0.0030$
$C = -0.2377 \pm 0.0026$
$a = -0.103 \pm 0.004$
$\phi_{AV} = (180.017 \pm 0.026)^\circ$ [i]
$D = (-1.2 \pm 2.0) \times 10^{-4}$ [j]
$R = 0.004 \pm 0.013$ [j]

n DECAY MODES		Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$pe^-\overline{\nu}_e$		100 %		1
$pe^-\overline{\nu}_e\gamma$	[k]	(3.09±0.32) × 10^{-3}		1
Charge conservation (Q) violating mode				
$p\nu_e\overline{\nu}_e$	Q	< 8 × 10^{-27}	68%	1

N(1440) 1/2+

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

Breit-Wigner mass = 1410 to 1450 (≈ 1430) MeV
Breit-Wigner full width = 250 to 450 (≈ 350) MeV
Re(pole position) = 1350 to 1380 (≈ 1365) MeV
−2Im(pole position) = 160 to 220 (≈ 190) MeV

The following branching fractions are our estimates, not fits or averages.

N(1440) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	55–75 %	391
$N\eta$	(0.0±1.0) %	†
$N\pi\pi$	30–40 %	338
$\Delta\pi$	20–30 %	135
$\Delta(1232)\pi$, P-wave	15–30 %	135
$N\rho$	<8 %	†
$N\rho$, S=1/2, P-wave	(0.0±1.0) %	†
$N(\pi\pi)^{I=0}_{S\text{-wave}}$	10–20 %	–
$p\gamma$	0.035–0.048 %	407
$p\gamma$, helicity=1/2	0.035–0.048 %	407
$n\gamma$	0.02–0.04 %	406
$n\gamma$, helicity=1/2	0.02–0.04 %	406

N(1520) 3/2−

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

Breit-Wigner mass = 1510 to 1520 (≈ 1515) MeV
Breit-Wigner full width = 100 to 125 (≈ 115) MeV
Re(pole position) = 1505 to 1515 (≈ 1510) MeV
−2Im(pole position) = 105 to 120 (≈ 110) MeV

The following branching fractions are our estimates, not fits or averages.

N(1520) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	55–65 %	453
$N\eta$	(2.3±0.4) × 10^{-3}	142

$N\pi\pi$	20–30 %	410
$\Delta\pi$	15–25 %	225
$\Delta(1232)\pi$, S-wave	10–20 %	225
$\Delta(1232)\pi$, D-wave	10–15 %	225
$N\rho$	15–25 %	†
$N\rho$, S=3/2, S-wave	(9.0±1.0) %	†
$N(\pi\pi)^{I=0}_{S\text{-wave}}$	<8 %	–
$p\gamma$	0.31–0.52 %	467
$p\gamma$, helicity=1/2	0.01–0.02 %	467
$p\gamma$, helicity=3/2	0.30–0.50 %	467
$n\gamma$	0.30–0.53 %	466
$n\gamma$, helicity=1/2	0.04–0.10 %	466
$n\gamma$, helicity=3/2	0.25–0.45 %	466

$N(1535)$ 1/2$^-$

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

Breit-Wigner mass = 1525 to 1545 (≈ 1535) MeV
Breit-Wigner full width = 125 to 175 (≈ 150) MeV
Re(pole position) = 1490 to 1530 (≈ 1510) MeV
−2Im(pole position) = 90 to 250 (≈ 170) MeV

The following branching fractions are our estimates, not fits or averages.

N(1535) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	35–55 %	468
$N\eta$	(42 ±10) %	186
$N\pi\pi$	1–10 %	426
$\Delta\pi$	<1 %	244
$\Delta(1232)\pi$, D-wave	0–4 %	244
$N\rho$	<4 %	†
$N\rho$, S=1/2, S-wave	(2.0± 1.0) %	†
$N\rho$, S=3/2, D-wave	(0.0± 1.0) %	†
$N(\pi\pi)^{I=0}_{S\text{-wave}}$	(2 ± 1) %	–
$N(1440)\pi$	(8 ± 3) %	†
$p\gamma$	0.15–0.30 %	481
$p\gamma$, helicity=1/2	0.15–0.30 %	481
$n\gamma$	0.01–0.25 %	480
$n\gamma$, helicity=1/2	0.01–0.25 %	480

N(1650) 1/2$^-$, N(1675) 5/2$^-$, N(1680) 5/2$^+$, N(1700) 3/2$^-$, N(1710) 1/2$^+$, N(1720) 3/2$^+$, N(2190) 7/2$^-$, N(2220) 9/2$^+$, N(2250) 9/2$^-$, N(2600) 11/2$^-$

The N resonances listed above are omitted from this Booklet but not from the Summary Table in the full *Review*.

$N(1875)\ 3/2^-$

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

Breit-Wigner mass = 1820 to 1920 (≈ 1875) MeV
Breit-Wigner full width
Re(pole position) = 1800 to 1950 MeV
−2Im(pole position) = 150 to 250 MeV

N(1875) DECAY MODES	Fraction (Γ_i/Γ)	Scale factor	p (MeV/c)
$N\pi$	(7 ± 6) %		695
$N\eta$	(1.2± 1.8) %	2.3	559
$N\omega$	(20 ± 4) %		371
ΣK	(7 ± 4) $\times 10^{-3}$		384
$\Delta(1232)\pi$, S-wave	(40 ±10) %		520
$\Delta(1232)\pi$, D-wave	(17 ±10) %		520
$N\rho$, S=3/2, S-wave	(6 ± 6) %		379
$N(\pi\pi)^{I=0}_{S\text{-wave}}$	(24 ±24) %		–
$p\gamma$	0.008–0.016 %		703
$p\gamma$, helicity=1/2	0.006–0.010 %		703
$p\gamma$, helicity=3/2	0.002–0.006 %		703

$N(1900)\ 3/2^+$

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

Breit-Wigner mass ≈ 1900 MeV
Breit-Wigner full width ∼ 250 MeV
Re(pole position) = 1900 ± 30 MeV
−2Im(pole position) = $200^{+100}_{-\ 60}$ MeV

N(1900) DECAY MODES	Fraction (Γ_i/Γ)	Scale factor	p (MeV/c)
$N\pi$	∼ 5 %		710
$N\eta$	∼ 12 %		579
$N\omega$	(13 ±9) %	3.1	401
ΛK	0–10 %		477
ΣK	(5.0±2.0) %		410

Δ BARYONS
(S = 0, I = 3/2)

$\Delta^{++} = uuu,\quad \Delta^{+} = uud,\quad \Delta^{0} = udd,\quad \Delta^{-} = ddd$

$\Delta(1232)\ 3/2^+$

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

Breit-Wigner mass (mixed charges) = 1230 to 1234 (≈ 1232) MeV
Breit-Wigner full width (mixed charges) = 114 to 120 (≈ 117) MeV
Re(pole position) = 1209 to 1211 (≈ 1210) MeV
−2Im(pole position) = 98 to 102 (≈ 100) MeV

The following branching fractions are our estimates, not fits or averages.

Δ(1232) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	100 %	229
$N\gamma$	0.55–0.65 %	259
$N\gamma$, helicity=1/2	0.11–0.13 %	259
$N\gamma$, helicity=3/2	0.44–0.52 %	259

Δ(1600) 3/2$^+$

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

Breit-Wigner mass = 1500 to 1700 (≈ 1600) MeV
Breit-Wigner full width = 220 to 420 (≈ 320) MeV
Re(pole position) = 1460 to 1560 (≈ 1510) MeV
−2Im(pole position) = 200 to 350 (≈ 275) MeV

The following branching fractions are our estimates, not fits or averages.

Δ(1600) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	10–25 %	513
$N\pi\pi$	75–90 %	477
$\Delta\pi$	40–70 %	303
$N\rho$	<25 %	†
$N(1440)\pi$	10–35 %	98
$N\gamma$	0.001–0.035 %	525
$N\gamma$, helicity=1/2	0.0–0.02 %	525
$N\gamma$, helicity=3/2	0.001–0.015 %	525

Δ(1620) 1/2$^-$

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

Breit-Wigner mass = 1600 to 1660 (≈ 1630) MeV
Breit-Wigner full width = 130 to 150 (≈ 140) MeV
Re(pole position) = 1590 to 1610 (≈ 1600) MeV
−2Im(pole position) = 120 to 140 (≈ 130) MeV

The following branching fractions are our estimates, not fits or averages.

