

N BARYONS

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

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

p

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

$$\text{Mass } m = 1.00727646688 \pm 0.00000000009 \text{ u}$$

$$\text{Mass } m = 938.272081 \pm 0.000006 \text{ MeV } [a]$$

$$|m_p - m_{\bar{p}}|/m_p < 7 \times 10^{-10}, \text{ CL} = 90\% [b]$$

$$|\frac{q_{\bar{p}}}{m_{\bar{p}}}|/(\frac{q_p}{m_p}) = 1.00000000000 \pm 0.00000000007$$

$$|q_p + q_{\bar{p}}|/e < 7 \times 10^{-10}, \text{ CL} = 90\% [b]$$

$$|q_p + q_e|/e < 1 \times 10^{-21} [c]$$

$$\text{Magnetic moment } \mu = 2.7928473446 \pm 0.0000000008 \mu_N$$

$$(\mu_p + \mu_{\bar{p}}) / \mu_p = (0.3 \pm 0.8) \times 10^{-6}$$

$$\text{Electric dipole moment } d < 0.021 \times 10^{-23} \text{ e cm}$$

$$\text{Electric polarizability } \alpha = (11.2 \pm 0.4) \times 10^{-4} \text{ fm}^3$$

$$\text{Magnetic polarizability } \beta = (2.5 \pm 0.4) \times 10^{-4} \text{ fm}^3 \quad (S = 1.2)$$

$$\text{Charge radius, } \mu p \text{ Lamb shift} = 0.84087 \pm 0.00039 \text{ fm } [d]$$

$$\text{Charge radius, } e p \text{ CODATA value} = 0.8751 \pm 0.0061 \text{ fm } [d]$$

$$\text{Magnetic radius} = 0.851 \pm 0.026 \text{ fm } [e]$$

$$\text{Mean life } \tau > 2.1 \times 10^{29} \text{ years, CL} = 90\% [f] \quad (p \rightarrow \text{invisible mode})$$

$$\text{Mean life } \tau > 10^{31} \text{ to } 10^{33} \text{ years } [f] \quad (\text{mode dependent})$$

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		p (MeV/c)
	(10^{30} years)	Confidence level	
Antilepton + meson			
$N \rightarrow e^+ \pi$	$> 5300 (n), > 16000 (p)$	90%	459
$N \rightarrow \mu^+ \pi$	$> 3500 (n), > 7700 (p)$	90%	453
$N \rightarrow \nu \pi$	$> 1100 (n), > 390 (p)$	90%	459
$p \rightarrow e^+ \eta$	> 10000	90%	309
$p \rightarrow \mu^+ \eta$	> 4700	90%	297
$n \rightarrow \nu \eta$	> 158	90%	310
$N \rightarrow e^+ \rho$	$> 217 (n), > 720 (p)$	90%	149
$N \rightarrow \mu^+ \rho$	$> 228 (n), > 570 (p)$	90%	113

$N \rightarrow \nu \rho$	$> 19 (n), > 162 (p)$	90%	149
$p \rightarrow e^+ \omega$	> 1600	90%	143
$p \rightarrow \mu^+ \omega$	> 2800	90%	105
$n \rightarrow \nu \omega$	> 108	90%	144
$N \rightarrow e^+ K$	$> 17 (n), > 1000 (p)$	90%	339
$N \rightarrow \mu^+ K$	$> 26 (n), > 1600 (p)$	90%	329
$N \rightarrow \nu K$	$> 86 (n), > 5900 (p)$	90%	339
$n \rightarrow \nu K_S^0$	> 260	90%	338
$p \rightarrow e^+ K^*(892)^0$	> 84	90%	45
$N \rightarrow \nu K^*(892)$	$> 78 (n), > 51 (p)$	90%	45

Antilepton + mesons

$p \rightarrow e^+ \pi^+ \pi^-$	> 82	90%	448
$p \rightarrow e^+ \pi^0 \pi^0$	> 147	90%	449
$n \rightarrow e^+ \pi^- \pi^0$	> 52	90%	449
$p \rightarrow \mu^+ \pi^+ \pi^-$	> 133	90%	425
$p \rightarrow \mu^+ \pi^0 \pi^0$	> 101	90%	427
$n \rightarrow \mu^+ \pi^- \pi^0$	> 74	90%	427
$n \rightarrow e^+ K^0 \pi^-$	> 18	90%	319

Lepton + meson

$n \rightarrow e^- \pi^+$	> 65	90%	459
$n \rightarrow \mu^- \pi^+$	> 49	90%	453
$n \rightarrow e^- \rho^+$	> 62	90%	150
$n \rightarrow \mu^- \rho^+$	> 7	90%	115
$n \rightarrow e^- K^+$	> 32	90%	340
$n \rightarrow \mu^- K^+$	> 57	90%	330

Lepton + mesons

$p \rightarrow e^- \pi^+ \pi^+$	> 30	90%	448
$n \rightarrow e^- \pi^+ \pi^0$	> 29	90%	449
$p \rightarrow \mu^- \pi^+ \pi^+$	> 17	90%	425
$n \rightarrow \mu^- \pi^+ \pi^0$	> 34	90%	427
$p \rightarrow e^- \pi^+ K^+$	> 75	90%	320
$p \rightarrow \mu^- \pi^+ K^+$	> 245	90%	279

Antilepton + photon(s)

$p \rightarrow e^+ \gamma$	> 670	90%	469
$p \rightarrow \mu^+ \gamma$	> 478	90%	463
$n \rightarrow \nu \gamma$	> 550	90%	470
$p \rightarrow e^+ \gamma \gamma$	> 100	90%	469
$n \rightarrow \nu \gamma \gamma$	> 219	90%	470

Antilepton + single massless

$p \rightarrow e^+ X$	> 790	90%	—
$p \rightarrow \mu^+ X$	> 410	90%	—

Three (or more) leptons

$p \rightarrow e^+ e^+ e^-$	> 793	90%	469
$p \rightarrow e^+ \mu^+ \mu^-$	> 359	90%	457
$p \rightarrow e^+ \nu \nu$	> 170	90%	469
$n \rightarrow e^+ e^- \nu$	> 257	90%	470
$n \rightarrow \mu^+ e^- \nu$	> 83	90%	464
$n \rightarrow \mu^+ \mu^- \nu$	> 79	90%	458
$p \rightarrow \mu^+ e^+ e^-$	> 529	90%	463
$p \rightarrow \mu^+ \mu^+ \mu^-$	> 675	90%	439
$p \rightarrow \mu^+ \nu \nu$	> 220	90%	463
$p \rightarrow e^- \mu^+ \mu^+$	> 6	90%	457
$n \rightarrow 3\nu$	$> 5 \times 10^{-4}$	90%	470

Inclusive modes

$N \rightarrow e^+$ anything	> 0.6 (n, p)	90%	—
$N \rightarrow \mu^+$ anything	> 12 (n, p)	90%	—
$N \rightarrow e^+ \pi^0$ anything	> 0.6 (n, p)	90%	—

$\Delta B = 2$ dinucleon modes

The following are lifetime limits per iron nucleus.

$pp \rightarrow \pi^+ \pi^+$	> 72.2	90%	—
$pn \rightarrow \pi^+ \pi^0$	> 170	90%	—
$nn \rightarrow \pi^+ \pi^-$	> 0.7	90%	—
$nn \rightarrow \pi^0 \pi^0$	> 404	90%	—
$pp \rightarrow K^+ K^+$	> 170	90%	—
$pp \rightarrow e^+ e^+$	> 5.8	90%	—
$pp \rightarrow e^+ \mu^+$	> 3.6	90%	—
$pp \rightarrow \mu^+ \mu^+$	> 1.7	90%	—
$pn \rightarrow e^+ \bar{\nu}$	> 260	90%	—
$pn \rightarrow \mu^+ \bar{\nu}$	> 200	90%	—
$pn \rightarrow \tau^+ \bar{\nu}_\tau$	> 29	90%	—
$nn \rightarrow \nu_e \bar{\nu}_e$	> 1.4	90%	—
$nn \rightarrow \nu_\mu \bar{\nu}_\mu$	> 1.4	90%	—
$pn \rightarrow$ invisible	$> 2.1 \times 10^{-5}$	90%	—
$pp \rightarrow$ invisible	$> 5 \times 10^{-5}$	90%	—

\bar{p} DECAY MODES

\bar{p} DECAY MODES	Partial mean life (years)	Confidence level	p (MeV/c)
$\bar{p} \rightarrow e^- \gamma$	$> 7 \times 10^5$	90%	469
$\bar{p} \rightarrow \mu^- \gamma$	$> 5 \times 10^4$	90%	463
$\bar{p} \rightarrow e^- \pi^0$	$> 4 \times 10^5$	90%	459
$\bar{p} \rightarrow \mu^- \pi^0$	$> 5 \times 10^4$	90%	453
$\bar{p} \rightarrow e^- \eta$	$> 2 \times 10^4$	90%	309

$\bar{p} \rightarrow \mu^- \eta$	$> 8 \times 10^3$	90%	297
$\bar{p} \rightarrow e^- K_S^0$	> 900	90%	337
$\bar{p} \rightarrow \mu^- K_S^0$	$> 4 \times 10^3$	90%	326
$\bar{p} \rightarrow e^- K_L^0$	$> 9 \times 10^3$	90%	337
$\bar{p} \rightarrow \mu^- K_L^0$	$> 7 \times 10^3$	90%	326
$\bar{p} \rightarrow e^- \gamma \gamma$	$> 2 \times 10^4$	90%	469
$\bar{p} \rightarrow \mu^- \gamma \gamma$	$> 2 \times 10^4$	90%	463
$\bar{p} \rightarrow e^- \omega$	> 200	90%	143

n

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

$$\text{Mass } m = 1.0086649159 \pm 0.0000000005 \text{ u}$$

$$\text{Mass } m = 939.565413 \pm 0.000006 \text{ MeV } [a]$$

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

$$m_n - m_p = 1.2933321 \pm 0.0000005 \text{ MeV}$$

$$= 0.00138844919(45) \text{ u}$$

$$\text{Mean life } \tau = 879.4 \pm 0.6 \text{ s } (S = 1.6)$$

$$c\tau = 2.6362 \times 10^8 \text{ km}$$

$$\text{Magnetic moment } \mu = -1.9130427 \pm 0.0000005 \mu_N$$

$$\text{Electric dipole moment } d < 0.30 \times 10^{-25} \text{ e cm, CL} = 90\%$$

$$\text{Mean-square charge radius } \langle r_n^2 \rangle = -0.1161 \pm 0.0022$$

$$\text{fm}^2 (S = 1.3)$$

$$\text{Magnetic radius } \sqrt{\langle r_M^2 \rangle} = 0.864_{-0.008}^{+0.009} \text{ fm}$$

$$\text{Electric polarizability } \alpha = (11.8 \pm 1.1) \times 10^{-4} \text{ fm}^3$$

$$\text{Magnetic polarizability } \beta = (3.7 \pm 1.2) \times 10^{-4} \text{ fm}^3$$

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

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

$$\text{Mean } n\bar{n}\text{-oscillation time } > 2.7 \times 10^8 \text{ s, CL} = 90\% [g] \text{ (bound } n)$$

$$\text{Mean } nn'\text{-oscillation time } > 448 \text{ s, CL} = 90\% [h]$$

$p e^- \nu_e$ decay parameters ^[i]

$$\lambda \equiv g_A / g_V = -1.2732 \pm 0.0023 (S = 2.4)$$

$$A = -0.1187 \pm 0.0010 (S = 2.6)$$

$$B = 0.9807 \pm 0.0030$$

$$C = -0.2377 \pm 0.0026$$

$$a = -0.1059 \pm 0.0028$$

$$\phi_{AV} = (180.017 \pm 0.026)^\circ [j]$$

$$D = (-1.2 \pm 2.0) \times 10^{-4} [k]$$

$$R = 0.004 \pm 0.013 [k]$$

<i>n</i> DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$p e^- \bar{\nu}_e$	100	%	1
$p e^- \bar{\nu}_e \gamma$	[J] (9.2 ± 0.7) $\times 10^{-3}$		1
hydrogen-atom $\bar{\nu}_e$	< 2.7	$\times 10^{-3}$	95% 1.19
Charge conservation (Q) violating mode			
$p \nu_e \bar{\nu}_e$	Q	< 8	$\times 10^{-27}$ 68% 1

$N(1440) 1/2^+$

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

Re(pole position) = 1360 to 1380 (≈ 1370) MeV

$-2\text{Im}(\text{pole position}) = 160$ to 190 (≈ 175) MeV

Breit-Wigner mass = 1410 to 1470 (≈ 1440) MeV

Breit-Wigner full width = 250 to 450 (≈ 350) MeV

$N(1440)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N \pi$	55–75 %	398
$N \eta$	<1 %	†
$N \pi \pi$	17–50 %	347
$\Delta(1232) \pi$, <i>P</i> -wave	6–27 %	147
$N \sigma$	11–23 %	–
$p \gamma$, helicity=1/2	0.035–0.048 %	414
$n \gamma$, helicity=1/2	0.02–0.04 %	413

$N(1520) 3/2^-$

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

Re(pole position) = 1505 to 1515 (≈ 1510) MeV

$-2\text{Im}(\text{pole position}) = 105$ to 120 (≈ 110) MeV

Breit-Wigner mass = 1510 to 1520 (≈ 1515) MeV

Breit-Wigner full width = 100 to 120 (≈ 110) MeV

$N(1520)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N \pi$	55–65 %	453
$N \eta$	0.07–0.09 %	142
$N \pi \pi$	25–35 %	410
$\Delta(1232) \pi$	22–34 %	225
$\Delta(1232) \pi$, <i>S</i> -wave	15–23 %	225
$\Delta(1232) \pi$, <i>D</i> -wave	7–11 %	225
$N \sigma$	< 2 %	–

$p\gamma$	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

 $N(1535) 1/2^-$

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

Re(pole position) = 1500 to 1520 (≈ 1510) MeV

$-2\text{Im}(\text{pole position}) = 110$ to 150 (≈ 130) MeV

Breit-Wigner mass = 1515 to 1545 (≈ 1530) MeV

Breit-Wigner full width = 125 to 175 (≈ 150) MeV

$N(1535)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	32–52 %	464
$N\eta$	30–55 %	176
$N\pi\pi$	3–14 %	422
$\Delta(1232)\pi$, D -wave	1–4 %	240
$N\sigma$	2–10 %	–
$N(1440)\pi$	5–12 %	†
$p\gamma$, helicity=1/2	0.15–0.30 %	477
$n\gamma$, helicity=1/2	0.01–0.25 %	477

