

N BARYONS

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

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

p

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

- Mass $m = 1.00727646688 \pm 0.00000000013$ u
 Mass $m = 938.27203 \pm 0.00008$ MeV [a]
 $|m_p - m_{\bar{p}}|/m_p < 1.0 \times 10^{-8}$, CL = 90% [b]
 $|\frac{q_{\bar{p}}}{m_{\bar{p}}}|/(\frac{q_p}{m_p}) = 0.99999999991 \pm 0.00000000009$
 $|q_p + q_{\bar{p}}|/e < 1.0 \times 10^{-8}$, CL = 90% [b]
 $|q_p + q_e|/e < 1.0 \times 10^{-21}$ [c]
 Magnetic moment $\mu = 2.792847351 \pm 0.000000028 \mu_N$
 $(\mu_p + \mu_{\bar{p}}) / \mu_p = (-2.6 \pm 2.9) \times 10^{-3}$
 Electric dipole moment $d < 0.54 \times 10^{-23}$ e cm
 Electric polarizability $\alpha = (12.0 \pm 0.6) \times 10^{-4}$ fm³
 Magnetic polarizability $\beta = (1.9 \pm 0.5) \times 10^{-4}$ fm³
 Charge radius = 0.875 ± 0.007 fm
 Mean life $\tau > 2.1 \times 10^{29}$ years, CL = 90% ($p \rightarrow$ invisible mode)
 Mean life $\tau > 10^{31}$ to 10^{33} years [d] (mode dependent)

See the "Note on Nucleon Decay" in our 1994 edition (Phys. Rev. **D50**, 1673) 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			
$N \rightarrow e^+ \pi$	> 158 (n), > 1600 (p)	90%	459
$N \rightarrow \mu^+ \pi$	> 100 (n), > 473 (p)	90%	453
$N \rightarrow \nu \pi$	> 112 (n), > 25 (p)	90%	459
$p \rightarrow e^+ \eta$	> 313	90%	309
$p \rightarrow \mu^+ \eta$	> 126	90%	297
$n \rightarrow \nu \eta$	> 158	90%	310
$N \rightarrow e^+ \rho$	> 217 (n), > 75 (p)	90%	149
$N \rightarrow \mu^+ \rho$	> 228 (n), > 110 (p)	90%	113
$N \rightarrow \nu \rho$	> 19 (n), > 162 (p)	90%	149
$p \rightarrow e^+ \omega$	> 107	90%	143

$p \rightarrow \mu^+ \omega$	> 117	90%	105
$n \rightarrow \nu \omega$	> 108	90%	144
$N \rightarrow e^+ K$	> 17 (n), > 150 (p)	90%	339
$p \rightarrow e^+ K_S^0$	> 120	90%	337
$p \rightarrow e^+ K_L^0$	> 51	90%	337
$N \rightarrow \mu^+ K$	> 26 (n), > 120 (p)	90%	329
$p \rightarrow \mu^+ K_S^0$	> 150	90%	326
$p \rightarrow \mu^+ K_L^0$	> 83	90%	326
$N \rightarrow \nu K$	> 86 (n), > 670 (p)	90%	339
$n \rightarrow \nu K_S^0$	> 51	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%	114
$n \rightarrow e^- K^+$	> 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
$n \rightarrow \nu \gamma$	> 28	90%	470
$p \rightarrow e^+ \gamma \gamma$	> 100	90%	469
$n \rightarrow \nu \gamma \gamma$	> 219	90%	470

Three (or more) leptons

$p \rightarrow e^+ e^+ e^-$	> 793	90%	469
$p \rightarrow e^+ \mu^+ \mu^-$	> 359	90%	457
$p \rightarrow e^+ \nu \nu$	> 17	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
$p \rightarrow \mu^+ \nu \nu$	> 21	90%	463
$p \rightarrow e^- \mu^+ \mu^+$	> 6	90%	457
$n \rightarrow 3\nu$	> 0.0005	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.