Δ(1620) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	20–30 %	534
$N\pi\pi$	70–80 %	499
$\Delta\pi$	30–60 %	328
$N\rho$	7–25 %	†
$N\gamma$	0.03–0.10 %	545
$N\gamma$, helicity=1/2	0.03–0.10 %	545

Δ(1700) 3/2$^-$, Δ(1905) 5/2$^+$, Δ(1910) 1/2$^+$, Δ(1920) 3/2$^+$, Δ(1930) 5/2$^-$, Δ(1950) 7/2$^+$, Δ(2420) 11/2$^+$

The Δ resonances listed above are omitted from this Booklet but not from the Summary Table in the full *Review*.

Λ BARYONS
$(S = -1, I = 0)$

$\Lambda^0 = uds$

Λ

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

Mass $m = 1115.683 \pm 0.006$ MeV
$(m_\Lambda - m_{\overline{\Lambda}})\ /\ m_\Lambda = (-0.1 \pm 1.1) \times 10^{-5}$ (S = 1.6)
Mean life $\tau = (2.632 \pm 0.020) \times 10^{-10}$ s (S = 1.6)
$(\tau_\Lambda - \tau_{\overline{\Lambda}})\ /\ \tau_\Lambda = -0.001 \pm 0.009$
$c\tau = 7.89$ cm
Magnetic moment $\mu = -0.613 \pm 0.004\ \mu_N$
Electric dipole moment $d < 1.5 \times 10^{-16}\ e$cm, CL = 95%

Decay parameters

$p\pi^-$	$\alpha_- = 0.642 \pm 0.013$
$\overline{p}\pi^+$	$\alpha_+ = -0.71 \pm 0.08$
$p\pi^-$	$\phi_- = (-6.5 \pm 3.5)^\circ$
"	$\gamma_- = 0.76$ [l]
"	$\Delta_- = (8 \pm 4)^\circ$ [l]
$n\pi^0$	$\alpha_0 = 0.65 \pm 0.04$
$pe^-\overline{\nu}_e$	$g_A/g_V = -0.718 \pm 0.015$ [h]

Λ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$p\pi^-$	(63.9 ± 0.5) %	101
$n\pi^0$	(35.8 ± 0.5) %	104
$n\gamma$	$(1.75 \pm 0.15) \times 10^{-3}$	162
$p\pi^-\gamma$	[n] $(8.4 \pm 1.4) \times 10^{-4}$	101
$pe^-\overline{\nu}_e$	$(8.32 \pm 0.14) \times 10^{-4}$	163
$p\mu^-\overline{\nu}_\mu$	$(1.57 \pm 0.35) \times 10^{-4}$	131

$\Lambda(1405)\ 1/2^-$

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

Mass $m = 1405.1^{+1.3}_{-1.0}$ MeV
Full width $\Gamma = 50.5 \pm 2.0$ MeV
Below $\overline{K}N$ threshold

$\Lambda(1405)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Sigma\pi$	100 %	155

$\Lambda(1520)\ 3/2^-$

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

Mass $m = 1519.5 \pm 1.0$ MeV [o]
Full width $\Gamma = 15.6 \pm 1.0$ MeV [o]

$\Lambda(1520)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\overline{K}$	45 ± 1%	243
$\Sigma\pi$	42 ± 1%	268

$\Lambda\pi\pi$	$10 \pm 1\%$	259
$\Sigma\pi\pi$	$0.9 \pm 0.1\%$	169
$\Lambda\gamma$	$0.85 \pm 0.15\%$	350

$\Lambda(1600)$ $1/2^+$, $\Lambda(1670)$ $1/2^-$, $\Lambda(1690)$ $3/2^-$,
$\Lambda(1800)$ $1/2^-$, $\Lambda(1810)$ $1/2^+$, $\Lambda(1820)$ $5/2^+$,
$\Lambda(1830)$ $5/2^-$, $\Lambda(1890)$ $3/2^+$, $\Lambda(2100)$ $7/2^-$, $\Lambda(2110)$ $5/2^+$, $\Lambda(2350)$ $9/2^+$

The Λ resonances listed above are omitted from this Booklet but not from the Summary Table in the full *Review*.

Σ BARYONS
$(S = -1, I = 1)$

$\Sigma^+ = uus$, $\Sigma^0 = uds$, $\Sigma^- = dds$

Σ^+

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

Mass $m = 1189.37 \pm 0.07$ MeV (S = 2.2)
Mean life $\tau = (0.8018 \pm 0.0026) \times 10^{-10}$ s
$c\tau = 2.404$ cm
$(\tau_{\Sigma^+} - \tau_{\overline{\Sigma}^-}) / \tau_{\Sigma^+} = (-0.6 \pm 1.2) \times 10^{-3}$
Magnetic moment $\mu = 2.458 \pm 0.010$ μ_N (S = 2.1)
$(\mu_{\Sigma^+} + \mu_{\overline{\Sigma}^-}) / \mu_{\Sigma^+} = 0.014 \pm 0.015$
$\Gamma(\Sigma^+ \to n\ell^+\nu)/\Gamma(\Sigma^- \to n\ell^-\overline{\nu}) < 0.043$

Decay parameters

$p\pi^0$	$\alpha_0 = -0.980^{+0.017}_{-0.015}$
"	$\phi_0 = (36 \pm 34)^\circ$
"	$\gamma_0 = 0.16$ [l]
"	$\Delta_0 = (187 \pm 6)^\circ$ [l]
$n\pi^+$	$\alpha_+ = 0.068 \pm 0.013$
"	$\phi_+ = (167 \pm 20)^\circ$ (S = 1.1)
"	$\gamma_+ = -0.97$ [l]
"	$\Delta_+ = (-73^{+133}_{-10})^\circ$ [l]
$p\gamma$	$\alpha_\gamma = -0.76 \pm 0.08$

Σ^+ DECAY MODES		Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$p\pi^0$		(51.57 ± 0.30) %		189
$n\pi^+$		(48.31 ± 0.30) %		185
$p\gamma$		$(1.23 \pm 0.05) \times 10^{-3}$		225
$n\pi^+\gamma$	[n]	$(4.5 \pm 0.5) \times 10^{-4}$		185
$\Lambda e^+\nu_e$		$(2.0 \pm 0.5) \times 10^{-5}$		71
$\Delta S = \Delta Q$ (SQ) violating modes or $\Delta S = 1$ weak neutral current ($S1$) modes				
$ne^+\nu_e$	SQ	$< 5 \times 10^{-6}$	90%	224
$n\mu^+\nu_\mu$	SQ	$< 3.0 \times 10^{-5}$	90%	202
pe^+e^-	$S1$	$< 7 \times 10^{-6}$		225
$p\mu^+\mu^-$	$S1$	$(9^{+9}_{-8}) \times 10^{-8}$		121

Σ^0

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

Mass $m = 1192.642 \pm 0.024$ MeV
$m_{\Sigma^-} - m_{\Sigma^0} = 4.807 \pm 0.035$ MeV (S = 1.1)
$m_{\Sigma^0} - m_{\Lambda} = 76.959 \pm 0.023$ MeV
Mean life $\tau = (7.4 \pm 0.7) \times 10^{-20}$ s
$c\tau = 2.22 \times 10^{-11}$ m
Transition magnetic moment $|\mu_{\Sigma\Lambda}| = 1.61 \pm 0.08\ \mu_N$

Σ^0 DECAY MODES		Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\Lambda\gamma$		100 %		74
$\Lambda\gamma\gamma$		< 3 %	90%	74
$\Lambda e^+ e^-$	[p]	5×10^{-3}		74

Σ^-

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

Mass $m = 1197.449 \pm 0.030$ MeV (S = 1.2)
$m_{\Sigma^-} - m_{\Sigma^+} = 8.08 \pm 0.08$ MeV (S = 1.9)
$m_{\Sigma^-} - m_{\Lambda} = 81.766 \pm 0.030$ MeV (S = 1.2)
Mean life $\tau = (1.479 \pm 0.011) \times 10^{-10}$ s (S = 1.3)
$c\tau = 4.434$ cm
Magnetic moment $\mu = -1.160 \pm 0.025\ \mu_N$ (S = 1.7)
Σ^- charge radius $= 0.78 \pm 0.10$ fm

Decay parameters

$n\pi^-$	$\alpha_- = -0.068 \pm 0.008$
"	$\phi_- = (10 \pm 15)^\circ$
"	$\gamma_- = 0.98$ [l]
"	$\Delta_- = (249^{+\ 12}_{-120})^\circ$ [l]
$n e^- \overline{\nu}_e$	$g_A/g_V = 0.340 \pm 0.017$ [h]
"	$f_2(0)/f_1(0) = 0.97 \pm 0.14$
"	$D = 0.11 \pm 0.10$
$\Lambda e^- \overline{\nu}_e$	$g_V/g_A = 0.01 \pm 0.10$ [h] (S = 1.5)
"	$g_{WM}/g_A = 2.4 \pm 1.7$ [h]