 $N(1650) 1/2^-$

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

Re(pole position) = 1640 to 1670 (≈ 1655) MeV

$-2\text{Im}(\text{pole position}) = 100$ to 170 (≈ 135) MeV

Breit-Wigner mass = 1635 to 1665 (≈ 1650) MeV

Breit-Wigner full width = 100 to 150 (≈ 125) MeV

$N(1650)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	50–70 %	547
$N\eta$	15–35 %	348
ΛK	5–15 %	169
$N\pi\pi$	8–36 %	514
$\Delta(1232)\pi$, D -wave	6–18 %	345
$N\sigma$	2–18 %	–
$N(1440)\pi$	6–26 %	150
$p\gamma$, helicity=1/2	0.04–0.20 %	558
$n\gamma$, helicity=1/2	0.003–0.17 %	557

$N(1675) 5/2^-$

$$I(J^P) = \frac{1}{2}(\frac{5}{2}^-)$$

Re(pole position) = 1655 to 1665 (≈ 1660) MeV $-2\text{Im}(\text{pole position}) = 125$ to 150 (≈ 135) MeVBreit-Wigner mass = 1665 to 1680 (≈ 1675) MeVBreit-Wigner full width = 130 to 160 (≈ 145) MeV

$N(1675)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	38–42 %	564
$N\eta$	< 1 %	376
$N\pi\pi$	25–45 %	532
$\Delta(1232)\pi$, D -wave	23–37 %	366
$N\sigma$	3–7 %	–
$p\gamma$	0–0.02 %	575
$p\gamma$, helicity=1/2	0–0.01 %	575
$p\gamma$, helicity=3/2	0–0.01 %	575
$n\gamma$	0–0.15 %	574
$n\gamma$, helicity=1/2	0–0.05 %	574
$n\gamma$, helicity=3/2	0–0.10 %	574

 $N(1680) 5/2^+$

$$I(J^P) = \frac{1}{2}(\frac{5}{2}^+)$$

Re(pole position) = 1665 to 1680 (≈ 1675) MeV $-2\text{Im}(\text{pole position}) = 110$ to 135 (≈ 120) MeVBreit-Wigner mass = 1680 to 1690 (≈ 1685) MeVBreit-Wigner full width = 115 to 130 (≈ 120) MeV

$N(1680)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	60–70 %	571
$N\eta$	<1 %	386
$N\pi\pi$	20–40 %	539
$\Delta(1232)\pi$	11–23 %	374
$\Delta(1232)\pi$, P -wave	4–10 %	374
$\Delta(1232)\pi$, F -wave	1–13 %	374
$N\sigma$	9–19 %	–
$p\gamma$	0.21–0.32 %	581
$p\gamma$, helicity=1/2	0.001–0.011 %	581
$p\gamma$, helicity=3/2	0.20–0.32 %	581
$n\gamma$	0.021–0.046 %	581
$n\gamma$, helicity=1/2	0.004–0.029 %	581
$n\gamma$, helicity=3/2	0.01–0.024 %	581

$N(1700) 3/2^-$

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

Re(pole position) = 1650 to 1750 (≈ 1700) MeV $-2\text{Im}(\text{pole position}) = 100$ to 300 (≈ 200) MeVBreit-Wigner mass = 1650 to 1800 (≈ 1720) MeVBreit-Wigner full width = 100 to 300 (≈ 200) MeV

$N(1700)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	7–17 %	594
$N\eta$	seen	422
$N\omega$	10–34 %	†
$N\pi\pi$	60–90 %	564
$\Delta(1232)\pi$	55–85 %	402
$\Delta(1232)\pi$, S -wave	50–80 %	402
$\Delta(1232)\pi$, D -wave	4–14 %	402
$N(1440)\pi$	3–11 %	225
$N(1520)\pi$	<4 %	145
$N\rho$, $S=3/2$, S -wave	32–44 %	74
$N\sigma$	2–14 %	–
$p\gamma$	0.01–0.05 %	604
$p\gamma$, helicity=1/2	0.0–0.024 %	604
$p\gamma$, helicity=3/2	0.002–0.026 %	604
$n\gamma$	0.01–0.13 %	603
$n\gamma$, helicity=1/2	0.0–0.09 %	603
$n\gamma$, helicity=3/2	0.01–0.05 %	603

 $N(1710) 1/2^+$

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

Re(pole position) = 1680 to 1720 (≈ 1700) MeV $-2\text{Im}(\text{pole position}) = 80$ to 160 (≈ 120) MeVBreit-Wigner mass = 1680 to 1740 (≈ 1710) MeVBreit-Wigner full width = 80 to 200 (≈ 140) MeV

$N(1710)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	5–20 %	588
$N\eta$	10–50 %	412
$N\omega$	1–5 %	†
ΛK	5–25 %	269
ΣK	seen	138

$N\pi\pi$	seen	557
$\Delta(1232)\pi$, P -wave	3–9 %	394
$N(1535)\pi$	9–21 %	113
$N\rho$, $S=1/2$, P -wave	11–23 %	†
$p\gamma$, helicity=1/2	0.002–0.08 %	598
$n\gamma$, helicity=1/2	0.0–0.02%	597

 $N(1720) 3/2^+$

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

Re(pole position) = 1660 to 1690 (≈ 1675) MeV

–2Im(pole position) = 150 to 400 (≈ 250) MeV

Breit-Wigner mass = 1680 to 1750 (≈ 1720) MeV

Breit-Wigner full width = 150 to 400 (≈ 250) MeV

$N(1720)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	8–14 %	594
$N\eta$	1–5 %	422
$N\omega$	12–40 %	†
ΛK	4–5 %	283
$N\pi\pi$	50–90 %	564
$\Delta(1232)\pi$	47–89 %	402
$\Delta(1232)\pi$, P -wave	47–77 %	402
$\Delta(1232)\pi$, F -wave	<12 %	402
$N\rho$, $S=1/2$, P -wave	1–2 %	74
$N\sigma$	2–14 %	–
$N(1440)\pi$	<2 %	225
$N(1520)\pi$, S -wave	1–5 %	145
$p\gamma$	0.05–0.25 %	604
$p\gamma$, helicity=1/2	0.05–0.15 %	604
$p\gamma$, helicity=3/2	0.002–0.16 %	604
$n\gamma$	0.0–0.016 %	603
$n\gamma$, helicity=1/2	0.0–0.01 %	603
$n\gamma$, helicity=3/2	0.0–0.015 %	603

 $N(1875) 3/2^-$

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

Re(pole position) = 1850 to 1950 (≈ 1900) MeV

–2Im(pole position) = 100 to 220 (≈ 160) MeV

Breit-Wigner mass = 1850 to 1920 (≈ 1875) MeV

Breit-Wigner full width = 120 to 250 (≈ 200) MeV

$N(1875)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	3–11 %	695
$N\eta$	<1 %	559
$N\omega$	15–25 %	371
ΛK	seen	454
ΣK	seen	384
$N\pi\pi$		670
$\Delta(1232)\pi$	10–35 %	520
$\Delta(1232)\pi$, S -wave	7–21 %	520
$\Delta(1232)\pi$, D -wave	2–12 %	520
$N\rho$, $S=3/2$, S -wave	seen	379
$N\sigma$	30–60 %	–
$N(1440)\pi$	2–8 %	365
$N(1520)\pi$	<2 %	301
$p\gamma$	0.001–0.025 %	703
$p\gamma$, helicity=1/2	0.001–0.021 %	703
$p\gamma$, helicity=3/2	<0.003 %	703
$n\gamma$	<0.040 %	702
$n\gamma$, helicity=1/2	<0.007 %	702
$n\gamma$, helicity=3/2	<0.033 %	702

 $N(1880) 1/2^+$

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

Re(pole position) = 1820 to 1900 (≈ 1860) MeV

–2Im(pole position) = 180 to 280 (≈ 230) MeV

Breit-Wigner mass = 1830 to 1930 (≈ 1880) MeV

Breit-Wigner full width = 200 to 400 (≈ 300) MeV

$N(1880)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	3–9 %	698
$N\eta$	5–55 %	563
$N\omega$	12–28 %	377
ΛK	12–28 %	459
ΣK	10–24 %	389
$N\pi\pi$	30–80 %	673
$\Delta(1232)\pi$	18–42 %	524
$N\sigma$	10–40 %	539
$N(1535)\pi$	4–12 %	293
$N a_0(980)$	1–5 %	†
$\Lambda K^*(892)$	0.5–1 %	†

$p\gamma$, helicity=1/2	seen	706
$n\gamma$, helicity=1/2	0.002–0.63 %	705

 $N(1895) 1/2^-$

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

Re(pole position) = 1890 to 1930 (≈ 1910) MeV

$-2\text{Im}(\text{pole position}) = 80$ to 140 (≈ 110) MeV

Breit-Wigner mass = 1870 to 1920 (≈ 1895) MeV

Breit-Wigner full width = 80 to 200 (≈ 120) MeV

$N(1895)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	2–18 %	707
$N\eta$	15–40 %	575
$N\eta'$	10–40 %	†
$N\omega$	16–40 %	395
ΛK	13–23 %	473
ΣK	6–20 %	405
$\Delta(1232)\pi$, D -wave	3–11 %	535
$N\rho$, $S=1/2$, S -wave	seen	403
$N\rho$, $S=3/2$, D -wave	3–12 %	403
$\Lambda K^*(892)$	4–9 %	†
$N\sigma$	seen	–
$N(1440)\pi$	1–4 %	382
$p\gamma$, helicity=1/2	0.01–0.06 %	715
$n\gamma$, helicity=1/2	0.003–0.05 %	715

 $N(1900) 3/2^+$

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

Re(pole position) = 1900 to 1940 (≈ 1920) MeV

$-2\text{Im}(\text{pole position}) = 100$ to 200 (≈ 150) MeV

Breit-Wigner mass = 1890 to 1950 (≈ 1920) MeV

Breit-Wigner full width = 100 to 320 (≈ 200) MeV

$N(1900)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	1–20 %	723
$N\eta$	2–14 %	595
$N\eta'$	4–8 %	151
$N\omega$	7–13 %	424
ΛK	2–20 %	495
ΣK	3–7 %	431
$N\pi\pi$	40–80 %	699

$\Delta(1232)\pi$	30–70 %	553
$\Delta(1232)\pi$, <i>P</i> -wave	9–25 %	553
$\Delta(1232)\pi$, <i>F</i> -wave	21–45 %	553
$\Lambda K^*(892)$	< 0.2 %	†
$N\sigma$	1–7 %	–
$N(1520)\pi$	7–23 %	341
$N(1535)\pi$	4–10 %	328
$p\gamma$	0.001–0.025 %	731
$p\gamma$, helicity=1/2	0.001–0.021 %	731
$p\gamma$, helicity=3/2	<0.003 %	731
$n\gamma$	<0.040 %	730
$n\gamma$, helicity=1/2	<0.007 %	730
$n\gamma$, helicity=3/2	<0.033 %	730

$N(2060) 5/2^-$

$$I(J^P) = \frac{1}{2}(5_2^-)$$

Re(pole position) = 2020 to 2130 (≈ 2070) MeV

–2Im(pole position) = 350 to 430 (≈ 400) MeV

Breit-Wigner mass = 2030 to 2200 (≈ 2100) MeV

Breit-Wigner full width = 300 to 450 (≈ 400) MeV

$N(2060)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	7–12 %	834
$N\eta$	2–6 %	729
$N\omega$	1–7 %	600
ΛK	seen	644
ΣK	1–5 %	593
$N\pi\pi$	7–19 %	814
$\Delta(1232)\pi$, <i>D</i> -wave	4–10 %	680
$N\rho$, $S=1/2$, <i>P</i> -wave	seen	605
$\Lambda K^*(892)$	0.3–1.3 %	307
$N\sigma$	3–9 %	–
$N(1440)\pi$	4–14 %	544
$N(1520)\pi$, <i>P</i> -wave	9–21 %	490
$N(1680)\pi$, <i>S</i> -wave	8–22 %	353
$p\gamma$	0.03–0.19 %	840
$p\gamma$, helicity=1/2	0.02–0.08 %	840
$p\gamma$, helicity=3/2	0.01–0.10 %	840
$n\gamma$	0.003–0.07 %	840
$n\gamma$, helicity=1/2	0.001–0.02 %	840
$n\gamma$, helicity=3/2	0.002–0.05 %	840

$N(2100) 1/2^+$

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

Re(pole position) = 2050 to 2150 (≈ 2100) MeV $-2\text{Im}(\text{pole position}) = 240$ to 340 (≈ 300) MeVBreit-Wigner mass = 2050 to 2150 (≈ 2100) MeVBreit-Wigner full width = 200 to 320 (≈ 260) MeV

$N(2100)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	8–18 %	834
$N\eta$	seen	729
$N\eta'$	5–11 %	451
$N\omega$	10–25 %	600
ΛK	seen	644
$N\pi\pi$	20–40 %	814
$\Delta(1232)\pi$, P -wave	6–14 %	680
$N\rho$, $S=1/2$, P -wave	seen	605
$\Lambda K^*(892)$	3–11 %	307
$N\sigma$	14–26 %	–
$N(1535)\pi$	26–34 %	478
$N\gamma$, helicity=1/2	0.001–0.012 %	840

 $N(2120) 3/2^-$

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

Re(pole position) = 2050 to 2150 (≈ 2100) MeV $-2\text{Im}(\text{pole position}) = 200$ to 360 (≈ 280) MeVBreit-Wigner mass = 2060 to 2160 (≈ 2120) MeVBreit-Wigner full width = 260 to 360 (≈ 300) MeV

$N(2120)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	5–15 %	846
$N\eta'$	2–6 %	474
$N\omega$	4–20 %	617
$N\pi\pi$	50–95 %	827
$\Delta(1232)\pi$	40–90 %	693
$\Delta(1232)\pi$, S -wave	30–70 %	693
$\Delta(1232)\pi$, D -wave	8–32 %	693
$\Lambda K^*(892)$	< 0.2 %	339
$N\sigma$	7–15 %	–
$N(1535)\pi$	7–23 %	494

$p\gamma$	0.16–2.1 %	852
$p\gamma$, helicity=1/2	0.07–0.80 %	852
$p\gamma$, helicity=3/2	0.09–1.3 %	852
$n\gamma$	0.04–0.72 %	852
$n\gamma$, helicity=1/2	0.04–0.60 %	852
$n\gamma$, helicity=3/2	0.001–0.12 %	852

 $N(2190) 7/2^-$

$$I(J^P) = \frac{1}{2}(\frac{7}{2}^-)$$

Re(pole position) = 2050 to 2150 (≈ 2100) MeV

$-2\text{Im}(\text{pole position}) = 300$ to 500 (≈ 400) MeV

Breit-Wigner mass = 2140 to 2220 (≈ 2180) MeV

Breit-Wigner full width = 300 to 500 (≈ 400) MeV

$N(2190)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	10–20 %	882
$N\eta$	1–3 %	785
$N\omega$	8–20 %	667
$\Delta(1232)\pi$, D -wave	19–31 %	734
$N\rho$, $S=3/2$, D -wave	seen	672
$\Lambda K^*(892)$	0.2–0.8 %	423
$N\sigma$	3–9 %	–
$p\gamma$	0.014–0.077 %	888
$n\gamma$	<0.04 %	888
$n\gamma$, helicity=3/2	<0.03 %	888