$pp \rightarrow \pi^+ \pi^+$	> 0.7	90%	—
$pn \rightarrow \pi^+ \pi^0$	> 2	90%	—
$nn \rightarrow \pi^+ \pi^-$	> 0.7	90%	—
$nn \rightarrow \pi^0 \pi^0$	> 3.4	90%	—
$pp \rightarrow e^+ e^+$	> 5.8	90%	—
$pp \rightarrow e^+ \mu^+$	> 3.6	90%	—
$pp \rightarrow \mu^+ \mu^+$	> 1.7	90%	—
$pn \rightarrow e^+ \bar{\nu}$	> 2.8	90%	—
$pn \rightarrow \mu^+ \bar{\nu}$	> 1.6	90%	—
$nn \rightarrow \nu_e \bar{\nu}_e$	> 0.000049	90%	—
$pn \rightarrow$ invisible	> 2.1×10^{-5}	90%	—
$pp \rightarrow$ invisible	> 0.00005	90%	—

\bar{p} DECAY MODES

\bar{p} DECAY MODES	Partial mean life (years)	Confidence level	p (MeV/c)
$\bar{p} \rightarrow e^- \gamma$	> 7×10^5	90%	469
$\bar{p} \rightarrow \mu^- \gamma$	> 5×10^4	90%	463
$\bar{p} \rightarrow e^- \pi^0$	> 4×10^5	90%	459
$\bar{p} \rightarrow \mu^- \pi^0$	> 5×10^4	90%	453
$\bar{p} \rightarrow e^- \eta$	> 2×10^4	90%	309
$\bar{p} \rightarrow \mu^- \eta$	> 8×10^3	90%	297

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

n

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

Mass $m = 1.0086649156 \pm 0.0000000006$ u

Mass $m = 939.56536 \pm 0.00008$ MeV [a]

$m_n - m_p = 1.2933317 \pm 0.0000005$ MeV
 $= 0.0013884487 \pm 0.0000000006$ u

Mean life $\tau = 885.7 \pm 0.8$ s

$$c\tau = 2.655 \times 10^8 \text{ km}$$

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

Electric dipole moment $d < 0.63 \times 10^{-25}$ e cm, CL = 90%

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

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

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

Charge $q = (-0.4 \pm 1.1) \times 10^{-21} e$

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

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

Decay parameters [f]

$p e^- \bar{\nu}_e$ $\lambda \equiv g_A / g_V = -1.2695 \pm 0.0029$ (S = 2.0)

" $A = -0.1173 \pm 0.0013$ (S = 2.3)

" $B = 0.981 \pm 0.004$ (S = 1.1)

" $a = -0.103 \pm 0.004$

" $\phi_{AV} = (180.06 \pm 0.07)^\circ$ [g]

" $D = (-4 \pm 6) \times 10^{-4}$

n DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	^P (MeV/c)
$p e^- \bar{\nu}_e$	100 %		1
$p e^- \bar{\nu}_e \gamma$	[h] < 6.9×10^{-3}	90%	1
Charge conservation (Q) violating mode			
$p \nu_e \bar{\nu}_e$	Q < 8×10^{-27}	68%	1

$N(1440) P_{11}$

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

Breit-Wigner mass = 1420 to 1470 (≈ 1440) MeVBreit-Wigner full width = 200 to 450 (≈ 300) MeV

$$p_{\text{beam}} = 0.61 \text{ GeV}/c \quad 4\pi\lambda^2 = 31.0 \text{ mb}$$

Re(pole position) = 1350 to 1380 (≈ 1365) MeV $-2\text{Im}(\text{pole position}) = 160$ to 220 (≈ 190) MeV

$N(1440)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	0.55 to 0.75	398
$N\pi\pi$	30–40 %	347
$\Delta\pi$	20–30 %	147
$N\rho$	<8 %	†
$N(\pi\pi)_{S\text{-wave}}^{I=0}$	5–10 %	–
$p\gamma$	0.035–0.048 %	414
$p\gamma$, helicity=1/2	0.035–0.048 %	414
$n\gamma$	0.009–0.032 %	413
$n\gamma$, helicity=1/2	0.009–0.032 %	413

 $N(1520) D_{13}$

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

Breit-Wigner mass = 1515 to 1525 (≈ 1520) MeVBreit-Wigner full width = 100 to 125 (≈ 115) MeV

$$p_{\text{beam}} = 0.74 \text{ GeV}/c \quad 4\pi\lambda^2 = 23.5 \text{ mb}$$

Re(pole position) = 1505 to 1515 (≈ 1510) MeV $-2\text{Im}(\text{pole position}) = 105$ to 120 (≈ 110) MeV