Σ^- DECAY MODES		Fraction (Γ_i/Γ)	p (MeV/c)
$n\pi^-$		(99.848 ± 0.005) %	193
$n\pi^-\gamma$	[n]	$(4.6 \pm 0.6) \times 10^{-4}$	193
$n e^- \overline{\nu}_e$		$(1.017 \pm 0.034) \times 10^{-3}$	230
$n \mu^- \overline{\nu}_\mu$		$(4.5 \pm 0.4) \times 10^{-4}$	210
$\Lambda e^- \overline{\nu}_e$		$(5.73 \pm 0.27) \times 10^{-5}$	79

Σ(1385) 3/2+

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

$\Sigma(1385)^+$ mass $m = 1382.80 \pm 0.35$ MeV (S = 1.9)
$\Sigma(1385)^0$ mass $m = 1383.7 \pm 1.0$ MeV (S = 1.4)
$\Sigma(1385)^-$ mass $m = 1387.2 \pm 0.5$ MeV (S = 2.2)
$\Sigma(1385)^+$ full width $\Gamma = 36.0 \pm 0.7$ MeV
$\Sigma(1385)^0$ full width $\Gamma = 36 \pm 5$ MeV
$\Sigma(1385)^-$ full width $\Gamma = 39.4 \pm 2.1$ MeV (S = 1.7)
Below $\overline{K}N$ threshold

Σ(1385) DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\Lambda\pi$	(87.0 ± 1.5) %		208
$\Sigma\pi$	(11.7 ± 1.5) %		129
$\Lambda\gamma$	$(1.25^{+0.13}_{-0.12})$ %		241
$\Sigma^+\gamma$	$(7.0 \pm 1.7) \times 10^{-3}$		180
$\Sigma^-\gamma$	$< 2.4 \times 10^{-4}$	90%	173

Σ(1660) 1/2+

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

Mass $m = 1630$ to 1690 (≈ 1660) MeV
Full width $\Gamma = 40$ to 200 (≈ 100) MeV

Σ(1660) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\overline{K}$	10–30 %	405
$\Lambda\pi$	seen	440
$\Sigma\pi$	seen	387

Σ(1670) 3/2−, Σ(1750) 1/2−, Σ(1775) 5/2−, Σ(1915) 5/2+, Σ(1940) 3/2−, Σ(2030) 7/2+, Σ(2250)

The Σ resonances listed above are omitted from this Booklet but not from the Summary Table in the full *Review*.

Ξ BARYONS
($S = -2, I = 1/2$)

$\Xi^0 = uss$, $\Xi^- = dss$

Ξ0

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

P is not yet measured; + is the quark model prediction.

Mass $m = 1314.86 \pm 0.20$ MeV
$m_{\Xi^-} - m_{\Xi^0} = 6.85 \pm 0.21$ MeV
Mean life $\tau = (2.90 \pm 0.09) \times 10^{-10}$ s
$c\tau = 8.71$ cm
Magnetic moment $\mu = -1.250 \pm 0.014\ \mu_N$

Decay parameters

$\Lambda \pi^0$	$\alpha = -0.406 \pm 0.013$
"	$\phi = (21 \pm 12)^\circ$
"	$\gamma = 0.85$ [l]
"	$\Delta = (218^{+12}_{-19})^\circ$ [l]
$\Lambda \gamma$	$\alpha = -0.70 \pm 0.07$
$\Lambda e^+ e^-$	$\alpha = -0.8 \pm 0.2$
$\Sigma^0 \gamma$	$\alpha = -0.69 \pm 0.06$
$\Sigma^+ e^- \overline{\nu}_e$	$g_1(0)/f_1(0) = 1.22 \pm 0.05$
$\Sigma^+ e^- \overline{\nu}_e$	$f_2(0)/f_1(0) = 2.0 \pm 0.9$

Ξ^0 DECAY MODES		Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\Lambda \pi^0$		(99.524 ± 0.012) %		135
$\Lambda \gamma$		$(1.17 \pm 0.07) \times 10^{-3}$		184
$\Lambda e^+ e^-$		$(7.6 \pm 0.6) \times 10^{-6}$		184
$\Sigma^0 \gamma$		$(3.33 \pm 0.10) \times 10^{-3}$		117
$\Sigma^+ e^- \overline{\nu}_e$		$(2.52 \pm 0.08) \times 10^{-4}$		120
$\Sigma^+ \mu^- \overline{\nu}_\mu$		$(2.33 \pm 0.35) \times 10^{-6}$		64
$\Delta S = \Delta Q$ (SQ) violating modes or $\Delta S = 2$ forbidden ($S2$) modes				
$\Sigma^- e^+ \nu_e$	SQ	$< 9 \times 10^{-4}$	90%	112
$\Sigma^- \mu^+ \nu_\mu$	SQ	$< 9 \times 10^{-4}$	90%	49
$p \pi^-$	$S2$	$< 8 \times 10^{-6}$	90%	299
$p e^- \overline{\nu}_e$	$S2$	$< 1.3 \times 10^{-3}$		323
$p \mu^- \overline{\nu}_\mu$	$S2$	$< 1.3 \times 10^{-3}$		309

Ξ^-

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

P is not yet measured; + is the quark model prediction.

Mass $m = 1321.71 \pm 0.07$ MeV

$(m_{\Xi^-} - m_{\overline{\Xi}^+}) \,/\, m_{\Xi^-} = (-3 \pm 9) \times 10^{-5}$

Mean life $\tau = (1.639 \pm 0.015) \times 10^{-10}$ s

$c\tau = 4.91$ cm

$(\tau_{\Xi^-} - \tau_{\overline{\Xi}^+}) \,/\, \tau_{\Xi^-} = -0.01 \pm 0.07$

Magnetic moment $\mu = -0.6507 \pm 0.0025\ \mu_N$

$(\mu_{\Xi^-} + \mu_{\overline{\Xi}^+}) \,/\, |\mu_{\Xi^-}| = +0.01 \pm 0.05$

Decay parameters

$\Lambda \pi^-$	$\alpha = -0.458 \pm 0.012$ (S = 1.8)
$[\alpha(\Xi^-)\alpha_-(\Lambda) - \alpha(\overline{\Xi}^+)\alpha_+(\overline{\Lambda})]$ / [sum] $= (0 \pm 7) \times 10^{-4}$	
"	$\phi = (-2.1 \pm 0.8)^\circ$
"	$\gamma = 0.89$ [l]
"	$\Delta = (175.9 \pm 1.5)^\circ$ [l]
$\Lambda e^- \overline{\nu}_e$	$g_A/g_V = -0.25 \pm 0.05$ [h]

Ξ^- DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\Lambda \pi^-$	(99.887 ± 0.035) %		140
$\Sigma^- \gamma$	$(1.27 \pm 0.23) \times 10^{-4}$		118
$\Lambda e^- \overline{\nu}_e$	$(5.63 \pm 0.31) \times 10^{-4}$		190

$\Lambda \mu^- \overline{\nu}_\mu$		(3.5 $^{+3.5}_{-2.2}$) $\times 10^{-4}$			163
$\Sigma^0 e^- \overline{\nu}_e$		(8.7 ± 1.7) $\times 10^{-5}$			123
$\Sigma^0 \mu^- \overline{\nu}_\mu$		< 8	$\times 10^{-4}$	90%	70
$\Xi^0 e^- \overline{\nu}_e$		< 2.3	$\times 10^{-3}$	90%	7
$\Delta S = 2$ forbidden ($S2$) modes					
$n \pi^-$	$S2$	< 1.9	$\times 10^{-5}$	90%	304
$n e^- \overline{\nu}_e$	$S2$	< 3.2	$\times 10^{-3}$	90%	327
$n \mu^- \overline{\nu}_\mu$	$S2$	< 1.5	%	90%	314
$p \pi^- \pi^-$	$S2$	< 4	$\times 10^{-4}$	90%	223
$p \pi^- e^- \overline{\nu}_e$	$S2$	< 4	$\times 10^{-4}$	90%	305
$p \pi^- \mu^- \overline{\nu}_\mu$	$S2$	< 4	$\times 10^{-4}$	90%	251
$p \mu^- \mu^-$	L	< 4	$\times 10^{-8}$	90%	272

$\Xi(1530)$ 3/2$^+$

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

$\Xi(1530)^0$ mass $m = 1531.80 \pm 0.32$ MeV (S = 1.3)
$\Xi(1530)^-$ mass $m = 1535.0 \pm 0.6$ MeV
$\Xi(1530)^0$ full width $\Gamma = 9.1 \pm 0.5$ MeV
$\Xi(1530)^-$ full width $\Gamma = 9.9^{+1.7}_{-1.9}$ MeV

Ξ(1530) DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\Xi \pi$	100 %		158
$\Xi \gamma$	<4 %	90%	202

$\Xi(1690)$, $\Xi(1820)$ 3/2$^-$, $\Xi(1950)$, $\Xi(2030)$

The Ξ resonances listed above are omitted from this Booklet but not from the Summary Table in the full *Review*.