 $N(2220) 9/2^+$

$$I(J^P) = \frac{1}{2}(\frac{9}{2}^+)$$

Re(pole position) = 2130 to 2200 (≈ 2170) MeV

$-2\text{Im}(\text{pole position}) = 360$ to 480 (≈ 400) MeV

Breit-Wigner mass = 2200 to 2300 (≈ 2250) MeV

Breit-Wigner full width = 350 to 500 (≈ 400) MeV

$N(2220)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	15–30 %	924

 $N(2250) 9/2^-$

$$I(J^P) = \frac{1}{2}(\frac{9}{2}^-)$$

Re(pole position) = 2150 to 2250 (≈ 2200) MeV

$-2\text{Im}(\text{pole position}) = 350$ to 500 (≈ 420) MeV

Breit-Wigner mass = 2250 to 2320 (≈ 2280) MeV

Breit-Wigner full width = 300 to 600 (≈ 500) MeV

$N(2250)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	0.05 to 0.15 (≈ 0.10)	941

 $N(2600) 11/2^-$

$$I(J^P) = \frac{1}{2}(\frac{11}{2}^-)$$

Breit-Wigner mass = 2550 to 2750 (≈ 2600) MeVBreit-Wigner full width = 500 to 800 (≈ 650) MeV

$N(2600)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	3–8 %	1126

Δ BARYONS

($S=0, I=3/2$)

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

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

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

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

$\Delta(1232)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	99.4 %	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
$p e^+ e^-$	$(4.2 \pm 0.7) \times 10^{-5}$	259

 $\Delta(1600) 3/2^+$

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

Re(pole position) = 1460 to 1560 (≈ 1510) MeV–2Im(pole position) = 200 to 340 (≈ 270) MeVBreit-Wigner mass = 1500 to 1640 (≈ 1570) MeVBreit-Wigner full width = 200 to 300 (≈ 250) MeV

$\Delta(1600)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	8–24 %	492
$N\pi\pi$	75–90 %	454
$\Delta(1232)\pi$	73–83 %	276
$\Delta(1232)\pi$, P -wave	72–82 %	276
$\Delta(1232)\pi$, F -wave	<2 %	276
$N(1440)\pi$, P -wave	15–25 %	†
$N\gamma$	0.001–0.035 %	505
$N\gamma$, helicity=1/2	0.0–0.02 %	505
$N\gamma$, helicity=3/2	0.001–0.015 %	505

 $\Delta(1620) 1/2^-$

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

Re(pole position) = 1590 to 1610 (≈ 1600) MeV

–2Im(pole position) = 100 to 140 (≈ 120) MeV

Breit-Wigner mass = 1590 to 1630 (≈ 1610) MeV

Breit-Wigner full width = 110 to 150 (≈ 130) MeV

$\Delta(1620)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	25–35 %	520
$N\pi\pi$	55–80 %	484
$\Delta(1232)\pi$, D -wave	52–72 %	311
$N\rho$, $S=1/2$, S -wave	seen	†
$N\rho$, $S=3/2$, D -wave	seen	†
$N(1440)\pi$	3–9 %	98
$N\gamma$, helicity=1/2	0.03–0.10 %	532

 $\Delta(1700) 3/2^-$

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

Re(pole position) = 1640 to 1690 (≈ 1665) MeV

–2Im(pole position) = 200 to 300 (≈ 250) MeV

Breit-Wigner mass = 1690 to 1730 (≈ 1710) MeV

Breit-Wigner full width = 220 to 380 (≈ 300) MeV

$\Delta(1700)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	10–20 %	588
$N\pi\pi$	10–55 %	557
$\Delta(1232)\pi$	10–50 %	394
$\Delta(1232)\pi$, S -wave	5–35 %	394
$\Delta(1232)\pi$, D -wave	4–16 %	394

$N\rho$, $S=3/2$, S -wave	seen	†
$N(1520)\pi$, P -wave	1–5 %	133
$N(1535)\pi$	0.5–1.5 %	113
$\Delta(1232)\eta$	3–7 %	†
$N\gamma$	0.22–0.60 %	598
$N\gamma$, helicity=1/2	0.12–0.30 %	598
$N\gamma$, helicity=3/2	0.10–0.30 %	598

 $\Delta(1900) 1/2^-$

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

Re(pole position) = 1830 to 1900 (≈ 1865) MeV

–2Im(pole position) = 180 to 300 (≈ 240) MeV

Breit-Wigner mass = 1840 to 1920 (≈ 1860) MeV

Breit-Wigner full width = 180 to 320 (≈ 250) MeV

$\Delta(1900)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	4–12 %	685
ΣK	seen	367
$N\pi\pi$	45–85 %	660
$\Delta(1232)\pi$, D -wave	30–70 %	509
$N\rho$, $S=1/2$, S -wave	8–16 %	360
$N\rho$, $S=3/2$, D -wave	18–28 %	360
$N(1440)\pi$	8–32 %	353
$N(1520)\pi$	2–10 %	288
$\Delta(1232)\eta$	0–2 %	251
$N\gamma$, helicity=1/2	0.06–0.43 %	693

 $\Delta(1905) 5/2^+$

$$I(J^P) = \frac{3}{2}(\frac{5}{2}^+)$$

Re(pole position) = 1770 to 1830 (≈ 1800) MeV

–2Im(pole position) = 260 to 340 (≈ 300) MeV

Breit-Wigner mass = 1855 to 1910 (≈ 1880) MeV

Breit-Wigner full width = 270 to 400 (≈ 330) MeV

$\Delta(1905)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	9–15 %	698
$N\pi\pi$		673
$\Delta(1232)\pi$	80–100 %	524
$\Delta(1232)\pi$, P -wave	23–43 %	524
$\Delta(1232)\pi$, F -wave	56–72 %	524
$N\rho$, $S=3/2$, P -wave	seen	385

$N(1535)\pi$	< 1 %	293
$N(1680)\pi$, P -wave	5–15 %	133
$\Delta(1232)\eta$	2–6 %	282
$N\gamma$	0.012–0.036 %	706
$N\gamma$, helicity=1/2	0.002–0.006 %	706
$N\gamma$, helicity=3/2	0.01–0.03 %	706

 $\Delta(1910) 1/2^+$

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

Re(pole position) = 1830 to 1890 (≈ 1860) MeV

–2Im(pole position) = 200 to 400 (≈ 300) MeV

Breit-Wigner mass = 1850 to 1950 (≈ 1900) MeV

Breit-Wigner full width = 200 to 400 (≈ 300) MeV

$\Delta(1910)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	15–30 %	710
ΣK	4–14 %	410
$N\pi\pi$		686
$\Delta(1232)\pi$	34–66 %	539
$N(1440)\pi$	3–9 %	386
$\Delta(1232)\eta$	5–13 %	310
$N\gamma$, helicity=1/2	0.0–0.02 %	718

 $\Delta(1920) 3/2^+$

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

Re(pole position) = 1850 to 1950 (≈ 1900) MeV

–2Im(pole position) = 200 to 400 (≈ 300) MeV

Breit-Wigner mass = 1870 to 1970 (≈ 1920) MeV

Breit-Wigner full width = 240 to 360 (≈ 300) MeV

$\Delta(1920)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	5–20 %	723
ΣK	2–6 %	431
$N\pi\pi$		699
$\Delta(1232)\pi$	50–90 %	553
$\Delta(1232)\pi$, P -wave	8–28 %	553
$\Delta(1232)\pi$, F -wave	44–72 %	553

$N(1440)\pi$, P -wave	<4 %	403
$N(1520)\pi$, S -wave	<5 %	341
$N(1535)\pi$	<2 %	328
$N a_0(980)$	seen	41
$\Delta(1232)\eta$	5–17 %	336

 $\Delta(1930) 5/2^-$

$$I(J^P) = \frac{3}{2}(\frac{5}{2}^-)$$

Re(pole position) = 1840 to 1920 (≈ 1880) MeV

–2Im(pole position) = 230 to 330 (≈ 280) MeV

Breit-Wigner mass = 1900 to 2000 (≈ 1950) MeV

Breit-Wigner full width = 200 to 400 (≈ 300) MeV

$\Delta(1930)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	5–15 %	742
$N\gamma$	0.0–0.01 %	749
$N\gamma$, helicity=1/2	0.0–0.005 %	749
$N\gamma$, helicity=3/2	0.0–0.004 %	749

 $\Delta(1950) 7/2^+$

$$I(J^P) = \frac{3}{2}(\frac{7}{2}^+)$$

Re(pole position) = 1870 to 1890 (≈ 1880) MeV

–2Im(pole position) = 220 to 260 (≈ 240) MeV

Breit-Wigner mass = 1915 to 1950 (≈ 1930) MeV

Breit-Wigner full width = 235 to 335 (≈ 285) MeV

$\Delta(1950)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	35–45 %	729
ΣK	0.3–0.5 %	441
$N\pi\pi$		706
$\Delta(1232)\pi$, F -wave	1–9 %	560
$N(1680)\pi$, P -wave	3–9 %	191
$\Delta(1232)\eta$	< 0.6 %	349

 $\Delta(2200) 7/2^-$

$$I(J^P) = \frac{3}{2}(\frac{7}{2}^-)$$

Re(pole position) = 2050 to 2150 (≈ 2100) MeV

–2Im(pole position) = 260 to 420 (≈ 340) MeV

Breit-Wigner mass = 2150 to 2250 (≈ 2200) MeV

Breit-Wigner full width = 200 to 500 (≈ 350) MeV

$\Delta(2200)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	2–8 %	894
ΣK	1–7 %	672
$\Delta\pi$, D -wave	40–100 %	747
$\Delta\pi$, G -wave	5–25 %	747
$\Delta\eta$, D -wave	seen	614

 $\Delta(2420)$ $11/2^+$

$$I(J^P) = \frac{3}{2}(\frac{11}{2}^+)$$

Re(pole position) = 2300 to 2500 (\approx 2400) MeV

–2Im(pole position) = 350 to 550 (\approx 450) MeV

Breit-Wigner mass = 2300 to 2600 (\approx 2450) MeV

Breit-Wigner full width = 300 to 700 (\approx 500) MeV

$\Delta(2420)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	5–10 %	1040

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

$(m_\Lambda - m_{\bar{\Lambda}}) / m_\Lambda = (-0.1 \pm 1.1) \times 10^{-5}$ ($S = 1.6$)

Mean life $\tau = (2.632 \pm 0.020) \times 10^{-10}$ s ($S = 1.6$)

$(\tau_\Lambda - \tau_{\bar{\Lambda}}) / \tau_\Lambda = -0.001 \pm 0.009$

$$c\tau = 7.89 \text{ cm}$$

Magnetic moment $\mu = -0.613 \pm 0.004 \mu_N$

Electric dipole moment $d < 1.5 \times 10^{-16}$ ecm, CL = 95%

Decay parameters

$$p\pi^- \quad \alpha_- = 0.750 \pm 0.010$$

$$\bar{p}\pi^+ \quad \alpha_+ = -0.758 \pm 0.012$$

$$\bar{\alpha}_0 \text{ FOR } \bar{\Lambda} \rightarrow \bar{n}\pi^0 = -0.692 \pm 0.017$$

$$p\pi^- \quad \phi_- = (-6.5 \pm 3.5)^\circ$$

$$" \quad \gamma_- = 0.76 [n]$$

$$" \quad \Delta_- = (8 \pm 4)^\circ [n]$$

$$\begin{aligned} \bar{\alpha}_0 / \alpha_+ \text{ in } \bar{\Lambda} \rightarrow \bar{n}\pi^0, \bar{\Lambda} \rightarrow \bar{p}\pi^+ &= 0.913 \pm 0.030 \\ n\pi^0 &\alpha_0 = 0.75 \pm 0.05 \\ p e^- \bar{\nu}_e &g_A/g_V = -0.718 \pm 0.015 [i] \end{aligned}$$

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

Lepton (L) and/or Baryon (B) number violating decay modes

$\pi^+ e^-$	L, B	< 6	$\times 10^{-7}$	90%	549
$\pi^+ \mu^-$	L, B	< 6	$\times 10^{-7}$	90%	544
$\pi^- e^+$	L, B	< 4	$\times 10^{-7}$	90%	549
$\pi^- \mu^+$	L, B	< 6	$\times 10^{-7}$	90%	544
$K^+ e^-$	L, B	< 2	$\times 10^{-6}$	90%	449
$K^+ \mu^-$	L, B	< 3	$\times 10^{-6}$	90%	441
$K^- e^+$	L, B	< 2	$\times 10^{-6}$	90%	449
$K^- \mu^+$	L, B	< 3	$\times 10^{-6}$	90%	441
$K_S^0 \nu$	L, B	< 2	$\times 10^{-5}$	90%	447
$\bar{p}\pi^+$	B	< 9	$\times 10^{-7}$	90%	101

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

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

Mass $m = 1405.1_{-1.0}^{+1.3}$ MeV
 Full width $\Gamma = 50.5 \pm 2.0$ MeV
 Below $\bar{K}N$ 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 [p]
 Full width $\Gamma = 15.6 \pm 1.0$ MeV [p]

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

 $\Lambda(1600) 1/2^+$

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

Mass $m = 1560$ to 1700 (≈ 1600) MeVFull width $\Gamma = 50$ to 250 (≈ 150) MeV

$\Lambda(1600)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	15–30 %	343
$\Sigma \pi$	10–60 %	338

 $\Lambda(1670) 1/2^-$

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

Mass $m = 1660$ to 1680 (≈ 1670) MeVFull width $\Gamma = 25$ to 50 (≈ 35) MeV

$\Lambda(1670)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	20–30 %	414
$\Sigma \pi$	25–55 %	394
$\Lambda \eta$	10–25 %	69
$N\bar{K}^*(892)$, $S=3/2$, D -wave	(5 \pm 4) %	†

 $\Lambda(1690) 3/2^-$

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

Mass $m = 1685$ to 1695 (≈ 1690) MeVFull width $\Gamma = 50$ to 70 (≈ 60) MeV

$\Lambda(1690)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	20–30 %	433
$\Sigma \pi$	20–40 %	410
$\Lambda \pi \pi$	~ 25 %	419
$\Sigma \pi \pi$	~ 20 %	358