$N(1520)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	0.55 to 0.65	457
$N\eta$	$(2.3 \pm 0.4) \times 10^{-3}$	155
$N\pi\pi$	40–50 %	414
$\Delta\pi$	15–25 %	230
$N\rho$	15–25 %	†
$N(\pi\pi)_{S\text{-wave}}^{I=0}$	<8 %	–
$p\gamma$	0.46–0.56 %	470
$p\gamma$, helicity=1/2	0.001–0.034 %	470
$p\gamma$, helicity=3/2	0.44–0.53 %	470
$n\gamma$	0.30–0.53 %	470
$n\gamma$, helicity=1/2	0.04–0.10 %	470
$n\gamma$, helicity=3/2	0.25–0.45 %	470

$N(1535) S_{11}$

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

Breit-Wigner mass = 1525 to 1545 (≈ 1535) MeV
 Breit-Wigner full width = 125 to 175 (≈ 150) MeV
 $p_{\text{beam}} = 0.76 \text{ GeV}/c$ $4\pi\lambda^2 = 22.5 \text{ mb}$
 Re(pole position) = 1490 to 1530 (≈ 1510) MeV
 $-2\text{Im}(\text{pole position}) = 90 \text{ to } 250$ (≈ 170) MeV

$N(1535)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	35–55 %	468
$N\eta$	45–60 %	186
$N\pi\pi$	1–10 %	426
$\Delta\pi$	<1 %	244
$N\rho$	<4 %	†
$N(\pi\pi)_{S\text{-wave}}^{I=0}$	<3 %	–
$N(1440)\pi$	<7 %	†
$p\gamma$	0.15–0.35 %	481
$p\gamma$, helicity=1/2	0.15–0.35 %	481
$n\gamma$	0.004–0.29 %	480
$n\gamma$, helicity=1/2	0.004–0.29 %	480

 $N(1650) S_{11}$

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

Breit-Wigner mass = 1645 to 1670 (≈ 1655) MeV
 Breit-Wigner full width = 145 to 185 (≈ 165) MeV
 $p_{\text{beam}} = 0.97 \text{ GeV}/c$ $4\pi\lambda^2 = 16.2 \text{ mb}$
 Re(pole position) = 1640 to 1670 (≈ 1655) MeV
 $-2\text{Im}(\text{pole position}) = 150 \text{ to } 180$ (≈ 165) MeV

$N(1650)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	0.60 to 0.95	551
$N\eta$	3–10 %	354
ΛK	3–11 %	179
$N\pi\pi$	10–20 %	517
$\Delta\pi$	1–7 %	349
$N\rho$	4–12 %	†
$N(\pi\pi)_{S\text{-wave}}^{I=0}$	<4 %	–
$N(1440)\pi$	<5 %	156
$p\gamma$	0.04–0.18 %	562
$p\gamma$, helicity=1/2	0.04–0.18 %	562
$n\gamma$	0.003–0.17 %	561
$n\gamma$, helicity=1/2	0.003–0.17 %	561

$N(1675) D_{15}$

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

Breit-Wigner mass = 1670 to 1680 (≈ 1675) MeVBreit-Wigner full width = 130 to 165 (≈ 150) MeV

$$p_{\text{beam}} = 1.01 \text{ GeV}/c \quad 4\pi\lambda^2 = 15.4 \text{ mb}$$

Re(pole position) = 1655 to 1665 (≈ 1660) MeV-2Im(pole position) = 125 to 150 (≈ 135) MeV

$N(1675)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	0.35 to 0.45	564
$N\eta$	(0.0 \pm 1.0) %	376
ΛK	<1 %	216
$N\pi\pi$	50–60 %	532
$\Delta\pi$	50–60 %	366
$N\rho$	< 1–3 %	†
$p\gamma$	0.004–0.023 %	575
$p\gamma$, helicity=1/2	0.0–0.015 %	575
$p\gamma$, helicity=3/2	0.0–0.011 %	575
$n\gamma$	0.02–0.12 %	574
$n\gamma$, helicity=1/2	0.006–0.046 %	574
$n\gamma$, helicity=3/2	0.01–0.08 %	574