Ω BARYONS
($S = -3$, $I = 0$)

$\Omega^- = sss$

Ω^-

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

$J^P = \frac{3}{2}^+$ is the quark-model prediction; and $J = 3/2$ is fairly well established.

Mass $m = 1672.45 \pm 0.29$ MeV
$(m_{\Omega^-} - m_{\overline{\Omega}^+}) \,/\, m_{\Omega^-} = (-1 \pm 8) \times 10^{-5}$
Mean life $\tau = (0.821 \pm 0.011) \times 10^{-10}$ s
$c\tau = 2.461$ cm
$(\tau_{\Omega^-} - \tau_{\overline{\Omega}^+}) \,/\, \tau_{\Omega^-} = 0.00 \pm 0.05$
Magnetic moment $\mu = -2.02 \pm 0.05\ \mu_N$

Decay parameters

ΛK^- $\alpha = 0.0180 \pm 0.0024$

ΛK^-, $\overline{\Lambda} K^+$ $(\alpha + \overline{\alpha})/(\alpha - \overline{\alpha}) = -0.02 \pm 0.13$

$\Xi^0 \pi^-$ $\alpha = 0.09 \pm 0.14$

$\Xi^- \pi^0$ $\alpha = 0.05 \pm 0.21$

Ω^- DECAY MODES		Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
ΛK^-		(67.8 ± 0.7) %		211
$\Xi^0 \pi^-$		(23.6 ± 0.7) %		294
$\Xi^- \pi^0$		(8.6 ± 0.4) %		289
$\Xi^- \pi^+ \pi^-$		$(3.7^{+0.7}_{-0.6}) \times 10^{-4}$		189
$\Xi(1530)^0 \pi^-$		$< 7 \times 10^{-5}$	90%	17
$\Xi^0 e^- \overline{\nu}_e$		$(5.6 \pm 2.8) \times 10^{-3}$		319
$\Xi^- \gamma$		$< 4.6 \times 10^{-4}$	90%	314
$\Delta S = 2$ forbidden ($S2$) modes				
$\Lambda \pi^-$	$S2$	$< 2.9 \times 10^{-6}$	90%	449

$\Omega(2250)^-$

$I(J^P) = 0(?^?)$

Mass $m = 2252 \pm 9$ MeV

Full width $\Gamma = 55 \pm 18$ MeV

$\Omega(2250)^-$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi^- \pi^+ K^-$	seen	532
$\Xi(1530)^0 K^-$	seen	437

CHARMED BARYONS ($C = +1$)

$\Lambda_c^+ = udc$, $\Sigma_c^{++} = uuc$, $\Sigma_c^+ = udc$, $\Sigma_c^0 = ddc$,
$\Xi_c^+ = usc$, $\Xi_c^0 = dsc$, $\Omega_c^0 = ssc$

Λ_c^+

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

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

Mass $m = 2286.46 \pm 0.14$ MeV

Mean life $\tau = (200 \pm 6) \times 10^{-15}$ s (S = 1.6)

$c\tau = 59.9$ μm

Decay asymmetry parameters

$\Lambda \pi^+$ $\alpha = -0.91 \pm 0.15$

$\Sigma^+ \pi^0$ $\alpha = -0.45 \pm 0.32$

$\Lambda \ell^+ \nu_\ell$ $\alpha = -0.86 \pm 0.04$

$(\alpha + \overline{\alpha})/(\alpha - \overline{\alpha})$ in $\Lambda_c^+ \to \Lambda \pi^+$, $\overline{\Lambda}_c^- \to \overline{\Lambda} \pi^- = -0.07 \pm 0.31$

$(\alpha + \overline{\alpha})/(\alpha - \overline{\alpha})$ in $\Lambda_c^+ \to \Lambda e^+ \nu_e$, $\overline{\Lambda}_c^- \to \overline{\Lambda} e^- \overline{\nu}_e = 0.00 \pm 0.04$

Nearly all branching fractions of the Λ_c^+ are measured relative to the $pK^-\pi^+$ mode, but there are no model-independent measurements of this branching fraction. We explain how we arrive at our value of B($\Lambda_c^+ \to pK^-\pi^+$) 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) %		873
$pK^-\pi^+$	[q]	(5.0 ± 1.3) %		823
$p\overline{K}^*(892)^0$	[r]	(1.6 ± 0.5) %		685
$\Delta(1232)^{++}K^-$		(8.6 ± 3.0) $\times 10^{-3}$		710
$\Lambda(1520)\pi^+$	[r]	(1.8 ± 0.6) %		627
$pK^-\pi^+$ nonresonant		(2.8 ± 0.8) %		823
$p\overline{K}^0\pi^0$		(3.3 ± 1.0) %		823
$p\overline{K}^0\eta$		(1.2 ± 0.4) %		568
$p\overline{K}^0\pi^+\pi^-$		(2.6 ± 0.7) %		754
$pK^-\pi^+\pi^0$		(3.4 ± 1.0) %		759
$pK^*(892)^-\pi^+$	[r]	(1.1 ± 0.5) %		580
$p(K^-\pi^+)_{\text{nonresonant}}\pi^0$		(3.6 ± 1.2) %		759
$\Delta(1232)\overline{K}^*(892)$		seen		419
$pK^-\pi^+\pi^+\pi^-$		(1.1 ± 0.8) $\times 10^{-3}$		671
$pK^-\pi^+\pi^0\pi^0$		(8 ± 4) $\times 10^{-3}$		678
Hadronic modes with a p: $S=0$ final states				
$p\pi^+\pi^-$		(3.5 ± 2.0) $\times 10^{-3}$		927
$pf_0(980)$	[r]	(2.8 ± 1.9) $\times 10^{-3}$		614
$p\pi^+\pi^+\pi^-\pi^-$		(1.8 ± 1.2) $\times 10^{-3}$		852
pK^+K^-		(7.7 ± 3.5) $\times 10^{-4}$		616
$p\phi$	[r]	(8.2 ± 2.7) $\times 10^{-4}$		590
pK^+K^- non-ϕ		(3.5 ± 1.7) $\times 10^{-4}$		616
Hadronic modes with a hyperon: $S=-1$ final states				
$\Lambda\pi^+$		(1.07 ± 0.28) %		864
$\Lambda\pi^+\pi^0$		(3.6 ± 1.3) %		844
$\Lambda\rho^+$		< 5 %	CL=95%	636
$\Lambda\pi^+\pi^+\pi^-$		(2.6 ± 0.7) %		807
$\Sigma(1385)^+\pi^+\pi^-$, $\Sigma^{*+}\to\Lambda\pi^+$		(7 ± 4) $\times 10^{-3}$		688
$\Sigma(1385)^-\pi^+\pi^+$, $\Sigma^{*-}\to\Lambda\pi^-$		(5.5 ± 1.7) $\times 10^{-3}$		688
$\Lambda\pi^+\rho^0$		(1.1 ± 0.5) %		524
$\Sigma(1385)^+\rho^0$, $\Sigma^{*+}\to\Lambda\pi^+$		(3.7 ± 3.1) $\times 10^{-3}$		363
$\Lambda\pi^+\pi^+\pi^-$ nonresonant		< 8 $\times 10^{-3}$	CL=90%	807
$\Lambda\pi^+\pi^+\pi^-\pi^0$ total		(1.8 ± 0.8) %		757
$\Lambda\pi^+\eta$	[r]	(1.8 ± 0.6) %		691
$\Sigma(1385)^+\eta$	[r]	(8.5 ± 3.3) $\times 10^{-3}$		570
$\Lambda\pi^+\omega$	[r]	(1.2 ± 0.5) %		517
$\Lambda\pi^+\pi^+\pi^-\pi^0$, no η or ω		< 7 $\times 10^{-3}$	CL=90%	757
$\Lambda K^+\overline{K}^0$		(4.7 ± 1.5) $\times 10^{-3}$	S=1.2	443
$\Xi(1690)^0K^+$, $\Xi^{*0}\to\Lambda\overline{K}^0$		(1.3 ± 0.5) $\times 10^{-3}$		286
$\Sigma^0\pi^+$		(1.05 ± 0.28) %		825
$\Sigma^+\pi^0$		(1.00 ± 0.34) %		827