 $\Lambda(1800) 1/2^-$

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

Mass $m = 1720$ to 1850 (≈ 1800) MeVFull width $\Gamma = 200$ to 400 (≈ 300) MeV

$\Lambda(1800)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	25–40 %	528
$\Sigma\pi$	seen	494
$\Sigma(1385)\pi$	seen	349
$\Lambda\eta$	(6 ± 5) %	326
$N\bar{K}^*(892)$	seen	†

$\Lambda(1810) 1/2^+$

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

Mass $m = 1750$ to 1850 (≈ 1810) MeV

Full width $\Gamma = 50$ to 250 (≈ 150) MeV

$\Lambda(1810)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	20–50 %	537
$\Sigma\pi$	10–40 %	501
$\Sigma(1385)\pi$	seen	357
$N\bar{K}^*(892)$	30–60 %	†

$\Lambda(1820) 5/2^+$

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

Mass $m = 1815$ to 1825 (≈ 1820) MeV

Full width $\Gamma = 70$ to 90 (≈ 80) MeV

$\Lambda(1820)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	55–65 %	545
$\Sigma\pi$	8–14 %	509
$\Sigma(1385)\pi$	5–10 %	366
$N\bar{K}^*(892)$, $S=3/2$, P -wave	(3.0 ± 1.0) %	†

$\Lambda(1830) 5/2^-$

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

Mass $m = 1810$ to 1830 (≈ 1830) MeV

Full width $\Gamma = 60$ to 110 (≈ 95) MeV

$\Lambda(1830)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	3–10 %	553
$\Sigma\pi$	35–75 %	516

$\Sigma(1385)\pi$	>15 %	374
$\Sigma(1385)\pi$, <i>D</i> -wave	(52 ± 6) %	374

 $\Lambda(1890) 3/2^+$

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

Mass $m = 1850$ to 1910 (≈ 1890) MeVFull width $\Gamma = 60$ to 200 (≈ 100) MeV

$\Lambda(1890)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	20–35 %	599
$\Sigma\pi$	3–10 %	560
$\Sigma(1385)\pi$	seen	423
$N\bar{K}^*(892)$	seen	236

 $\Lambda(2100) 7/2^-$

$$I(J^P) = 0(\frac{7}{2}^-)$$

Mass $m = 2090$ to 2110 (≈ 2100) MeVFull width $\Gamma = 100$ to 250 (≈ 200) MeV

$\Lambda(2100)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	25–35 %	751
$\Sigma\pi$	~ 5 %	705
$\Lambda\eta$	<3 %	617
ΞK	<3 %	491
$\Lambda\omega$	<8 %	443
$N\bar{K}^*(892)$	10–20 %	515

 $\Lambda(2110) 5/2^+$

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

Mass $m = 2090$ to 2140 (≈ 2110) MeVFull width $\Gamma = 150$ to 250 (≈ 200) MeV

$\Lambda(2110)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	5–25 %	757
$\Sigma\pi$	10–40 %	711
$\Lambda\omega$	seen	455
$\Sigma(1385)\pi$	seen	591
$N\bar{K}^*(892)$	10–60 %	525

$\Lambda(2350) 9/2^+$

$$I(J^P) = 0(\frac{9}{2}^+)$$

Mass $m = 2340$ to 2370 (≈ 2350) MeVFull width $\Gamma = 100$ to 250 (≈ 150) MeV

$\Lambda(2350)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	$\sim 12\%$	915
$\Sigma\pi$	$\sim 10\%$	867

Σ BARYONS

$(S = -1, I = 1)$

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

 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

$$(\tau_{\Sigma^+} - \tau_{\Sigma^-}) / \tau_{\Sigma^+} = -0.0006 \pm 0.0012$$

Magnetic moment $\mu = 2.458 \pm 0.010 \mu_N$ ($S = 2.1$)

$$(\mu_{\Sigma^+} + \mu_{\Sigma^-}) / \mu_{\Sigma^+} = 0.014 \pm 0.015$$

$$\Gamma(\Sigma^+ \rightarrow n\ell^+\nu) / \Gamma(\Sigma^- \rightarrow n\ell^-\bar{\nu}) < 0.043$$

Decay parameters

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

Σ^+ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$p\pi^0$	$(51.57 \pm 0.30)\%$		189
$n\pi^+$	$(48.31 \pm 0.30)\%$		185
$p\gamma$	$(1.23 \pm 0.05) \times 10^{-3}$		225

$n\pi^+\gamma$	[o]	$(4.5 \pm 0.5) \times 10^{-4}$	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	$(2.4 \begin{smallmatrix} +1.7 \\ -1.3 \end{smallmatrix})$	$\times 10^{-8}$		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	$\frac{P}{(\text{MeV}/c)}$
$\Lambda\gamma$	100 %		74
$\Lambda\gamma\gamma$	< 3 %	90%	74
Λe^+e^-	[q] 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 ± 0.10 fm

Decay parameters

$n\pi^-$ $\alpha_- = -0.068 \pm 0.008$

" $\phi_- = (10 \pm 15)^\circ$

" $\gamma_- = 0.98$ [n]

" $\Delta_- = (249 \begin{smallmatrix} + \\ - \end{smallmatrix} \begin{smallmatrix} 12 \\ 120 \end{smallmatrix})^\circ$ [n]

$ne^-\bar{\nu}_e$ $g_A/g_V = 0.340 \pm 0.017$ [i]

" $f_2(0)/f_1(0) = 0.97 \pm 0.14$

$$\begin{aligned}
 & \text{"} && D = 0.11 \pm 0.10 \\
 \Lambda e^- \bar{\nu}_e & && g_V/g_A = 0.01 \pm 0.10 \text{ [i]} \quad (S = 1.5) \\
 & \text{"} && g_{WM}/g_A = 2.4 \pm 1.7 \text{ [i]}
 \end{aligned}$$

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

$\Sigma(1385) 3/2^+$

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

$$\Sigma(1385)^+ \text{ mass } m = 1382.80 \pm 0.35 \text{ MeV} \quad (S = 1.9)$$

$$\Sigma(1385)^0 \text{ mass } m = 1383.7 \pm 1.0 \text{ MeV} \quad (S = 1.4)$$

$$\Sigma(1385)^- \text{ mass } m = 1387.2 \pm 0.5 \text{ MeV} \quad (S = 2.2)$$

$$\Sigma(1385)^+ \text{ full width } \Gamma = 36.0 \pm 0.7 \text{ MeV}$$

$$\Sigma(1385)^0 \text{ full width } \Gamma = 36 \pm 5 \text{ MeV}$$

$$\Sigma(1385)^- \text{ full width } \Gamma = 39.4 \pm 2.1 \text{ MeV} \quad (S = 1.7)$$

Below $\bar{K}N$ threshold

$\Sigma(1385)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\Lambda\pi$	$(87.0 \pm 1.5) \%$		208
$\Sigma\pi$	$(11.7 \pm 1.5) \%$		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

$\Sigma(1660) 1/2^+$

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

$$\text{Mass } m = 1630 \text{ to } 1690 (\approx 1660) \text{ MeV}$$

$$\text{Full width } \Gamma = 40 \text{ to } 200 (\approx 100) \text{ MeV}$$

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

$\Sigma(1670) 3/2^-$

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

Mass $m = 1665$ to 1685 (≈ 1670) MeVFull width $\Gamma = 40$ to 80 (≈ 60) MeV

$\Sigma(1670)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	7–13 %	414
$\Lambda\pi$	5–15 %	448
$\Sigma\pi$	30–60 %	394

 $\Sigma(1750) 1/2^-$

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

Mass $m = 1730$ to 1800 (≈ 1750) MeVFull width $\Gamma = 60$ to 160 (≈ 90) MeV

$\Sigma(1750)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	10–40 %	486
$\Lambda\pi$	seen	507
$\Sigma\pi$	<8 %	456
$\Sigma\eta$	15–55 %	98
$N\bar{K}^*(892)$, $S=1/2$	(8 ± 4) %	†

 $\Sigma(1775) 5/2^-$

$$I(J^P) = 1(\frac{5}{2}^-)$$

Mass $m = 1770$ to 1780 (≈ 1775) MeVFull width $\Gamma = 105$ to 135 (≈ 120) MeV

$\Sigma(1775)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	37–43%	508
$\Lambda\pi$	14–20%	525
$\Sigma\pi$	2–5%	475
$\Sigma(1385)\pi$	8–12%	327
$\Lambda(1520)\pi$, P -wave	17–23%	201

 $\Sigma(1915) 5/2^+$

$$I(J^P) = 1(\frac{5}{2}^+)$$

Mass $m = 1900$ to 1935 (≈ 1915) MeVFull width $\Gamma = 80$ to 160 (≈ 120) MeV

$\Sigma(1915)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	5–15 %	618
$\Lambda\pi$	seen	623
$\Sigma\pi$	seen	577
$\Sigma(1385)\pi$	<5 %	443

$\Sigma(1940) 3/2^-$

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

Mass $m = 1900$ to 1950 (≈ 1940) MeV

Full width $\Gamma = 150$ to 300 (≈ 220) MeV

$\Sigma(1940)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	<20 %	637
$\Lambda\pi$	seen	640
$\Sigma\pi$	seen	595
$\Sigma(1385)\pi$	seen	463
$\Lambda(1520)\pi$	seen	355
$\Delta(1232)\bar{K}$	seen	410
$N\bar{K}^*(892)$	seen	322

$\Sigma(2030) 7/2^+$

$$I(J^P) = 1(\frac{7}{2}^+)$$

Mass $m = 2025$ to 2040 (≈ 2030) MeV

Full width $\Gamma = 150$ to 200 (≈ 180) MeV

$\Sigma(2030)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	17–23 %	702
$\Lambda\pi$	17–23 %	700
$\Sigma\pi$	5–10 %	657
ΞK	<2 %	422
$\Sigma(1385)\pi$	5–15 %	532
$\Lambda(1520)\pi$	10–20 %	430
$\Delta(1232)\bar{K}$	10–20 %	498
$N\bar{K}^*(892)$	<5 %	439

$\Sigma(2250)$

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

Mass $m = 2210$ to 2280 (≈ 2250) MeV

Full width $\Gamma = 60$ to 150 (≈ 100) MeV

$\Sigma(2250)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	<10 %	851
$\Lambda\pi$	seen	842
$\Sigma\pi$	seen	803

Ξ BARYONS

$(S = -2, I = 1/2)$

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

Ξ^0

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

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

$$\text{Mass } m = 1314.86 \pm 0.20 \text{ MeV}$$

$$m_{\Xi^-} - m_{\Xi^0} = 6.85 \pm 0.21 \text{ MeV}$$

$$\text{Mean life } \tau = (2.90 \pm 0.09) \times 10^{-10} \text{ s}$$

$$c\tau = 8.71 \text{ cm}$$

$$\text{Magnetic moment } \mu = -1.250 \pm 0.014 \mu_N$$

Decay parameters

$$\Lambda\pi^0 \quad \alpha = -0.347 \pm 0.010$$

$$" \quad \phi = (21 \pm 12)^\circ$$

$$" \quad \gamma = 0.85 [n]$$

$$" \quad \Delta = (218_{-19}^{+12})^\circ [n]$$

$$\Lambda\gamma \quad \alpha = -0.70 \pm 0.07$$

$$\Lambda e^+ e^- \quad \alpha = -0.8 \pm 0.2$$

$$\Sigma^0\gamma \quad \alpha = -0.69 \pm 0.06$$

$$\Sigma^+ e^- \bar{\nu}_e \quad g_1(0)/f_1(0) = 1.22 \pm 0.05$$

$$\Sigma^+ e^- \bar{\nu}_e \quad f_2(0)/f_1(0) = 2.0 \pm 0.9$$

Ξ^0 DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\Lambda\pi^0$	$(99.524 \pm 0.012) \%$		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
$\Sigma^+ e^- \bar{\nu}_e$	$(2.52 \pm 0.08) \times 10^{-4}$		120
$\Sigma^+ \mu^- \bar{\nu}_\mu$	$(2.33 \pm 0.35) \times 10^{-6}$		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
$\rho \pi^-$	S2	< 8	$\times 10^{-6}$	90%	299
$\rho e^- \bar{\nu}_e$	S2	< 1.3	$\times 10^{-3}$		323
$\rho \mu^- \bar{\nu}_\mu$	S2	< 1.3	$\times 10^{-3}$		309



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

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

Mass $m = 1321.71 \pm 0.07$ MeV

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

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

$$c\tau = 4.91 \text{ cm}$$

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

$$\text{Magnetic moment } \mu = -0.6507 \pm 0.0025 \mu_N$$

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

Decay parameters

$$\Lambda \pi^- \quad \alpha = -0.392 \pm 0.008$$

$$[\alpha(\Xi^-)\alpha_-(\Lambda) - \alpha(\Xi^+)\alpha_+(\bar{\Lambda})] / [\text{sum}] = (0 \pm 7) \times 10^{-4}$$

$$" \quad \phi = (-2.1 \pm 0.8)^\circ$$

$$" \quad \gamma = 0.89 [n]$$

$$" \quad \Delta = (175.9 \pm 1.5)^\circ [n]$$

$$\Lambda e^- \bar{\nu}_e \quad g_A/g_V = -0.25 \pm 0.05 [i]$$

Ξ^- DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	P (MeV/c)
$\Lambda \pi^-$	$(99.887 \pm 0.035) \%$		140
$\Sigma^- \gamma$	$(1.27 \pm 0.23) \times 10^{-4}$		118
$\Lambda e^- \bar{\nu}_e$	$(5.63 \pm 0.31) \times 10^{-4}$		190
$\Lambda \mu^- \bar{\nu}_\mu$	$(3.5 \text{ }^{+3.5}_{-2.2}) \times 10^{-4}$		163
$\Sigma^0 e^- \bar{\nu}_e$	$(8.7 \pm 1.7) \times 10^{-5}$		123
$\Sigma^0 \mu^- \bar{\nu}_\mu$	< 8	$\times 10^{-4}$	90% 70
$\Xi^0 e^- \bar{\nu}_e$	< 2.3	$\times 10^{-3}$	90% 7

$\Delta S = 2$ forbidden (S2) modes

$n \pi^-$	S2	< 1.9	$\times 10^{-5}$	90%	304
$n e^- \bar{\nu}_e$	S2	< 3.2	$\times 10^{-3}$	90%	327
$n \mu^- \bar{\nu}_\mu$	S2	< 1.5	%	90%	314
$\rho \pi^- \pi^-$	S2	< 4	$\times 10^{-4}$	90%	223

$p\pi^- e^- \bar{\nu}_e$	$S2$	< 4	$\times 10^{-4}$	90%	305
$p\pi^- \mu^- \bar{\nu}_\mu$	$S2$	< 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

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

 $\Xi(1690)$

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

 Mass $m = 1690 \pm 10$ MeV [p]

 Full width $\Gamma < 30$ MeV

$\Xi(1690)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda\bar{K}$	seen	240
$\Sigma\bar{K}$	seen	70
$\Xi\pi$	seen	311
$\Xi^-\pi^+\pi^-$	possibly seen	213