 $N(1680) F_{15}$

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

Breit-Wigner mass = 1680 to 1690 (≈ 1685) MeVBreit-Wigner full width = 120 to 140 (≈ 130) MeV

$$p_{\text{beam}} = 1.02 \text{ GeV}/c \quad 4\pi\lambda^2 = 15.0 \text{ mb}$$

Re(pole position) = 1665 to 1680 (≈ 1675) MeV-2Im(pole position) = 110 to 135 (≈ 120) MeV

$N(1680)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	0.65 to 0.70	571
$N\eta$	(0.0 \pm 1.0) %	387
$N\pi\pi$	30–40 %	539
$\Delta\pi$	5–15 %	374
$N\rho$	3–15 %	†
$N(\pi\pi)_{S\text{-wave}}^{I=0}$	5–20 %	–
$p\gamma$	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

$N(1700) D_{13}$

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

Breit-Wigner mass = 1650 to 1750 (≈ 1700) MeV

Breit-Wigner full width = 50 to 150 (≈ 100) MeV

$$p_{\text{beam}} = 1.05 \text{ GeV}/c \quad 4\pi\chi^2 = 14.5 \text{ mb}$$

Re(pole position) = 1630 to 1730 (≈ 1680) MeV

$-2\text{Im}(\text{pole position}) = 50$ to 150 (≈ 100) MeV

$N(1700)$ DECAY MODES	Fraction (Γ_i/Γ)	ρ (MeV/c)
$N\pi$	5–15 %	581
$N\eta$	(0.0 ± 1.0) %	402
ΛK	<3 %	255
$N\pi\pi$	85–95 %	550
$N\rho$	<35 %	†
$p\gamma$	0.01–0.05 %	591
$p\gamma$, helicity=1/2	0.0–0.024 %	591
$p\gamma$, helicity=3/2	0.002–0.026 %	591
$n\gamma$	0.01–0.13 %	590
$n\gamma$, helicity=1/2	0.0–0.09 %	590
$n\gamma$, helicity=3/2	0.01–0.05 %	590

$N(1710) P_{11}$

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

Breit-Wigner mass = 1680 to 1740 (≈ 1710) MeV

Breit-Wigner full width = 50 to 250 (≈ 100) MeV

$$p_{\text{beam}} = 1.07 \text{ GeV}/c \quad 4\pi\chi^2 = 14.2 \text{ mb}$$

Re(pole position) = 1670 to 1770 (≈ 1720) MeV

$-2\text{Im}(\text{pole position}) = 80$ to 380 (≈ 230) MeV

$N(1710)$ DECAY MODES	Fraction (Γ_i/Γ)	ρ (MeV/c)
$N\pi$	10–20 %	588
$N\eta$	(6.2 ± 1.0) %	412
$N\omega$	(13.0 ± 2.0) %	†
ΛK	5–25 %	269
$N\pi\pi$	40–90 %	557

$\Delta\pi$	15–40 %	394
$N\rho$	5–25 %	†
$N(\pi\pi)_{S\text{-wave}}^{I=0}$	10–40 %	–
$p\gamma$	0.002–0.05%	598
$p\gamma$, helicity=1/2	0.002–0.05%	598
$n\gamma$	0.0–0.02%	597
$n\gamma$, helicity=1/2	0.0–0.02%	597

$N(1720) P_{13}$

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

Breit-Wigner mass = 1700 to 1750 (≈ 1720) MeV
 Breit-Wigner full width = 150 to 300 (≈ 200) MeV
 $p_{\text{beam}} = 1.09 \text{ GeV}/c$ $4\pi\chi^2 = 13.9 \text{ mb}$
 Re(pole position) = 1660 to 1690 (≈ 1675) MeV
 $-2\text{Im}(\text{pole position}) = 115 \text{ to } 275 \text{ MeV}$

$N(1720)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	10–20 %	594
$N\eta$	(4.0 ± 1.0) %	422
ΛK	1–15 %	283
$N\pi\pi$	>70 %	564
$N\rho$	70–85 %	73
$p\gamma$	0.003–0.10 %	604
$p\gamma$, helicity=1/2	0.003–0.08 %	604
$p\gamma$, helicity=3/2	0.001–0.03 %	604
$n\gamma$	0.002–0.39 %	603
$n\gamma$, helicity=1/2	0.0–0.002 %	603
$n\gamma$, helicity=3/2	0.001–0.39 %	603