$\Sigma^+\eta$		$(5.5 \pm 2.3) \times 10^{-3}$		713
$\Sigma^+\pi^+\pi^-$		(3.6 ± 1.0) %		804
$\Sigma^+\rho^0$		< 1.4 %	CL=95%	575
$\Sigma^-\pi^+\pi^+$		(1.7 ± 0.5) %		799
$\Sigma^0\pi^+\pi^0$		(1.8 ± 0.8) %		803
$\Sigma^0\pi^+\pi^+\pi^-$		$(8.3 \pm 3.1) \times 10^{-3}$		763
$\Sigma^+\pi^+\pi^-\pi^0$		—		767
$\Sigma^+\omega$	[r]	(2.7 ± 1.0) %		569
$\Sigma^+K^+K^-$		$(2.8 \pm 0.8) \times 10^{-3}$		349
$\Sigma^+\phi$	[r]	$(3.1 \pm 0.9) \times 10^{-3}$		295
$\Xi(1690)^0K^+$, $\Xi^{*0} \to \Sigma^+K^-$		$(8.1 \pm 3.0) \times 10^{-4}$		286
$\Sigma^+K^+K^-$ nonresonant		$< 6 \times 10^{-4}$	CL=90%	349
Ξ^0K^+		$(3.9 \pm 1.4) \times 10^{-3}$		653
$\Xi^-K^+\pi^+$		$(5.1 \pm 1.4) \times 10^{-3}$		565
$\Xi(1530)^0K^+$	[r]	$(2.6 \pm 1.0) \times 10^{-3}$		473

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

ΛK^+		$(5.0 \pm 1.6) \times 10^{-4}$		781
$\Lambda K^+\pi^+\pi^-$		$< 4 \times 10^{-4}$	CL=90%	637
Σ^0K^+		$(4.2 \pm 1.3) \times 10^{-4}$		735
$\Sigma^0K^+\pi^+\pi^-$		$< 2.1 \times 10^{-4}$	CL=90%	574
$\Sigma^+K^+\pi^-$		$(1.7 \pm 0.7) \times 10^{-3}$		670
$\Sigma^+K^*(892)^0$	[r]	$(2.8 \pm 1.1) \times 10^{-3}$		470
$\Sigma^-K^+\pi^+$		$< 1.0 \times 10^{-3}$	CL=90%	664

Doubly Cabibbo-suppressed modes

$pK^+\pi^-$		$< 2.3 \times 10^{-4}$	CL=90%	823

Semileptonic modes

$\Lambda\ell^+\nu_\ell$	[s]	(2.0 ± 0.6) %		871
$\Lambda e^+\nu_e$		(2.1 ± 0.6) %		871
$\Lambda\mu^+\nu_\mu$		(2.0 ± 0.7) %		867

Inclusive modes

e^+ anything		(4.5 ± 1.7) %		–
pe^+ 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	[t]	(10 ± 5) %		–
3prongs		(24 ± 8) %		–

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

pe^+e^-	$C1$	$< 5.5 \times 10^{-6}$	CL=90%	951
$p\mu^+\mu^-$	$C1$	$< 4.4 \times 10^{-5}$	CL=90%	937
$pe^+\mu^-$	LF	$< 9.9 \times 10^{-6}$	CL=90%	947
$pe^-\mu^+$	LF	$< 1.9 \times 10^{-5}$	CL=90%	947
$\overline{p}2e^+$	L,B	$< 2.7 \times 10^{-6}$	CL=90%	951
$\overline{p}2\mu^+$	L,B	$< 9.4 \times 10^{-6}$	CL=90%	937
$\overline{p}e^+\mu^+$	L,B	$< 1.6 \times 10^{-5}$	CL=90%	947
$\Sigma^-\mu^+\mu^+$	L	$< 7.0 \times 10^{-4}$	CL=90%	812

$\Lambda_c(2595)^+$

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

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 $m = 2592.25 \pm 0.28$ MeV
$m - m_{\Lambda_c^+} = 305.79 \pm 0.24$ MeV
Full width $\Gamma = 2.6 \pm 0.6$ 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.

$\Lambda_c(2595)^+$ DECAY MODES		Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_c^+ \pi^+ \pi^-$	[u]	≈ 67 %	117
$\Sigma_c(2455)^{++} \pi^-$		24 ± 7 %	†
$\Sigma_c(2455)^0 \pi^+$		24 ± 7 %	†
$\Lambda_c^+ \pi^+ \pi^-$ 3-body		18 ± 10 %	117
$\Lambda_c^+ \pi^0$	[v]	not seen	258
$\Lambda_c^+ \gamma$		not seen	288

$\Lambda_c(2625)^+$

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

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

Mass $m = 2628.11 \pm 0.19$ MeV (S = 1.1)
$m - m_{\Lambda_c^+} = 341.65 \pm 0.13$ MeV (S = 1.1)
Full width $\Gamma < 0.97$ 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)
$\Lambda_c^+ \pi^+ \pi^-$	[u]	≈ 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
$\Lambda_c^+ \pi^0$	[v]	not seen		293
$\Lambda_c^+ \gamma$		not seen		319

$\Lambda_c(2880)^+$

$I(J^P) = 0(\frac{5}{2}^+)$

There is some good evidence that indeed $J^P = 5/2^+$

Mass $m = 2881.53 \pm 0.35$ MeV
$m - m_{\Lambda_c^+} = 595.1 \pm 0.4$ MeV
Full width $\Gamma = 5.8 \pm 1.1$ MeV

$\Lambda_c(2880)^+$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_c^+ \pi^+ \pi^-$	seen	471
$\Sigma_c(2455)^{0,++} \pi^\pm$	seen	376
$\Sigma_c(2520)^{0,++} \pi^\pm$	seen	317
$p D^0$	seen	316

$\Lambda_c(2940)^+$

$I(J^P) = 0(?^?)$

Mass $m = 2939.3^{+1.4}_{-1.5}$ MeV
Full width $\Gamma = 17^{+8}_{-6}$ MeV

$\Lambda_c(2940)^+$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$p D^0$	seen	420
$\Sigma_c(2455)^{0,++} \pi^\pm$	seen	–

$\Sigma_c(2455)$

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

$\Sigma_c(2455)^{++}$ mass $m = 2453.98 \pm 0.16$ MeV
$\Sigma_c(2455)^{+}$ mass $m = 2452.9 \pm 0.4$ MeV
$\Sigma_c(2455)^{0}$ mass $m = 2453.74 \pm 0.16$ MeV
$m_{\Sigma_c^{++}} - m_{\Lambda_c^+} = 167.52 \pm 0.08$ MeV
$m_{\Sigma_c^{+}} - m_{\Lambda_c^+} = 166.4 \pm 0.4$ MeV
$m_{\Sigma_c^{0}} - m_{\Lambda_c^+} = 167.27 \pm 0.08$ MeV
$m_{\Sigma_c^{++}} - m_{\Sigma_c^{0}} = 0.24 \pm 0.09$ MeV (S = 1.1)
$m_{\Sigma_c^{+}} - m_{\Sigma_c^{0}} = -0.9 \pm 0.4$ MeV
$\Sigma_c(2455)^{++}$ full width $\Gamma = 2.26 \pm 0.25$ MeV
$\Sigma_c(2455)^{+}$ full width $\Gamma < 4.6$ MeV, CL = 90%
$\Sigma_c(2455)^{0}$ full width $\Gamma = 2.16 \pm 0.26$ MeV (S = 1.1)

$\Lambda_c^+ \pi$ 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 $m = 2517.9 \pm 0.6$ MeV (S = 1.6)
$\Sigma_c(2520)^{+}$ mass $m = 2517.5 \pm 2.3$ MeV
$\Sigma_c(2520)^{0}$ mass $m = 2518.8 \pm 0.6$ MeV (S = 1.5)
$m_{\Sigma_c(2520)^{++}} - m_{\Lambda_c^+} = 231.4 \pm 0.6$ MeV (S = 1.6)
$m_{\Sigma_c(2520)^{+}} - m_{\Lambda_c^+} = 231.0 \pm 2.3$ MeV
$m_{\Sigma_c(2520)^{0}} - m_{\Lambda_c^+} = 232.3 \pm 0.5$ MeV (S = 1.6)
$m_{\Sigma_c(2520)^{++}} - m_{\Sigma_c(2520)^{0}}$
$\Sigma_c(2520)^{++}$ full width $\Gamma = 14.9 \pm 1.5$ MeV
$\Sigma_c(2520)^{+}$ full width $\Gamma < 17$ MeV, CL = 90%
$\Sigma_c(2520)^{0}$ full width $\Gamma = 14.5 \pm 1.5$ MeV