 $\Xi(1820) 3/2^-$

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

 Mass $m = 1823 \pm 5$ MeV [p]

 Full width $\Gamma = 24^{+15}_{-10}$ MeV [p]

$\Xi(1820)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda\bar{K}$	large	402
$\Sigma\bar{K}$	small	324
$\Xi\pi$	small	421
$\Xi(1530)\pi$	small	237

$\Xi(1950)$

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

Mass $m = 1950 \pm 15$ MeV [ρ]

Full width $\Gamma = 60 \pm 20$ MeV [ρ]

$\Xi(1950)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda \bar{K}$	seen	522
$\Sigma \bar{K}$	possibly seen	460
$\Xi \pi$	seen	519

 $\Xi(2030)$

$$I(J^P) = \frac{1}{2}(\geq \frac{5}{2}?)$$

Mass $m = 2025 \pm 5$ MeV [ρ]

Full width $\Gamma = 20_{-5}^{+15}$ MeV [ρ]

$\Xi(2030)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda \bar{K}$	$\sim 20\%$	585
$\Sigma \bar{K}$	$\sim 80\%$	529
$\Xi \pi$	small	574
$\Xi(1530)\pi$	small	416
$\Lambda \bar{K} \pi$	small	499
$\Sigma \bar{K} \pi$	small	428

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

$$(m_{\Omega^-} - m_{\bar{\Omega}^+}) / m_{\Omega^-} = (-1 \pm 8) \times 10^{-5}$$

Mean life $\tau = (0.821 \pm 0.011) \times 10^{-10}$ s

$$c\tau = 2.461$$
 cm

$$(\tau_{\Omega^-} - \tau_{\bar{\Omega}^+}) / \tau_{\Omega^-} = 0.00 \pm 0.05$$

Magnetic moment $\mu = -2.02 \pm 0.05 \mu_N$

Decay parameters

$$\alpha(\Omega^-) \alpha_-(\Lambda) \text{ FOR } \Omega^- \rightarrow \Lambda K^- = 0.0115 \pm 0.0015$$

$$\Lambda K^- \quad \alpha = 0.0154 \pm 0.0020$$

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

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

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

Ω^- DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
ΛK^-	$(67.8 \pm 0.7) \%$		211
$\Xi^0 \pi^-$	$(23.6 \pm 0.7) \%$		294
$\Xi^- \pi^0$	$(8.6 \pm 0.4) \%$		289
$\Xi^- \pi^+ \pi^-$	$(3.7^{+0.7}_{-0.6}) \times 10^{-4}$		189
$\Xi(1530)^0 \pi^-$	$< 7 \times 10^{-5}$	90%	17
$\Xi^0 e^- \bar{\nu}_e$	$(5.6 \pm 2.8) \times 10^{-3}$		319
$\Xi^- \gamma$	$< 4.6 \times 10^{-4}$	90%	314
$\Delta S = 2$ forbidden (S_2) modes			
$\Lambda \pi^-$	$S_2 \quad < 2.9 \times 10^{-6}$	90%	449

$\Omega(2012)^-$

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

$$\text{Mass } m = 2012.4 \pm 0.9 \text{ MeV}$$

$$\text{Full width } \Gamma = 6.4^{+3.0}_{-2.6} \text{ MeV}$$

$\Omega(2012)^-$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi^0 K^-$	seen	403
$\Xi^- K^0$	seen	392

$\Omega(2250)^-$

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

$$\text{Mass } m = 2252 \pm 9 \text{ MeV}$$

$$\text{Full width } \Gamma = 55 \pm 18 \text{ MeV}$$

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

CHARMED BARYONS

($C = +1$)

$$\Lambda_c^+ = udc, \quad \Sigma_c^{++} = uuc, \quad \Sigma_c^+ = udc, \quad \Sigma_c^0 = ddc,$$

$$\Xi_c^+ = usc, \quad \Xi_c^0 = dsc, \quad \Omega_c^0 = ssc$$

Λ_c^+

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

$$\text{Mass } m = 2286.46 \pm 0.14 \text{ MeV}$$

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

$$c\tau = 59.9 \mu\text{m}$$

Decay asymmetry parameters

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

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

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

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

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

$$A_{CP}(\Lambda X) \text{ in } \Lambda_c \rightarrow \Lambda X, \bar{\Lambda}_c \rightarrow \bar{\Lambda} X = (2 \pm 7)\%$$

$$\Delta A_{CP} = A_{CP}(\Lambda_c^+ \rightarrow pK^+K^-) - A_{CP}(\Lambda_c^+ \rightarrow p\pi^+\pi^-) = (0.3 \pm 1.1)\%$$

Branching fractions marked with a footnote, e.g. [a], have been corrected for decay modes not observed in the experiments. For example, the sub-mode fraction $\Lambda_c^+ \rightarrow p\bar{K}^*(892)^0$ seen in $\Lambda_c^+ \rightarrow pK^-\pi^+$ has been multiplied up to include $\bar{K}^*(892)^0 \rightarrow \bar{K}^0\pi^0$ decays.

Λ_c^+ DECAY MODES	Fraction (Γ_j/Γ)	Scale factor/ Confidence level	ρ (MeV/c)
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Hadronic modes with a p or n : $S = -1$ final states

pK_S^0	(1.59 ± 0.08) %	S=1.1	873
$pK^-\pi^+$	(6.28 ± 0.32) %	S=1.4	823
$p\bar{K}^*(892)^0$	[r] (1.96 ± 0.27) %		685
$\Delta(1232)^{++}K^-$	(1.08 ± 0.25) %		710
$\Lambda(1520)\pi^+$	[r] (2.2 ± 0.5) %		627
$pK^-\pi^+$ nonresonant	(3.5 ± 0.4) %		823
$pK_S^0\pi^0$	(1.97 ± 0.13) %	S=1.1	823
$nK_S^0\pi^+$	(1.82 ± 0.25) %		821
$p\bar{K}^0\eta$	(1.6 ± 0.4) %		568

$\rho K_S^0 \pi^+ \pi^-$	(1.60 ± 0.12) %	S=1.1	754
$\rho K^- \pi^+ \pi^0$	(4.46 ± 0.30) %	S=1.5	759
$\rho K^*(892)^- \pi^+$	[r] (1.4 ± 0.5) %		580
$\rho (K^- \pi^+)_{\text{nonresonant}} \pi^0$	(4.6 ± 0.8) %		759
$\Delta(1232) \bar{K}^*(892)$	seen		419
$\rho K^- 2\pi^+ \pi^-$	(1.4 ± 0.9) × 10 ⁻³		671
$\rho K^- \pi^+ 2\pi^0$	(1.0 ± 0.5) %		678

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

$\rho \pi^0$	< 2.7	× 10 ⁻⁴	CL=90%	945
$\rho \eta$	(1.24 ± 0.30) × 10 ⁻³			856
$\rho \omega(782)^0$	(9 ± 4) × 10 ⁻⁴			751
$\rho \pi^+ \pi^-$	(4.61 ± 0.28) × 10 ⁻³			927
$\rho f_0(980)$	[r] (3.5 ± 2.3) × 10 ⁻³			614
$\rho 2\pi^+ 2\pi^-$	(2.3 ± 1.4) × 10 ⁻³			852
$\rho K^+ K^-$	(1.06 ± 0.06) × 10 ⁻³			616
$\rho \phi$	[r] (1.06 ± 0.14) × 10 ⁻³			590
$\rho K^+ K^- \text{ non-}\phi$	(5.3 ± 1.2) × 10 ⁻⁴			616
$\rho \phi \pi^0$	(10 ± 4) × 10 ⁻⁵			460
$\rho K^+ K^- \pi^0 \text{ nonresonant}$	< 6.3	× 10 ⁻⁵	CL=90%	494

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

$\Lambda \pi^+$	(1.30 ± 0.07) %	S=1.1	864	
$\Lambda \pi^+ \pi^0$	(7.1 ± 0.4) %	S=1.1	844	
$\Lambda \rho^+$	< 6	%	CL=95%	636
$\Lambda \pi^- 2\pi^+$	(3.64 ± 0.29) %	S=1.4	807	
$\Sigma(1385)^+ \pi^+ \pi^-, \Sigma^{*+} \rightarrow$	(1.0 ± 0.5) %		688	
$\Lambda \pi^+$				
$\Sigma(1385)^- 2\pi^+, \Sigma^{*-} \rightarrow$	(7.6 ± 1.4) × 10 ⁻³		688	
$\Lambda \pi^-$				
$\Lambda \pi^+ \rho^0$	(1.5 ± 0.6) %		524	
$\Sigma(1385)^+ \rho^0, \Sigma^{*+} \rightarrow \Lambda \pi^+$	(5 ± 4) × 10 ⁻³		363	
$\Lambda \pi^- 2\pi^+ \text{ nonresonant}$	< 1.1	%	CL=90%	807
$\Lambda \pi^- \pi^0 2\pi^+ \text{ total}$	(2.3 ± 0.8) %		757	
$\Lambda \pi^+ \eta$	[r] (2.2 ± 0.5) %		691	
$\Sigma(1385)^+ \eta$	[r] (1.07 ± 0.32) %		570	
$\Lambda \pi^+ \omega$	[r] (1.5 ± 0.5) %		517	
$\Lambda \pi^- \pi^0 2\pi^+, \text{ no } \eta \text{ or } \omega$	< 8	× 10 ⁻³	CL=90%	757
$\Lambda K^+ \bar{K}^0$	(5.7 ± 1.1) × 10 ⁻³	S=1.9	443	
$\Xi(1690)^0 K^+, \Xi^{*0} \rightarrow \Lambda \bar{K}^0$	(1.6 ± 0.5) × 10 ⁻³		286	
$\Sigma^0 \pi^+$	(1.29 ± 0.07) %	S=1.1	825	
$\Sigma^+ \pi^0$	(1.25 ± 0.10) %		827	
$\Sigma^+ \eta$	(6.9 ± 2.3) × 10 ⁻³		713	
$\Sigma^+ \pi^+ \pi^-$	(4.50 ± 0.25) %	S=1.3	804	
$\Sigma^+ \rho^0$	< 1.7	%	CL=95%	575

$\Sigma^- 2\pi^+$		$(1.87 \pm 0.18) \%$		799
$\Sigma^0 \pi^+ \pi^0$		$(3.5 \pm 0.4) \%$		803
$\Sigma^+ \pi^0 \pi^0$		$(1.55 \pm 0.15) \%$		806
$\Sigma^0 \pi^- 2\pi^+$		$(1.11 \pm 0.30) \%$		763
$\Sigma^+ \pi^+ \pi^- \pi^0$		—		767
$\Sigma^+ \omega$	[r]	$(1.70 \pm 0.21) \%$		569
$\Sigma^- \pi^0 2\pi^+$		$(2.1 \pm 0.4) \%$		762
$\Sigma^+ K^+ K^-$		$(3.5 \pm 0.4) \times 10^{-3}$	S=1.1	349
$\Sigma^+ \phi$	[r]	$(3.9 \pm 0.6) \times 10^{-3}$	S=1.1	295
$\Xi(1690)^0 K^+, \Xi^{*0} \rightarrow$		$(1.02 \pm 0.25) \times 10^{-3}$		286
$\Sigma^+ K^-$				
$\Sigma^+ K^+ K^-$ nonresonant		$< 8 \times 10^{-4}$	CL=90%	349
$\Xi^0 K^+$		$(5.5 \pm 0.7) \times 10^{-3}$		653
$\Xi^- K^+ \pi^+$		$(6.2 \pm 0.6) \times 10^{-3}$	S=1.1	565
$\Xi(1530)^0 K^+$		$(4.3 \pm 0.9) \times 10^{-3}$	S=1.1	473

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

ΛK^+		$(6.1 \pm 1.2) \times 10^{-4}$		781
$\Lambda K^+ \pi^+ \pi^-$		$< 5 \times 10^{-4}$	CL=90%	637
$\Sigma^0 K^+$		$(5.2 \pm 0.8) \times 10^{-4}$		735
$\Sigma^0 K^+ \pi^+ \pi^-$		$< 2.6 \times 10^{-4}$	CL=90%	574
$\Sigma^+ K^+ \pi^-$		$(2.1 \pm 0.6) \times 10^{-3}$		670
$\Sigma^+ K^*(892)^0$	[r]	$(3.5 \pm 1.0) \times 10^{-3}$		470
$\Sigma^- K^+ \pi^+$		$< 1.2 \times 10^{-3}$	CL=90%	664

Doubly Cabibbo-suppressed modes

$p K^+ \pi^-$		$(1.11 \pm 0.18) \times 10^{-4}$		823
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Semileptonic modes

$\Lambda e^+ \nu_e$		$(3.6 \pm 0.4) \%$		871
$\Lambda \mu^+ \nu_\mu$		$(3.5 \pm 0.5) \%$		867

Inclusive modes

e^+ anything		$(3.95 \pm 0.35) \%$		—
p anything		$(50 \pm 16) \%$		—
n anything		$(50 \pm 16) \%$		—
Λ anything		$(38.2 \pm 2.9) \%$		—
3prongs		$(24 \pm 8) \%$		—

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

$p e^+ e^-$	C1	$< 5.5 \times 10^{-6}$	CL=90%	951
$p \mu^+ \mu^-$ non-resonant	C1	$< 7.7 \times 10^{-8}$	CL=90%	937
$p e^+ \mu^-$	LF	$< 9.9 \times 10^{-6}$	CL=90%	947
$p e^- \mu^+$	LF	$< 1.9 \times 10^{-5}$	CL=90%	947

$\bar{p}2e^+$	L,B	< 2.7	$\times 10^{-6}$	CL=90%	951
$\bar{p}2\mu^+$	L,B	< 9.4	$\times 10^{-6}$	CL=90%	937
$\bar{p}e^+\mu^+$	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 $\Sigma_c(2455)$.

$$\text{Mass } m = 2592.25 \pm 0.28 \text{ MeV}$$

$$m - m_{\Lambda_c^+} = 305.79 \pm 0.24 \text{ MeV}$$

$$\text{Full width } \Gamma = 2.6 \pm 0.6 \text{ MeV}$$

$\Lambda_c^+\pi\pi$ 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)
$\Lambda_c^+\pi^+\pi^-$	[s] —	117
$\Sigma_c(2455)^{++}\pi^-$	$24 \pm 7\%$	†
$\Sigma_c(2455)^0\pi^+$	$24 \pm 7\%$	†
$\Lambda_c^+\pi^+\pi^-$ 3-body	$18 \pm 10\%$	117
$\Lambda_c^+\pi^0$	[t] 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.