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

Σ_c(2520) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_c^+ \pi$	$\approx$ 100 %	179

$\Sigma_c(2800)$

$I(J^P) = 1(?^?)$

$\Sigma_c(2800)^{++}$ mass $m = 2801^{+4}_{-6}$ MeV
$\Sigma_c(2800)^{+}$ mass $m = 2792^{+14}_{-\ 5}$ MeV
$\Sigma_c(2800)^{0}$ mass $m = 2806^{+5}_{-7}$ MeV (S = 1.3)
$m_{\Sigma_c(2800)^{++}} - m_{\Lambda_c^+} = 514^{+4}_{-6}$ MeV
$m_{\Sigma_c(2800)^{+}} - m_{\Lambda_c^+} = 505^{+14}_{-\ 5}$ MeV
$m_{\Sigma_c(2800)^{0}} - m_{\Lambda_c^+} = 519^{+5}_{-7}$ MeV (S = 1.3)
$\Sigma_c(2800)^{++}$ full width $\Gamma = 75^{+22}_{-17}$ MeV
$\Sigma_c(2800)^{+}$ full width $\Gamma = 62^{+60}_{-40}$ MeV
$\Sigma_c(2800)^{0}$ full width $\Gamma = 72^{+22}_{-15}$ MeV

Σ_c(2800) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_c^+ \pi$	seen	443

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 $m = 2467.8^{+0.4}_{-0.6}$ MeV
Mean life $\tau = (442 \pm 26) \times 10^{-15}$ s (S = 1.3)
$c\tau = 132\ \mu$m

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 $\Xi^- 2\pi^+$.				
Cabibbo-favored ($S = -2$) decays — relative to $\Xi^- 2\pi^+$				
$p 2K_S^0$		0.087 ± 0.021		767
$\Lambda \overline{K}^0 \pi^+$		—		852
$\Sigma(1385)^+ \overline{K}^0$	[r]	1.0 ± 0.5		746
$\Lambda K^- 2\pi^+$		0.323 ± 0.033		787
$\Lambda \overline{K}^*(892)^0 \pi^+$	[r]	<0.16	90%	608
$\Sigma(1385)^+ K^- \pi^+$	[r]	<0.23	90%	678
$\Sigma^+ K^- \pi^+$		0.94 ± 0.10		810
$\Sigma^+ \overline{K}^*(892)^0$	[r]	0.81 ± 0.15		658
$\Sigma^0 K^- 2\pi^+$		0.27 ± 0.12		735
$\Xi^0 \pi^+$		0.55 ± 0.16		877
$\Xi^- 2\pi^+$		**DEFINED AS 1**		851
$\Xi(1530)^0 \pi^+$	[r]	<0.10	90%	750
$\Xi^0 \pi^+ \pi^0$		2.3 ± 0.7		856
$\Xi^0 \pi^- 2\pi^+$		1.7 ± 0.5		818
$\Xi^0 e^+ \nu_e$		$2.3\ ^{+0.7}_{-0.8}$		884
$\Omega^- K^+ \pi^+$		0.07 ± 0.04		399
Cabibbo-suppressed decays — relative to $\Xi^- 2\pi^+$				
$p K^- \pi^+$		0.21 ± 0.04		944
$p \overline{K}^*(892)^0$	[r]	0.116 ± 0.030		828
$\Sigma^+ \pi^+ \pi^-$		0.48 ± 0.20		922
$\Sigma^- 2\pi^+$		0.18 ± 0.09		918
$\Sigma^+ K^+ K^-$		0.15 ± 0.06		579
$\Sigma^+ \phi$	[r]	<0.11	90%	549
$\Xi(1690)^0 K^+$, $\Xi(1690)^0 \to \Sigma^+ K^-$		<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 $m = 2470.88^{+0.34}_{-0.80}$ MeV (S = 1.1)

$m_{\Xi_c^0} - m_{\Xi_c^+} = 3.1^{+0.4}_{-0.5}$ MeV

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

$c\tau = 33.6\ \mu$m

Decay asymmetry parameters

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

No absolute branching fractions have been measured. Several measurements of ratios of fractions may be found in the Listings that follow.

Ξ_c^0 DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
No absolute branching fractions have been measured. The following are branching *ratios* relative to $\Xi^-\pi^+$.		
Cabibbo-favored (S = −2) decays — relative to $\Xi^-\pi^+$		
$pK^-K^-\pi^+$	0.34 ±0.04	676
$pK^-\overline{K}^*(892)^0$	0.21 ±0.05	413
$pK^-K^-\pi^+$ (no $\overline{K}^{*0}$)	0.21 ±0.04	676
ΛK_S^0	0.210±0.028	906
$\Lambda K^-\pi^+$	1.07 ±0.14	856
$\Lambda\overline{K}^0\pi^+\pi^-$	seen	787
$\Lambda K^-\pi^+\pi^+\pi^-$	seen	703
$\Xi^-\pi^+$	DEFINED AS 1	875
$\Xi^-\pi^+\pi^+\pi^-$	3.3 ±1.4	816
Ω^-K^+	0.297±0.024	522
$\Xi^-e^+\nu_e$	3.1 ±1.1	882
$\Xi^-\ell^+$ anything	1.0 ±0.5	–
Cabibbo-suppressed decays — relative to $\Xi^-\pi^+$		
Ξ^-K^+	0.028±0.006	790
ΛK^+K^- (no ϕ)	0.029±0.007	648
$\Lambda\phi$	0.034±0.007	621

$\Xi_c^{\prime +}$

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

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

Mass $m = 2575.6 \pm 3.1$ MeV

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

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

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

$\Xi_c^{\prime 0}$

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

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

Mass $m = 2577.9 \pm 2.9$ MeV

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

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

$\Xi_c^{\prime 0}$ 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 $m = 2645.9^{+0.5}_{-0.6}$ MeV (S = 1.1)
$\Xi_c(2645)^0$ mass $m = 2645.9 \pm 0.5$ MeV
$m_{\Xi_c(2645)^+} - m_{\Xi_c^0} = 175.0^{+0.8}_{-0.6}$ MeV (S = 1.2)
$m_{\Xi_c(2645)^0} - m_{\Xi_c^+} = 178.1 \pm 0.6$ MeV
$m_{\Xi_c(2645)^+} - m_{\Xi_c(2645)^0} = 0.0 \pm 0.5$ 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.

Ξ_c(2645) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_c^0\pi^+$	seen	102
$\Xi_c^+\pi^-$	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 $= 2789.1 \pm 3.2$ MeV
$\Xi_c(2790)^0$ mass $= 2791.8 \pm 3.3$ 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%

Ξ_c(2790) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_c'\pi$	seen	159

$\Xi_c(2815)$

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

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

$\Xi_c(2815)^+$ mass $m = 2816.6 \pm 0.9$ MeV
$\Xi_c(2815)^0$ mass $m = 2819.6 \pm 1.2$ MeV
$m_{\Xi_c(2815)^+} - m_{\Xi_c^+} = 348.8 \pm 0.9$ MeV
$m_{\Xi_c(2815)^0} - m_{\Xi_c^0} = 348.7 \pm 1.2$ MeV
$m_{\Xi_c(2815)^+} - m_{\Xi_c(2815)^0} = -3.1 \pm 1.3$ 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 $\Xi_c(2645)\pi$.

Ξ_c(2815) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_c^+\pi^+\pi^-$	seen	196
$\Xi_c^0\pi^+\pi^-$	seen	191

$\Xi_c(2980)$

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

$\Xi_c(2980)^+$ $m = 2971.4 \pm 3.3$ MeV (S = 2.1)
$\Xi_c(2980)^0$ $m = 2968.0 \pm 2.6$ MeV (S = 1.2)
$\Xi_c(2980)^+$ width $\Gamma = 26 \pm 7$ MeV (S = 1.5)
$\Xi_c(2980)^0$ width $\Gamma = 20 \pm 7$ MeV (S = 1.3)

Ξ_c(2980) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_c^+ \overline{K} \pi$	seen	231
$\Sigma_c(2455) \overline{K}$	seen	134
$\Lambda_c^+ \overline{K}$	not seen	414
$\Xi_c\, 2\pi$	seen	–
$\Xi_c(2645) \pi$	seen	277

$\Xi_c(3080)$

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

$\Xi_c(3080)^+$ $m = 3077.0 \pm 0.4$ MeV
$\Xi_c(3080)^0$ $m = 3079.9 \pm 1.4$ MeV (S = 1.3)
$\Xi_c(3080)^+$ width $\Gamma = 5.8 \pm 1.0$ MeV
$\Xi_c(3080)^0$ width $\Gamma = 5.6 \pm 2.2$ MeV

Ξ_c(3080) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_c^+ \overline{K} \pi$	seen	415
$\Sigma_c(2455) \overline{K}$	seen	342
$\Sigma_c(2455) \overline{K} + \Sigma_c(2520) \overline{K}$	seen	–
$\Lambda_c^+ \overline{K}$	not seen	536
$\Lambda_c^+ \overline{K} \pi^+ \pi^-$	not seen	143

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 $m = 2695.2 \pm 1.7$ MeV (S = 1.3)
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	689
$\Xi^0 K^- \pi^+$	seen	901
$\Xi^- K^- \pi^+ \pi^+$	seen	830
$\Omega^- e^+ \nu_e$	seen	829
$\Omega^- \pi^+$	seen	821
$\Omega^- \pi^+ \pi^0$	seen	797
$\Omega^- \pi^- \pi^+ \pi^+$	seen	753

$\Omega_c(2770)^0$

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

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

Mass $m = 2765.9 \pm 2.0$ MeV (S = 1.2)
$m_{\Omega_c(2770)^0} - m_{\Omega_c^0} = 70.7^{+0.8}_{-0.9}$ MeV

The $\Omega_c(2770)^0$–Ω_c^0 mass difference is too small for any strong decay to occur.

$\Omega_c(2770)^0$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Omega_c^0 \gamma$	presumably 100%	70

BOTTOM BARYONS
$(B = -1)$

$\Lambda_b^0 = udb$, $\Xi_b^0 = usb$, $\Xi_b^- = dsb$, $\Omega_b^- = ssb$

Λ_b^0

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

$I(J^P)$ not yet measured; $0(\frac{1}{2}^+)$ is the quark model prediction.

Mass $m = 5619.5 \pm 0.4$ MeV
$m_{\Lambda_b^0} - m_{B^0} = 339.2 \pm 1.4$ MeV
$m_{\Lambda_b^0} - m_{B^+} = 339.7 \pm 0.7$ MeV
Mean life $\tau = (1.451 \pm 0.013) \times 10^{-12}$ s
$c\tau = 435$ μm
$A_{CP}(\Lambda_b \to p\pi^-) = 0.03 \pm 0.18$
$A_{CP}(\Lambda_b \to pK^-) = 0.37 \pm 0.17$
α decay parameter for $\Lambda_b \to J/\psi \Lambda = 0.05 \pm 0.18$

The branching fractions B(b-baryon $\to \Lambda \ell^- \overline{\nu}_\ell$ anything) and B($\Lambda_b^0 \to \Lambda_c^+ \ell^- \overline{\nu}_\ell$ anything) are not pure measurements because the underlying measured products of these with B($b \to b$-baryon) were used to determine B($b \to b$-baryon), as described in the note "Production and Decay of b-Flavored Hadrons."

For inclusive branching fractions, *e.g.*, $\Lambda_b \to \overline{\Lambda}_c$ anything, the values usually are multiplicities, not branching fractions. They can be greater than one.

Λ_b^0 DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$J/\psi(1S)\Lambda \times$ B($b \to \Lambda_b^0$)	$(5.8 \pm 0.8) \times 10^{-5}$		1740
$pD^0\pi^-$	$(5.9\ ^{+4.0}_{-3.2}) \times 10^{-4}$		2370
pD^0K^-	$(4.3\ ^{+3.0}_{-2.4}) \times 10^{-5}$		2269
$\Lambda_c^+\pi^-$	$(5.7\ ^{+4.0}_{-2.6}) \times 10^{-3}$	S=1.6	2342
$\Lambda_c^+K^-$	$(4.2\ ^{+2.6}_{-1.9}) \times 10^{-4}$		2314
$\Lambda_c^+a_1(1260)^-$	seen		2153
$\Lambda_c^+\pi^+\pi^-\pi^-$	$(8\ ^{+5}_{-4}) \times 10^{-3}$	S=1.6	2323

$\Lambda_c(2595)^+\pi^-$, $\Lambda_c(2595)^+ \to \Lambda_c^+\pi^+\pi^-$		$(3.7\ ^{+2.8}_{-2.3}) \times 10^{-4}$		2210
$\Lambda_c(2625)^+\pi^-$, $\Lambda_c(2625)^+ \to \Lambda_c^+\pi^+\pi^-$		$(3.6\ ^{+2.7}_{-2.1}) \times 10^{-4}$		2193
$\Sigma_c(2455)^0\pi^+\pi^-$, $\Sigma_c^0 \to \Lambda_c^+\pi^-$		$(6\ ^{+5}_{-4}) \times 10^{-4}$		2265
$\Sigma_c(2455)^{++}\pi^-\pi^-$, $\Sigma_c^{++} \to \Lambda_c^+\pi^+$		$(3.5\ ^{+2.8}_{-2.3}) \times 10^{-4}$		2265
$\Lambda_c^+\ell^-\overline{\nu}_\ell$ anything	[x]	(9.9 ± 2.2) %		–
$\Lambda_c^+\ell^-\overline{\nu}_\ell$		$(6.5\ ^{+3.2}_{-2.5})$ %	S=1.8	2345
$\Lambda_c^+\pi^+\pi^-\ell^-\overline{\nu}_\ell$		(5.6 ± 3.1) %		2335
$\Lambda_c(2595)^+\ell^-\overline{\nu}_\ell$		$(8 \pm 5) \times 10^{-3}$		2212
$\Lambda_c(2625)^+\ell^-\overline{\nu}_\ell$		$(1.4\ ^{+0.9}_{-0.7})$ %		2195
$p h^-$	[y]	$< 2.3 \times 10^{-5}$	CL=90%	2730
$p\pi^-$		$(4.1 \pm 0.8) \times 10^{-6}$		2730
pK^-		$(4.9 \pm 0.9) \times 10^{-6}$		2708
$\Lambda\mu^+\mu^-$		$(1.08 \pm 0.28) \times 10^{-6}$		2695
$\Lambda\gamma$		$< 1.3 \times 10^{-3}$	CL=90%	2699

$\Lambda_b(5912)^0$

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

Mass $m = 5912.1 \pm 0.4$ MeV
Full width $\Gamma < 0.66$ MeV, CL = 90%

$\Lambda_b(5912)^0$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_b^0\pi^+\pi^-$	seen	86

$\Lambda_b(5920)^0$

$J^P = \frac{3}{2}^-$

Mass $m = 5919.73 \pm 0.32$ MeV
Full width $\Gamma < 0.63$ MeV, CL = 90%

$\Lambda_b(5920)^0$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_b^0\pi^+\pi^-$	seen	108

Σ_b

$I(J^P) = 1(\frac{1}{2}^+)$
I, J, P need confirmation.

Mass $m(\Sigma_b^+) = 5811.3 \pm 1.9$ MeV
Mass $m(\Sigma_b^-) = 5815.5 \pm 1.8$ MeV
$m_{\Sigma_b^+} - m_{\Sigma_b^-} = -4.2 \pm 1.1$ MeV
$\Gamma(\Sigma_b^+) = 9.7^{+4.0}_{-3.0}$ MeV
$\Gamma(\Sigma_b^-) = 4.9^{+3.3}_{-2.4}$ MeV

Σ_b DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_b^0\pi$	dominant	134

Σ_b^*

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

Mass $m(\Sigma_b^{*+}) = 5832.1 \pm 1.9$ MeV
Mass $m(\Sigma_b^{*-}) = 5835.1 \pm 1.9$ MeV
$m_{\Sigma_b^{*+}} - m_{\Sigma_b^{*-}} = -3.0^{+1.0}_{-0.9}$ MeV
$\Gamma(\Sigma_b^{*+}) = 11.5 \pm 2.8$ MeV
$\Gamma(\Sigma_b^{*-}) = 7.5 \pm 2.3$ MeV
$m_{\Sigma_b^*} - m_{\Sigma_b} = 21.2 \pm 2.0$ MeV

Σ_b^* DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_b^0 \pi$	dominant	161

Ξ_b^0, Ξ_b^-

$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$
I, J, P need confirmation.