$$\text{Mass } m = 2628.11 \pm 0.19 \text{ MeV} \quad (S = 1.1)$$

$$m - m_{\Lambda_c^+} = 341.65 \pm 0.13 \text{ MeV} \quad (S = 1.1)$$

$$\text{Full width } \Gamma < 0.97 \text{ MeV, CL} = 90\%$$

$\Lambda_c^+\pi\pi$ 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)
$\Lambda_c^+\pi^+\pi^-$	$\approx 67\%$		184
$\Sigma_c(2455)^{++}\pi^-$	< 5	90%	102

$\Sigma_c(2455)^0 \pi^+$	<5	90%	102
$\Lambda_c^+ \pi^+ \pi^-$ 3-body	large		184
$\Lambda_c^+ \pi^0$	[t] not seen		293
$\Lambda_c^+ \gamma$	not seen		319

$\Lambda_c(2860)^+$

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

$$\text{Mass } m = 2856.1^{+2.3}_{-6.0} \text{ MeV}$$

$$\text{Full width } \Gamma = 68^{+12}_{-22} \text{ MeV}$$

$\Lambda_c(2860)^+$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$D^0 p$	seen	259

$\Lambda_c(2880)^+$

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

$$\text{Mass } m = 2881.63 \pm 0.24 \text{ MeV}$$

$$m - m_{\Lambda_c^+} = 595.17 \pm 0.28 \text{ MeV}$$

$$\text{Full width } \Gamma = 5.6^{+0.8}_{-0.6} \text{ MeV}$$

$\Lambda_c(2880)^+$ 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

$\Lambda_c(2940)^+$

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

$J^P = 3/2^-$ is favored, but is not certain

$$\text{Mass } m = 2939.6^{+1.3}_{-1.5} \text{ MeV}$$

$$\text{Full width } \Gamma = 20^{+6}_{-5} \text{ MeV}$$

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

$\Sigma_c(2455)$

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

$$\Sigma_c(2455)^{++} \text{ mass } m = 2453.97 \pm 0.14 \text{ MeV}$$

$$\Sigma_c(2455)^+ \text{ mass } m = 2452.9 \pm 0.4 \text{ MeV}$$

$$\Sigma_c(2455)^0 \text{ mass } m = 2453.75 \pm 0.14 \text{ MeV}$$

$$m_{\Sigma_c^{++}} - m_{\Lambda_c^+} = 167.510 \pm 0.017 \text{ MeV}$$

$$m_{\Sigma_c^+} - m_{\Lambda_c^+} = 166.4 \pm 0.4 \text{ MeV}$$

$$m_{\Sigma_c^0} - m_{\Lambda_c^+} = 167.290 \pm 0.017 \text{ MeV}$$

$$m_{\Sigma_c^{++}} - m_{\Sigma_c^0} = 0.220 \pm 0.013 \text{ MeV}$$

$$m_{\Sigma_c^+} - m_{\Sigma_c^0} = -0.9 \pm 0.4 \text{ MeV}$$

$$\Sigma_c(2455)^{++} \text{ full width } \Gamma = 1.89_{-0.18}^{+0.09} \text{ MeV} \quad (S = 1.1)$$

$$\Sigma_c(2455)^+ \text{ full width } \Gamma < 4.6 \text{ MeV, CL} = 90\%$$

$$\Sigma_c(2455)^0 \text{ full width } \Gamma = 1.83_{-0.19}^{+0.11} \text{ MeV} \quad (S = 1.2)$$

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

 $\Sigma_c(2455)$ DECAY MODESFraction (Γ_i/Γ) p (MeV/c) $\Lambda_c^+ \pi$ $\approx 100\%$

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.

$$\Sigma_c(2520)^{++} \text{ mass } m = 2518.41_{-0.19}^{+0.21} \text{ MeV} \quad (S = 1.1)$$

$$\Sigma_c(2520)^+ \text{ mass } m = 2517.5 \pm 2.3 \text{ MeV}$$

$$\Sigma_c(2520)^0 \text{ mass } m = 2518.48 \pm 0.20 \text{ MeV} \quad (S = 1.1)$$

$$m_{\Sigma_c(2520)^{++}} - m_{\Lambda_c^+} = 231.95_{-0.12}^{+0.17} \text{ MeV} \quad (S = 1.3)$$

$$m_{\Sigma_c(2520)^+} - m_{\Lambda_c^+} = 231.0 \pm 2.3 \text{ MeV}$$

$$m_{\Sigma_c(2520)^0} - m_{\Lambda_c^+} = 232.02_{-0.14}^{+0.15} \text{ MeV} \quad (S = 1.3)$$

$$m_{\Sigma_c(2520)^{++}} - m_{\Sigma_c(2520)^0} = 0.01 \pm 0.15 \text{ MeV}$$

$$\Sigma_c(2520)^{++} \text{ full width } \Gamma = 14.78_{-0.40}^{+0.30} \text{ MeV}$$

$$\Sigma_c(2520)^+ \text{ full width } \Gamma < 17 \text{ MeV, CL} = 90\%$$

$$\Sigma_c(2520)^0 \text{ full width } \Gamma = 15.3_{-0.5}^{+0.4} \text{ MeV}$$

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

 $\Sigma_c(2520)$ DECAY MODESFraction (Γ_i/Γ) p (MeV/c) $\Lambda_c^+ \pi$ $\approx 100\%$

179

$\Sigma_c(2800)$

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

$$\Sigma_c(2800)^{++} \text{ mass } m = 2801_{-6}^{+4} \text{ MeV}$$

$$\Sigma_c(2800)^+ \text{ mass } m = 2792_{-5}^{+14} \text{ MeV}$$

$$\Sigma_c(2800)^0 \text{ mass } m = 2806_{-7}^{+5} \text{ MeV} \quad (S = 1.3)$$

$$m_{\Sigma_c(2800)^{++}} - m_{\Lambda_c^+} = 514_{-6}^{+4} \text{ MeV}$$

$$m_{\Sigma_c(2800)^+} - m_{\Lambda_c^+} = 505_{-5}^{+14} \text{ MeV}$$

$$m_{\Sigma_c(2800)^0} - m_{\Lambda_c^+} = 519_{-7}^{+5} \text{ MeV} \quad (S = 1.3)$$

$$\Sigma_c(2800)^{++} \text{ full width } \Gamma = 75_{-17}^{+22} \text{ MeV}$$

$$\Sigma_c(2800)^+ \text{ full width } \Gamma = 62_{-40}^{+60} \text{ MeV}$$

$$\Sigma_c(2800)^0 \text{ full width } \Gamma = 72_{-15}^{+22} \text{ MeV}$$

 $\Sigma_c(2800)$ DECAY MODES

 Fraction (Γ_i/Γ)

 p (MeV/c)

$\Sigma_c(2800)$ 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.

$$\text{Mass } m = 2467.93 \pm 0.18 \text{ MeV} \quad (S = 1.1)$$

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

$$c\tau = 132 \mu\text{m}$$

Branching fractions marked with a footnote, e.g. [a], have been corrected for decay modes not observed in the experiments. For example, the sub-mode fraction $\Xi_c^+ \rightarrow \Sigma^+ \bar{K}^*(892)^0$ seen in $\Xi_c^+ \rightarrow \Sigma^+ K^- \pi^+$ has been multiplied up to include $\bar{K}^*(892)^0 \rightarrow \bar{K}^0 \pi^0$ decays.

 Ξ_c^+ DECAY MODES

 Fraction (Γ_i/Γ)

 p
 Confidence level (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
$\Lambda \bar{K}^0 \pi^+$	—	852
$\Sigma(1385)^+ \bar{K}^0$	[r] 1.0 ± 0.5	746
$\Lambda K^- 2\pi^+$	0.323 ± 0.033	787
$\Lambda \bar{K}^*(892)^0 \pi^+$	[r] < 0.16	90% 608
$\Sigma(1385)^+ K^- \pi^+$	[r] < 0.23	90% 678

$\Sigma^+ K^- \pi^+$		0.94 ± 0.10		811
$\Sigma^+ \bar{K}^*(892)^0$	[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
$\Xi(1620)^0 \pi^+$		seen		—
$\Xi(1690)^0 \pi^+$		seen		644
$\Xi^0 \pi^+ \pi^0$		2.3 ± 0.7		856
$\Xi^0 \pi^- 2\pi^+$		1.7 ± 0.5		818
$\Xi^0 e^+ \nu_e$		$2.3 \begin{smallmatrix} +0.7 \\ -0.8 \end{smallmatrix}$		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
$p \bar{K}^*(892)^0$	[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		580
$\Sigma^+ \phi$	[r]	<0.11	90%	549
$\Xi(1690)^0 K^+, \Xi^0 \rightarrow \Sigma^+ K^-$		<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.

$$\text{Mass } m = 2470.91 \pm 0.25 \text{ MeV}$$

$$m_{\Xi_c^0} - m_{\Xi_c^+} = 2.98 \pm 0.22 \text{ MeV}$$

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

$$c\tau = 33.6 \mu\text{m}$$

Decay asymmetry parameters

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

Ξ_c^0 DECAY MODES	Fraction (Γ_i/Γ)	Scale factor	P (MeV/c)
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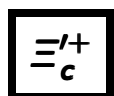
Cabibbo-favored ($S = -2$) decays

$p K^- K^- \pi^+$	$(4.8 \pm 1.2) \times 10^{-3}$	1.1	676
$p K^- \bar{K}^*(892)^0, \bar{K}^{*0} \rightarrow K^- \pi^+$	$(2.0 \pm 0.6) \times 10^{-3}$		413
$p K^- K^- \pi^+$ (no \bar{K}^{*0})	$(3.0 \pm 0.9) \times 10^{-3}$		676
ΛK_S^0	$(3.0 \pm 0.8) \times 10^{-3}$		906
$\Lambda K^- \pi^+$	$(1.45 \pm 0.33) \%$	1.1	856

$\Lambda \bar{K}^0 \pi^+ \pi^-$	seen		787
$\Lambda K^- \pi^+ \pi^+ \pi^-$	seen		703
$\Xi^- \pi^+$	$(1.43 \pm 0.32) \%$	1.1	875
$\Xi^- \pi^+ \pi^+ \pi^-$	$(4.8 \pm 2.3) \%$		816
$\Omega^- K^+$	$(4.2 \pm 1.0) \times 10^{-3}$		522
$\Xi^- e^+ \nu_e$	$(1.8 \pm 1.2) \%$		882

Cabibbo-suppressed decays

$\Xi^- K^+$	$(3.9 \pm 1.2) \times 10^{-4}$		790
$\Lambda K^+ K^-$ (no ϕ)	$(4.1 \pm 1.4) \times 10^{-4}$		648
$\Lambda \phi$	$(4.9 \pm 1.5) \times 10^{-4}$		621



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

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

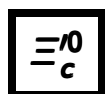
Mass $m = 2578.4 \pm 0.5$ MeV

$$m_{\Xi_c^{'+}} - m_{\Xi_c^+} = 110.5 \pm 0.4 \text{ MeV}$$

$$m_{\Xi_c^{'+}} - m_{\Xi_c^0} = -0.8 \pm 0.6 \text{ MeV}$$

The $\Xi_c^{'+} - \Xi_c^+$ 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	108



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

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

Mass $m = 2579.2 \pm 0.5$ MeV

$$m_{\Xi_c^{'0}} - m_{\Xi_c^0} = 108.3 \pm 0.4 \text{ MeV}$$

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	106

$\Xi_c(2645)$

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

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

$$\Xi_c(2645)^+ \text{ mass } m = 2645.57 \pm 0.26 \text{ MeV}$$

$$\Xi_c(2645)^0 \text{ mass } m = 2646.38 \pm 0.21 \text{ MeV} \quad (S = 1.1)$$

$$m_{\Xi_c(2645)^+} - m_{\Xi_c^0} = 174.66 \pm 0.09 \text{ MeV}$$

$$m_{\Xi_c(2645)^0} - m_{\Xi_c^+} = 178.44 \pm 0.10 \text{ MeV}$$

$$m_{\Xi_c(2645)^+} - m_{\Xi_c(2645)^0} = -0.80 \pm 0.26 \text{ MeV}$$

$$\Xi_c(2645)^+ \text{ full width } \Gamma = 2.14 \pm 0.19 \text{ MeV} \quad (S = 1.1)$$

$$\Xi_c(2645)^0 \text{ full width } \Gamma = 2.35 \pm 0.22 \text{ MeV}$$

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

 $\Xi_c(2645)$ DECAY MODES

$\Xi_c(2645)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_c^0 \pi^+$	seen	102
$\Xi_c^+ \pi^-$	seen	106

 $\Xi_c(2790)$

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

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

$$\Xi_c(2790)^+ \text{ mass } = 2792.4 \pm 0.5 \text{ MeV}$$

$$\Xi_c(2790)^0 \text{ mass } = 2794.1 \pm 0.5 \text{ MeV}$$

$$m_{\Xi_c(2790)^+} - m_{\Xi_c^0} = 213.20 \pm 0.22 \text{ MeV}$$

$$m_{\Xi_c(2790)^0} - m_{\Xi_c^+} = 215.70 \pm 0.22 \text{ MeV}$$

$$m_{\Xi_c(2790)^+} - m_{\Xi_c(2790)^0} = -1.7 \pm 0.7 \text{ MeV}$$

$$\Xi_c(2790)^+ \text{ width } = 8.9 \pm 1.0 \text{ MeV}$$

$$\Xi_c(2790)^0 \text{ width } = 10.0 \pm 1.1 \text{ MeV}$$

 $\Xi_c(2790)$ DECAY MODES

$\Xi_c(2790)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_c' \pi$	seen	160

 $\Xi_c(2815)$

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

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

$$\Xi_c(2815)^+ \text{ mass } m = 2816.73 \pm 0.21 \text{ MeV}$$

$$\Xi_c(2815)^0 \text{ mass } m = 2820.26 \pm 0.27 \text{ MeV}$$

$$m_{\Xi_c(2815)^+} - m_{\Xi_c^+} = 348.80 \pm 0.10 \text{ MeV}$$

$$\begin{aligned}
 m_{\Xi_c(2815)^0} - m_{\Xi_c^0} &= 349.35 \pm 0.11 \text{ MeV} \\
 m_{\Xi_c(2815)^+} - m_{\Xi_c(2815)^0} &= -3.53 \pm 0.27 \text{ MeV} \\
 \Xi_c(2815)^+ \text{ full width } \Gamma &= 2.43 \pm 0.26 \text{ MeV} \\
 \Xi_c(2815)^0 \text{ full width } \Gamma &= 2.54 \pm 0.25 \text{ MeV}
 \end{aligned}$$

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)
$\Xi_c' \pi$	seen	188
$\Xi_c(2645)\pi$	seen	102