$m(\Xi_b^-) = 5794.9 \pm 0.9$ MeV (S = 1.1)
$m(\Xi_b^0) = 5793.1 \pm 2.5$ MeV (S = 1.1)
$m_{\Xi_b^-} - m_{\Lambda_b^0} = 176.2 \pm 0.9$ MeV
$m_{\Xi_b^0} - m_{\Lambda_b^0} = 174.8 \pm 2.5$ MeV
$m_{\Xi_b^-} - m_{\Xi_b^0} = 3 \pm 6$ MeV
Mean life $\tau_{\Xi_b^-} = (1.56^{+0.27}_{-0.25}) \times 10^{-12}$ s
Mean life $\tau_{\Xi_b} = (1.49^{+0.19}_{-0.18}) \times 10^{-12}$ s

Ξ_b DECAY MODES	Fraction (Γ_i/Γ)	Scale factor	p (MeV/c)
$\Xi_b \to \Xi^- \ell^- \overline{\nu}_\ell X \times$ B($\overline{b} \to \Xi_b$)	$(3.9 \pm 1.2) \times 10^{-4}$	1.4	–
$\Xi_b^- \to J/\psi \Xi^- \times$ B($b \to \Xi_b^-$)	$(1.02^{+0.26}_{-0.21}) \times 10^{-5}$		1783
$\Xi_b^0 \to p D^0 K^- \times$ B($\overline{b} \to \Xi_b$)	$(1.8 \ {}^{+1.3}_{-1.1}) \times 10^{-6}$		–
$\Xi_b^0 \to \Lambda_c^+ K^- \times$ B($\overline{b} \to \Xi_b$)	$(8 \pm 7) \times 10^{-7}$		–

$\Xi_b(5945)^0$

$J^P = \frac{3}{2}^+$

Mass $m = 5949.3 \pm 1.2$ MeV
Full width $\Gamma = 2.1 \pm 1.7$ MeV

$\Xi_b(5945)^0$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_b^- \pi^+$	seen	69

Ω_b^-

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

Mass $m = 6048.8 \pm 3.2$ MeV (S = 1.5)
$m_{\Omega_b^-} - m_{\Lambda_b^0} = 426.4 \pm 2.2$ MeV
Mean life $\tau = (1.1^{+0.5}_{-0.4}) \times 10^{-12}$ s

Ω_b^- DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$J/\psi\,\Omega^- \times \mathrm{B}(b \to \Omega_b)$	$(2.9^{+1.1}_{-0.8}) \times 10^{-6}$	1808

b-baryon ADMIXTURE (Λ_b, Ξ_b, Σ_b, Ω_b)

Mean life $\tau = (1.449 \pm 0.015) \times 10^{-12}$ s

These branching fractions are actually an average over weakly decaying b-baryons weighted by their production rates at the LHC, LEP, and Tevatron, branching ratios, and detection efficiencies. They scale with the b-baryon production fraction B($b \to b$-baryon).

The branching fractions B(b-baryon $\to \Lambda\ell^-\overline{\nu}_\ell$ anything) and B($\Lambda_b^0 \to \Lambda_c^+\ell^-\overline{\nu}_\ell$ anything) are not pure measurements because the underlying measured products of these with B($b \to b$-baryon) were used to determine B($b \to b$-baryon), as described in the note "Production and Decay of b-Flavored Hadrons."

For inclusive branching fractions, *e.g.*, $B \to D^\pm$ anything, the values usually are multiplicities, not branching fractions. They can be greater than one.

b-baryon ADMIXTURE DECAY MODES (Λ_b,Ξ_b,Σ_b,Ω_b)	Fraction (Γ_i/Γ)	p (MeV/c)
$p\mu^-\overline{\nu}$ anything	$(5.3^{+2.2}_{-1.9})$ %	–
$p\ell\overline{\nu}_\ell$ anything	(5.1 ± 1.2) %	–
p anything	(64 ± 21) %	–
$\Lambda\ell^-\overline{\nu}_\ell$ anything	(3.5 ± 0.6) %	–
$\Lambda/\overline{\Lambda}$ anything	(36 ± 7) %	–
$\Xi^-\ell^-\overline{\nu}_\ell$ anything	$(6.0 \pm 1.6) \times 10^{-3}$	–

NOTES

This Summary Table only includes established baryons. The Particle Listings include evidence for other baryons. The masses, widths, and branching fractions for the resonances in this Table are Breit-Wigner parameters, but pole positions are also given for most of the N and Δ resonances.

For most of the resonances, the parameters come from various partial-wave analyses of more or less the same sets of data, and it is not appropriate to treat the results of the analyses as independent or to average them together. Furthermore, the systematic errors on the results are not well understood. Thus, we usually only give ranges for the parameters. We then also give a best guess for the mass (as part of the name of the resonance) and for the width. The *Note on N and Δ Resonances* and the *Note on Λ and Σ Resonances* in the Particle Listings review the partial-wave analyses.

When a quantity has "(S = ...)" to its right, the error on the quantity has been enlarged by the "scale factor" S, defined as $S = \sqrt{\chi^2/(N-1)}$, where N is the number of measurements used in calculating the quantity. We do this when $S > 1$, which often indicates that the measurements are inconsistent. When $S > 1.25$, we also show in the Particle Listings an ideogram of the measurements. For more about S, see the Introduction.

A decay momentum p is given for each decay mode. For a 2-body decay, p is the momentum of each decay product in the rest frame of the decaying particle. For a 3-or-more-body decay, p is the largest momentum any of the products can have in this frame. For any resonance, the *nominal* mass is used in calculating p. A dagger ("†") in this column indicates that the mode is forbidden when the nominal masses of resonances are used, but is in fact allowed due to the nonzero widths of the resonances.

[*a*] The masses of the p and n are most precisely known in u (unified atomic mass units). The conversion factor to MeV, 1 u = 931.494061(21) MeV, is less well known than are the masses in u.

[*b*] The $\left|m_p - m_{\overline{p}}\right|/m_p$ and $\left|q_p + q_{\overline{p}}\right|/e$ are not independent, and both use the more precise measurement of $\left|q_{\overline{p}}/m_{\overline{p}}\right|/(q_p/m_p)$.

[*c*] The limit is from neutrality-of-matter experiments; it assumes $q_n = q_p + q_e$. See also the charge of the neutron.

[*d*] The μp and $e p$ values for the charge radius are much too different to average them. The disagreement is not yet understood.

[*e*] The first limit is for $p \rightarrow$ anything or "disappearance" modes of a bound proton. The second entry, a rough range of limits, assumes the dominant decay modes are among those investigated. For antiprotons the best limit, inferred from the observation of cosmic ray $\overline{p}$'s is $\tau_{\overline{p}} > 10^7$ yr, the cosmic-ray storage time, but this limit depends on a number of assumptions. The best direct observation of stored antiprotons gives $\tau_{\overline{p}}/\mathrm{B}(\overline{p} \rightarrow e^- \gamma) > 7 \times 10^5$ yr.

[*f*] There is some controversy about whether nuclear physics and model dependence complicate the analysis for bound neutrons (from which the best limit comes). The first limit here is from reactor experiments with free neutrons.

[*g*] Lee and Yang in 1956 proposed the existence of a mirror world in an attempt to restore global parity symmetry—thus a search for oscillations between the two worlds. Oscillations between the worlds would be maximal when the magnetic fields B and B' were equal. The limit for any B' in the range 0 to 12.5 μT is >12 s (95% CL).

[*h*] The parameters g_A, g_V, and g_{WM} for semileptonic modes are defined by $\overline{B}_f[\gamma_\lambda(g_V + g_A\gamma_5) + i(g_{WM}/m_{B_i})\,\sigma_{\lambda\nu}\,q^\nu]B_i$, and ϕ_{AV} is defined by

$g_A/g_V = |g_A/g_V| e^{i\phi_{AV}}$. See the "Note on Baryon Decay Parameters" in the neutron Particle Listings in the Full *Review of Particle Physics*.

[*i*] Time-reversal invariance requires this to be 0° or 180°.

[*j*] This coefficient is zero if time invariance is not violated.

[*k*] This limit is for γ energies between 15 and 340 keV.

[*l*] The decay parameters γ and Δ are calculated from α and ϕ using

$$\gamma = \sqrt{1-\alpha^2}\,\cos\phi\,, \qquad \tan\Delta = -\frac{1}{\alpha}\,\sqrt{1-\alpha^2}\,\sin\phi\,.$$

See the "Note on Baryon Decay Parameters" in the neutron Particle Listings in the Full *Review of Particle Physics*.

[*n*] See Particle Listings in the Full *Review of Particle Physics* for the pion momentum range used in this measurement.

[*o*] The error given here is only an educated guess. It is larger than the error on the weighted average of the published values.

[*p*] A theoretical value using QED.

[*q*] See the note on "Λ_c^+ Branching Fractions" in the Λ_c^+ Particle Listings in the Full *Review of Particle Physics*.

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

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

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

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

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

[*x*] Not a pure measurement. See note at head of Λ_b^0 Decay Modes.

[*y*] Here h^- means π^- or K^-.