$\Xi_c(2970)$

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

$$\begin{aligned}
 \Xi_c(2970)^+ m &= 2969.4 \pm 0.8 \text{ MeV} \quad (S = 1.1) \\
 \Xi_c(2970)^0 m &= 2967.8^{+0.9}_{-0.7} \text{ MeV} \quad (S = 1.1) \\
 m_{\Xi_c(2970)^+} - m_{\Xi_c^0} &= 498.5 \pm 0.8 \text{ MeV} \quad (S = 1.1) \\
 m_{\Xi_c(2970)^0} - m_{\Xi_c^+} &= 499.9^{+0.8}_{-0.7} \text{ MeV} \quad (S = 1.1) \\
 m_{\Xi_c(2970)^+} - m_{\Xi_c(2970)^0} &= 1.5^{+1.1}_{-1.2} \text{ MeV} \quad (S = 1.1) \\
 \Xi_c(2970)^+ \text{ width } \Gamma &= 20.9^{+2.4}_{-3.5} \text{ MeV} \quad (S = 1.2) \\
 \Xi_c(2970)^0 \text{ width } \Gamma &= 28.1^{+3.4}_{-4.0} \text{ MeV} \quad (S = 1.5)
 \end{aligned}$$

$\Xi_c(2970)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_c^+ \bar{K} \pi$	seen	231
$\Sigma_c(2455) \bar{K}$	seen	133
$\Lambda_c^+ \bar{K}$	not seen	414
$\Xi_c 2\pi$	seen	385
$\Xi_c' \pi$	seen	—
$\Xi_c(2645)\pi$	seen	277

$\Xi_c(3055)$

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

$$\begin{aligned}
 \text{Mass } m &= 3055.9 \pm 0.4 \text{ MeV} \\
 \text{Full width } \Gamma &= 7.8 \pm 1.9 \text{ MeV}
 \end{aligned}$$

$\Xi_c(3055)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Sigma^{++} K^-$	seen	—
ΛD^+	seen	316

$\Xi_c(3080)$

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

$$\Xi_c(3080)^+ \quad m = 3077.2 \pm 0.4 \text{ MeV}$$

$$\Xi_c(3080)^0 \quad m = 3079.9 \pm 1.4 \text{ MeV} \quad (S = 1.3)$$

$$\Xi_c(3080)^+ \quad \text{width } \Gamma = 3.6 \pm 1.1 \text{ MeV} \quad (S = 1.5)$$

$$\Xi_c(3080)^0 \quad \text{width } \Gamma = 5.6 \pm 2.2 \text{ MeV}$$

$\Xi_c(3080)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_c^+ \bar{K} \pi$	seen	415
$\Sigma_c(2455) \bar{K}$	seen	342
$\Sigma_c(2455)^{++} K^-$	seen	342
$\Sigma_c(2520)^{++} K^-$	seen	239
$\Sigma_c(2455) \bar{K} + \Sigma_c(2520) \bar{K}$	seen	—
$\Lambda_c^+ \bar{K}$	not seen	536
$\Lambda_c^+ \bar{K} \pi^+ \pi^-$	not seen	144
ΛD^+	seen	362

Ω_c^0

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

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

$$\text{Mass } m = 2695.2 \pm 1.7 \text{ MeV} \quad (S = 1.3)$$

$$\text{Mean life } \tau = (268 \pm 26) \times 10^{-15} \text{ s}$$

$$c\tau = 80 \text{ } \mu\text{m}$$

Ω_c^0 DECAY MODES	Fraction (Γ_i/Γ)	Confidence level (p (MeV/c))
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No absolute branching fractions have been measured.

The following are branching *ratios* relative to $\Omega^- \pi^+$.

Cabibbo-favored ($S = -3$) decays — relative to $\Omega^- \pi^+$

$\Omega^- \pi^+$	DEFINED AS 1	821
$\Omega^- \pi^+ \pi^0$	1.80 ± 0.33	797
$\Omega^- \rho^+$	> 1.3	90% 532
$\Omega^- \pi^- 2\pi^+$	0.31 ± 0.05	753
$\Omega^- e^+ \nu_e$	2.4 ± 1.2	829
$\Xi^0 \bar{K}^0$	1.64 ± 0.29	950
$\Xi^0 K^- \pi^+$	1.20 ± 0.18	901
$\Xi^0 \bar{K}^{*0}, \bar{K}^{*0} \rightarrow K^- \pi^+$	0.68 ± 0.16	764
$\Xi^- \bar{K}^0 \pi^+$	2.12 ± 0.28	895

$\Xi^- K^- 2\pi^+$	0.63 ± 0.09	830
$\Xi(1530)^0 K^- \pi^+, \Xi^{*0} \rightarrow$	0.21 ± 0.06	757
$\Xi^- \bar{K}^{*0} \pi^+$	0.34 ± 0.11	653
$\Sigma^+ K^- K^- \pi^+$	< 0.32	90% 689
$\Lambda \bar{K}^0 \bar{K}^0$	1.72 ± 0.35	837

$\Omega_c(2770)^0$

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

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

$$\text{Mass } m = 2765.9 \pm 2.0 \text{ MeV} \quad (S = 1.2)$$

$$m_{\Omega_c(2770)^0} - m_{\Omega_c^0} = 70.7_{-0.9}^{+0.8} \text{ MeV}$$

The $\Omega_c(2770)^0 - \Omega_c^0$ 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

$\Omega_c(3000)^0$

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

$$\text{Mass } m = 3000.41 \pm 0.22 \text{ MeV}$$

$$\text{Full width } \Gamma = 4.5 \pm 0.7 \text{ MeV}$$

$\Omega_c(3000)^0$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_c^+ K^-$	seen	181

$\Omega_c(3050)^0$

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

$$\text{Mass } m = 3050.20 \pm 0.13 \text{ MeV}$$

$$\text{Full width } \Gamma < 1.2 \text{ MeV, CL} = 95\%$$

$\Omega_c(3050)^0$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_c^+ K^-$	seen	278

$\Omega_c(3065)^0$

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

$$\text{Mass } m = 3065.46 \pm 0.28 \text{ MeV}$$

$$\text{Full width } \Gamma = 3.5 \pm 0.4 \text{ MeV}$$

$\Omega_c(3065)^0$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_c^+ K^-$	seen	303

$\Omega_c(3090)^0$

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

Mass $m = 3090.0 \pm 0.5$ MeV

Full width $\Gamma = 8.7 \pm 1.3$ MeV

$\Omega_c(3090)^0$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_c^+ K^-$	seen	339

$\Omega_c(3120)^0$

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

Mass $m = 3119.1 \pm 1.0$ MeV

Full width $\Gamma < 2.6$ MeV, CL = 95%

$\Omega_c(3120)^0$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_c^+ K^-$	seen	379

DOUBLY CHARMED BARYONS ($C = +2$)

$$\Xi_{cc}^{++} = ucc, \Xi_{cc}^+ = dcc, \Omega_{cc}^+ = scc$$

Ξ_{cc}^{++}

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

Mass $m = 3621.2 \pm 0.7$ MeV

Mean life $\tau = (256 \pm 27) \times 10^{-15}$ s

Ξ_{cc}^{++} DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_c^+ K^- \pi^+ \pi^+$	seen	880
$\Xi_c^+ \pi^+, \Xi_c^+ \rightarrow p K^- \pi^+$	seen	—

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.

$$\text{Mass } m = 5619.60 \pm 0.17 \text{ MeV}$$

$$m_{\Lambda_b^0} - m_{B^0} = 339.2 \pm 1.4 \text{ MeV}$$

$$m_{\Lambda_b^0} - m_{B^+} = 339.72 \pm 0.28 \text{ MeV}$$

$$\text{Mean life } \tau = (1.471 \pm 0.009) \times 10^{-12} \text{ s}$$

$$c\tau = 441.0 \text{ } \mu\text{m}$$

$$A_{CP}(\Lambda_b \rightarrow p\pi^-) = -0.025 \pm 0.029 \quad (S = 1.2)$$

$$A_{CP}(\Lambda_b \rightarrow pK^-) = -0.025 \pm 0.022$$

$$\Delta A_{CP}(pK^-/\pi^-) \equiv A_{CP}(pK^-) - A_{CP}(p\pi^-) = 0.014 \pm 0.024$$

$$A_{CP}(\Lambda_b \rightarrow p\bar{K}^0\pi^-) = 0.22 \pm 0.13$$

$$\Delta A_{CP}(J/\psi p\pi^-/K^-) \equiv A_{CP}(J/\psi p\pi^-) - A_{CP}(J/\psi pK^-) \\ = (5.7 \pm 2.7) \times 10^{-2}$$

$$A_{CP}(\Lambda_b \rightarrow \Lambda K^+\pi^-) = -0.53 \pm 0.25$$

$$A_{CP}(\Lambda_b \rightarrow \Lambda K^+K^-) = -0.28 \pm 0.12$$

$$\Delta A_{CP}(\Lambda_b^0 \rightarrow pK^- \mu^+ \mu^-) \equiv A_{CP}(pK^- \mu^+ \mu^-) \\ - A_{CP}(pK^- J/\psi) = (-4 \pm 5) \times 10^{-2}$$

$$A_{FB}^\ell(\mu\mu) \text{ in } \Lambda_b \rightarrow \Lambda \mu^+ \mu^- = -0.39 \pm 0.04$$

$$\Delta(A_{FB}^\ell(\mu\mu)) \text{ in } \Lambda_b \rightarrow \Lambda \mu^+ \mu^- = -0.05 \pm 0.09$$

$$A_{FB}^h(p\pi) \text{ in } \Lambda_b \rightarrow \Lambda(p\pi) \mu^+ \mu^- = -0.30 \pm 0.05$$

$$A_{FB}^{lh} \text{ in } \Lambda_b \rightarrow \Lambda \mu^+ \mu^- = 0.25 \pm 0.04$$

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

For inclusive branching fractions, e.g., $\Lambda_b \rightarrow \bar{\Lambda}_C \text{ anything}$, 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)
$J/\psi(1S)\Lambda \times B(b \rightarrow \Lambda_b^0)$	$(5.8 \pm 0.8) \times 10^{-5}$		1740
$pD^0\pi^-$	$(6.3 \pm 0.7) \times 10^{-4}$		2370
pD^0K^-	$(4.6 \pm 0.8) \times 10^{-5}$		2269
$pJ/\psi\pi^-$	$(2.6^{+0.5}_{-0.4}) \times 10^{-5}$		1755
$p\pi^- J/\psi, J/\psi \rightarrow \mu^+\mu^-$	$(1.6 \pm 0.8) \times 10^{-6}$		—
$pJ/\psi K^-$	$(3.2^{+0.6}_{-0.5}) \times 10^{-4}$		1589
$P_c(4380)^+ K^-, P_c \rightarrow pJ/\psi$	[u] $(2.7 \pm 1.4) \times 10^{-5}$		—
$P_c(4450)^+ K^-, P_c \rightarrow pJ/\psi$	[u] $(1.3 \pm 0.4) \times 10^{-5}$		—
$\chi_{c1}(1P)pK^-$	$(7.6^{+1.5}_{-1.3}) \times 10^{-5}$		1242
$\chi_{c2}(1P)pK^-$	$(7.9^{+1.6}_{-1.4}) \times 10^{-5}$		1198
$pJ/\psi(1S)\pi^+\pi^-K^-$	$(6.6^{+1.3}_{-1.1}) \times 10^{-5}$		1410
$p\psi(2S)K^-$	$(6.6^{+1.2}_{-1.0}) \times 10^{-5}$		1063
$\psi(2S)p\pi^-$	$(7.5^{+1.6}_{-1.4}) \times 10^{-6}$		1320
$p\bar{K}^0\pi^-$	$(1.3 \pm 0.4) \times 10^{-5}$		2693
pK^0K^-	$< 3.5 \times 10^{-6}$	CL=90%	2639
$\Lambda_c^+\pi^-$	$(4.9 \pm 0.4) \times 10^{-3}$	S=1.2	2342
$\Lambda_c^+K^-$	$(3.59 \pm 0.30) \times 10^{-4}$	S=1.2	2314
$\Lambda_c^+ a_1(1260)^-$	seen		2153
$\Lambda_c^+ D^-$	$(4.6 \pm 0.6) \times 10^{-4}$		1886
$\Lambda_c^+ D_s^-$	$(1.10 \pm 0.10) \%$		1833
$\Lambda_c^+\pi^+\pi^-\pi^-$	$(7.7 \pm 1.1) \times 10^{-3}$	S=1.1	2323
$\Lambda_c(2595)^+\pi^-, \Lambda_c(2595)^+ \rightarrow \Lambda_c^+\pi^+\pi^-$	$(3.4 \pm 1.5) \times 10^{-4}$		2210
$\Lambda_c(2625)^+\pi^-, \Lambda_c(2625)^+ \rightarrow \Lambda_c^+\pi^+\pi^-$	$(3.3 \pm 1.3) \times 10^{-4}$		2193
$\Sigma_c(2455)^0\pi^+\pi^-, \Sigma_c^0 \rightarrow \Lambda_c^+\pi^-$	$(5.7 \pm 2.2) \times 10^{-4}$		2265
$\Sigma_c(2455)^{++}\pi^-\pi^-, \Sigma_c^{++} \rightarrow \Lambda_c^+\pi^+$	$(3.2 \pm 1.6) \times 10^{-4}$		2265
$\Lambda_c^+ p\bar{p}\pi^-$	$(2.65 \pm 0.29) \times 10^{-4}$		1805
$\Sigma_c(2455)^0 p\bar{p}, \Sigma_c(2455)^0 \rightarrow \Lambda_c^+\pi^-$	$(2.4 \pm 0.5) \times 10^{-5}$		—

$\Sigma_c(2520)^0 p \bar{p}, \Sigma_c(2520)^0 \rightarrow \Lambda_c^+ \pi^-$	$(3.2 \pm 0.7) \times 10^{-5}$	—
$\Lambda_c^+ \ell^- \bar{\nu}_\ell$ anything	[ν] $(10.4 \pm 2.2) \%$	—
$\Lambda_c^+ \ell^- \bar{\nu}_\ell$	$(6.2^{+1.4}_{-1.3}) \%$	2345
$\Lambda_c^+ \pi^+ \pi^- \ell^- \bar{\nu}_\ell$	$(5.6 \pm 3.1) \%$	2335
$\Lambda_c(2595)^+ \ell^- \bar{\nu}_\ell$	$(7.9^{+4.0}_{-3.5}) \times 10^{-3}$	2212
$\Lambda_c(2625)^+ \ell^- \bar{\nu}_\ell$	$(1.3^{+0.6}_{-0.5}) \%$	2195
$p h^-$	[x] $< 2.3 \times 10^{-5}$	CL=90% 2730
$p \pi^-$	$(4.3 \pm 0.8) \times 10^{-6}$	2730
$p K^-$	$(5.1 \pm 0.9) \times 10^{-6}$	2709
$p D_s^-$	$< 4.8 \times 10^{-4}$	CL=90% 2364
$p \mu^- \bar{\nu}_\mu$	$(4.1 \pm 1.0) \times 10^{-4}$	2730
$\Lambda \mu^+ \mu^-$	$(1.08 \pm 0.28) \times 10^{-6}$	2695
$p \pi^- \mu^+ \mu^-$	$(6.9 \pm 2.5) \times 10^{-8}$	2720
$\Lambda \gamma$	$< 1.3 \times 10^{-3}$	CL=90% 2699
$\Lambda \eta$	$(9^{+7}_{-5}) \times 10^{-6}$	2670
$\Lambda \eta'(958)$	$< 3.1 \times 10^{-6}$	CL=90% 2611
$\Lambda \pi^+ \pi^-$	$(4.7 \pm 1.9) \times 10^{-6}$	2692
$\Lambda K^+ \pi^-$	$(5.7 \pm 1.3) \times 10^{-6}$	2660
$\Lambda K^+ K^-$	$(1.62 \pm 0.23) \times 10^{-5}$	2605
$\Lambda \phi$	$(9.3 \pm 2.5) \times 10^{-6}$	2599
$p \pi^- \pi^+ \pi^-$	$(2.11 \pm 0.23) \times 10^{-5}$	2715
$p K^- K^+ \pi^-$	$(4.1 \pm 0.6) \times 10^{-6}$	2612
$p K^- \pi^+ \pi^-$	$(5.1 \pm 0.5) \times 10^{-5}$	2675
$p K^- K^+ K^-$	$(1.27 \pm 0.14) \times 10^{-5}$	2524

$\Lambda_b(5912)^0$

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

Mass $m = 5912.20 \pm 0.21$ 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 $m = 5919.92 \pm 0.19$ MeV ($S = 1.1$)

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.

$$\text{Mass } m(\Sigma_b^+) = 5810.56 \pm 0.25 \text{ MeV}$$

$$\text{Mass } m(\Sigma_b^-) = 5815.64 \pm 0.27 \text{ MeV}$$

$$m_{\Sigma_b^+} - m_{\Sigma_b^-} = -5.06 \pm 0.18 \text{ MeV}$$

$$\Gamma(\Sigma_b^+) = 5.0 \pm 0.5 \text{ MeV}$$

$$\Gamma(\Sigma_b^-) = 5.3 \pm 0.5 \text{ MeV}$$

Σ_b DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_b^0 \pi$	dominant	133

Σ_b^*

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

I, J, P need confirmation.

$$\text{Mass } m(\Sigma_b^{*+}) = 5830.32 \pm 0.27 \text{ MeV}$$

$$\text{Mass } m(\Sigma_b^{*-}) = 5834.74 \pm 0.30 \text{ MeV}$$

$$m_{\Sigma_b^{*+}} - m_{\Sigma_b^{*-}} = -4.37 \pm 0.33 \text{ MeV} \quad (S = 1.6)$$

$$m_{\Sigma_b^{*+}} - m_{\Sigma_b^+} = 19.73 \pm 0.18$$

$$m_{\Sigma_b^{*-}} - m_{\Sigma_b^-} = 19.09 \pm 0.22$$

$$\Gamma(\Sigma_b^{*+}) = 9.4 \pm 0.5 \text{ MeV}$$

$$\Gamma(\Sigma_b^{*-}) = 10.4 \pm 0.8 \text{ MeV} \quad (S = 1.3)$$

$$m_{\Sigma_b^*} - m_{\Sigma_b} = 21.2 \pm 2.0 \text{ MeV}$$

Σ_b^* DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_b^0 \pi$	dominant	159

$\Sigma_b(6097)^+$

$$J^P = ??$$

$$\text{Mass } m = 6095.8 \pm 1.7 \text{ MeV}$$

$$\text{Full width } \Gamma = 31 \pm 6 \text{ MeV}$$

$\Sigma_b(6097)^+$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_b \pi^+ \times B(b \rightarrow \Sigma_b(6097)^+)$	seen	—

$\Sigma_b(6097)^-$

$$J^P = ??$$

$$\text{Mass } m = 6098.0 \pm 1.8 \text{ MeV}$$

$$\text{Full width } \Gamma = 29 \pm 4 \text{ MeV}$$

$\Sigma_b(6097)^-$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_b \pi^- \times B(b \rightarrow \Sigma_b(6097)^-)$	seen	—

 Ξ_b^0, Ξ_b^-

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

 I, J, P need confirmation.

$$m(\Xi_b^-) = 5797.0 \pm 0.9 \text{ MeV} \quad (S = 1.8)$$

$$m(\Xi_b^0) = 5791.9 \pm 0.5 \text{ MeV}$$

$$m_{\Xi_b^-} - m_{\Lambda_b^0} = 177.5 \pm 0.5 \text{ MeV} \quad (S = 1.6)$$

$$m_{\Xi_b^0} - m_{\Lambda_b^0} = 172.5 \pm 0.4 \text{ MeV}$$

$$m_{\Xi_b^-} - m_{\Xi_b^0} = 5.9 \pm 0.6 \text{ MeV}$$

$$\text{Mean life } \tau_{\Xi_b^-} = (1.572 \pm 0.040) \times 10^{-12} \text{ s}$$

$$\text{Mean life } \tau_{\Xi_b^0} = (1.480 \pm 0.030) \times 10^{-12} \text{ s}$$

Ξ_b DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\Xi^- \ell^- \bar{\nu}_\ell X \times B(\bar{b} \rightarrow \Xi_b)$	$(3.9 \pm 1.2) \times 10^{-4}$	S=1.4	—
$J/\psi \Xi^- \times B(b \rightarrow \Xi_b^-)$	$(1.02^{+0.26}_{-0.21}) \times 10^{-5}$		1782
$J/\psi \Lambda K^- \times B(b \rightarrow \Xi_b^-)$	$(2.5 \pm 0.4) \times 10^{-6}$		1631
$p D^0 K^- \times B(\bar{b} \rightarrow \Xi_b)$	$(1.8 \pm 0.6) \times 10^{-6}$		2374
$p \bar{K}^0 \pi^- \times B(\bar{b} \rightarrow \Xi_b)/B(\bar{b} \rightarrow B^0)$	$< 1.6 \times 10^{-6}$	CL=90%	2783
$p K^0 K^- \times B(\bar{b} \rightarrow \Xi_b)/B(\bar{b} \rightarrow B^0)$	$< 1.1 \times 10^{-6}$	CL=90%	2730
$p K^- K^- \times B(\bar{b} \rightarrow \Xi_b)$	$(3.6 \pm 0.8) \times 10^{-8}$		2731
$\Lambda \pi^+ \pi^- \times B(b \rightarrow \Xi_b^0)/B(b \rightarrow \Lambda_b^0)$	$< 1.7 \times 10^{-6}$	CL=90%	2781
$\Lambda K^- \pi^+ \times B(b \rightarrow \Xi_b^0)/B(b \rightarrow \Lambda_b^0)$	$< 8 \times 10^{-7}$	CL=90%	2751
$\Lambda K^+ K^- \times B(b \rightarrow \Xi_b^0)/B(b \rightarrow \Lambda_b^0)$	$< 3 \times 10^{-7}$	CL=90%	2698
$\Lambda_c^+ K^- \times B(\bar{b} \rightarrow \Xi_b)$	$(6 \pm 4) \times 10^{-7}$		2416
$\Lambda_b^0 \pi^- \times B(b \rightarrow \Xi_b^-)/B(b \rightarrow \Lambda_b^0)$	$(5.7 \pm 2.0) \times 10^{-4}$		99

$pK^- \pi^+ \pi^- \times B(b \rightarrow \Xi_b^0)/B(b \rightarrow \Lambda_b^0)$	$(1.9 \pm 0.4) \times 10^{-6}$	2766
$pK^- K^- \pi^+ \times B(b \rightarrow \Xi_b^0)/B(b \rightarrow \Lambda_b^0)$	$(1.73 \pm 0.32) \times 10^{-6}$	2704
$pK^- K^+ K^- \times B(b \rightarrow \Xi_b^0)/B(b \rightarrow \Lambda_b^0)$	$(1.8 \pm 1.0) \times 10^{-7}$	2620

$\Xi'_b(5935)^-$

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

Mass $m = 5935.02 \pm 0.05$ MeV

$m_{\Xi'_b(5935)^-} - m_{\Xi_b^0} - m_{\pi^-} = 3.653 \pm 0.019$ MeV

Full width $\Gamma < 0.08$ MeV, CL = 95%

$\Xi'_b(5935)^-$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_b^0 \pi^- \times B(\bar{b} \rightarrow \Xi'_b(5935)^-)/B(\bar{b} \rightarrow \Xi_b^0)$	$(11.8 \pm 1.8) \%$	31

$\Xi_b(5945)^0$

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

Mass $m = 5952.3 \pm 0.9$ MeV

Full width $\Gamma = 0.90 \pm 0.18$ MeV

$\Xi_b(5945)^0$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_b^- \pi^+$	seen	78

$\Xi_b(5955)^-$

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

Mass $m = 5955.33 \pm 0.13$ MeV

$m_{\Xi_b(5955)^-} - m_{\Xi_b^0} - m_{\pi^-} = 23.96 \pm 0.13$ MeV

Full width $\Gamma = 1.65 \pm 0.33$ MeV

$\Xi_b(5955)^-$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_b^0 \pi^- \times B(\bar{b} \rightarrow \Xi_b^*(5955)^-)/B(\bar{b} \rightarrow \Xi_b^0)$	$(20.7 \pm 3.5) \%$	84

$\Xi_b(6227)$

$$J^P = ??$$

Mass $m = 6226.9 \pm 2.0$ MeV

Full width $\Gamma = 18 \pm 6$ MeV

$\Xi_b(6227)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor	P (MeV/c)
$\Lambda_b^0 K^- \times B(b \rightarrow \Xi_b(6227))/B(b \rightarrow \Lambda_b^0)$	$(3.20 \pm 0.35) \times 10^{-3}$		336
$\Xi_b^0 \pi^- \times B(b \rightarrow \Xi_b(6227))/B(b \rightarrow \Xi_b^0)$	$(2.8 \pm 1.1) \%$	1.8	398

Ω_b^-

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

Mass $m = 6046.1 \pm 1.7$ MeV

$m_{\Omega_b^-} - m_{\Lambda_b^0} = 426.4 \pm 2.2$ MeV

$m_{\Omega_b^-} - m_{\Xi_b^-} = 247.3 \pm 3.2$ MeV

Mean life $\tau = (1.64_{-0.17}^{+0.18}) \times 10^{-12}$ s

$\tau(\Omega_b^-)/\tau(\Xi_b^-)$ mean life ratio = 1.11 ± 0.16

Ω_b^- DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	P (MeV/c)
$J/\psi \Omega^- \times B(b \rightarrow \Omega_b)$	$(2.9_{-0.8}^{+1.1}) \times 10^{-6}$		1806
$p K^- K^- \times B(\bar{b} \rightarrow \Omega_b)$	$< 2.5 \times 10^{-9}$	90%	2866
$p \pi^- \pi^- \times B(\bar{b} \rightarrow \Omega_b)$	$< 1.5 \times 10^{-8}$	90%	2943
$p K^- \pi^- \times B(\bar{b} \rightarrow \Omega_b)$	$< 7 \times 10^{-9}$	90%	2915

b -baryon ADMIXTURE ($\Lambda_b, \Xi_b, \Sigma_b, \Omega_b$)

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 $B(b \rightarrow b\text{-baryon})$.

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

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

***b*-baryon ADMIXTURE DECAY MODES**

$(\Lambda_b, \Xi_b, \Sigma_b, \Omega_b)$	Fraction (Γ_i/Γ)	p (MeV/c)
$p\mu^-\bar{\nu}$ anything	$(5.6^{+2.2}_{-1.9})\%$	—
$p\ell\bar{\nu}_\ell$ anything	$(5.4 \pm 1.2)\%$	—
p anything	$(67 \pm 21)\%$	—
$\Lambda\ell^-\bar{\nu}_\ell$ anything	$(3.6 \pm 0.6)\%$	—
$\Lambda\ell^+\nu_\ell$ anything	$(3.0 \pm 0.8)\%$	—
Λ anything	$(38 \pm 7)\%$	—
$\Xi^-\ell^-\bar{\nu}_\ell$ anything	$(6.3 \pm 1.6) \times 10^{-3}$	—

EXOTIC BARYONS

$P_c(4380)^+$

Mass $m = 4380 \pm 30$ MeV

Full width $\Gamma = 205 \pm 90$ MeV

$P_c(4380)^+$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$J/\psi p$	seen	741

$P_c(4450)^+$

Mass $m = 4449.8 \pm 3.0$ MeV

Full width $\Gamma = 39 \pm 20$ MeV

$P_c(4450)^+$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$J/\psi p$	seen	820

NOTES

- [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 $|m_p - m_{\bar{p}}|/m_p$ and $|q_p + q_{\bar{p}}|/e$ are not independent, and both use the more precise measurement of $|q_{\bar{p}}/m_{\bar{p}}|/(q_p/m_p)$.
- [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] There is a lot of disagreement about the value of the proton magnetic charge radius. See the Listings.
- [f] 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 \bar{p} 's is $\tau_{\bar{p}} > 10^7$ yr, the cosmic-ray storage time, but this limit depends on a number of assumptions. The best direct observation of stored antiprotons gives $\tau_{\bar{p}}/B(\bar{p} \rightarrow e^- \gamma) > 7 \times 10^5$ yr.
- [g] 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.
- [h] 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 $12.5 \mu\text{T}$ is >12 s (95% CL).
- [i] The parameters g_A , g_V , and g_{WM} for semileptonic modes are defined by $\bar{B}_f[\gamma_\lambda(g_V + g_A\gamma_5) + i(g_{WM}/m_{B_i}) \sigma_{\lambda\nu} q^\nu]B_i$, 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.
- [j] Time-reversal invariance requires this to be 0° or 180° .
- [k] This coefficient is zero if time invariance is not violated.
- [l] This limit is for γ energies between 0.4 and 782 keV.
- [n] The decay parameters γ and Δ are calculated from α and ϕ using

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

See the "Note on Baryon Decay Parameters" in the neutron Particle Listings.

- [o] See the Listings for the pion momentum range used in this measurement.
- [p] The error given here is only an educated guess. It is larger than the error on the weighted average of the published values.
- [q] A theoretical value using QED.
- [r] This branching fraction includes all the decay modes of the final-state resonance.
- [s] 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.
- [t] A test that the isospin is indeed 0, so that the particle is indeed a Λ_c^+ .
- [u] P_c^+ is a pentaquark-charmonium state.
- [v] Not a pure measurement. See note at head of Λ_b^0 Decay Modes.
- [x] Here h^- means π^- or K^- .