$N(2190) G_{17}$

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

Breit-Wigner mass = 2100 to 2200 (≈ 2190) MeV
 Breit-Wigner full width = 300 to 700 (≈ 500) MeV
 $p_{\text{beam}} = 2.07 \text{ GeV}/c$ $4\pi\chi^2 = 6.21 \text{ mb}$
 Re(pole position) = 2050 to 2100 (≈ 2075) MeV
 $-2\text{Im}(\text{pole position}) = 400 \text{ to } 520$ (≈ 450) MeV

$N(2190)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	10–20 %	888
$N\eta$	(0.0 ± 1.0) %	792

$N(2220) H_{19}$

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

Breit-Wigner mass = 2200 to 2300 (≈ 2250) MeVBreit-Wigner full width = 350 to 500 (≈ 400) MeV

$$p_{\text{beam}} = 2.21 \text{ GeV}/c \quad 4\pi\lambda^2 = 5.74 \text{ mb}$$

Re(pole position) = 2130 to 2200 (≈ 2170) MeV $-2\text{Im}(\text{pole position}) = 400$ to 560 (≈ 480) MeV

$N(2220)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	10–20 %	924

 $N(2250) G_{19}$

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

Breit-Wigner mass = 2200 to 2350 (≈ 2275) MeVBreit-Wigner full width = 230 to 800 (≈ 500) MeV

$$p_{\text{beam}} = 2.27 \text{ GeV}/c \quad 4\pi\lambda^2 = 5.56 \text{ mb}$$

Re(pole position) = 2150 to 2250 (≈ 2200) MeV $-2\text{Im}(\text{pole position}) = 350$ to 550 (≈ 450) MeV

$N(2250)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	5–15 %	938

 $N(2600) I_{1,11}$

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

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

$$p_{\text{beam}} = 3.12 \text{ GeV}/c \quad 4\pi\lambda^2 = 3.86 \text{ mb}$$

$N(2600)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	5–10 %	1126

Δ BARYONS ($S = 0, I = 3/2$)

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

$\Delta(1232) P_{33}$

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

Breit-Wigner mass (mixed charges) = 1231 to 1233 (≈ 1232) MeV

Breit-Wigner full width (mixed charges) = 116 to 120 (≈ 118) MeV

$$p_{\text{beam}} = 0.30 \text{ GeV}/c \quad 4\pi\lambda^2 = 94.8 \text{ mb}$$

Re(pole position) = 1209 to 1211 (≈ 1210) MeV

$-2\text{Im}(\text{pole position}) = 98$ to 102 (≈ 100) MeV

$\Delta(1232)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	100 %	229
$N\gamma$	0.52–0.60 %	259
$N\gamma$, helicity=1/2	0.11–0.13 %	259
$N\gamma$, helicity=3/2	0.41–0.47 %	259

$\Delta(1600) P_{33}$

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

Breit-Wigner mass = 1550 to 1700 (≈ 1600) MeV

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

$$p_{\text{beam}} = 0.87 \text{ GeV}/c \quad 4\pi\lambda^2 = 18.6 \text{ mb}$$

Re(pole position) = 1500 to 1700 (≈ 1600) MeV

$-2\text{Im}(\text{pole position}) = 200$ to 400 (≈ 300) MeV

$\Delta(1600)$ 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 %	82
$N\gamma$	0.001–0.02 %	525
$N\gamma$, helicity=1/2	0.0–0.02 %	525
$N\gamma$, helicity=3/2	0.001–0.005 %	525

$\Delta(1620) S_{31}$

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

Breit-Wigner mass = 1600 to 1660 (≈ 1630) MeVBreit-Wigner full width = 135 to 150 (≈ 145) MeV

$$p_{\text{beam}} = 0.93 \text{ GeV}/c \quad 4\pi\lambda^2 = 17.2 \text{ mb}$$

Re(pole position) = 1590 to 1610 (≈ 1600) MeV $-2\text{Im}(\text{pole position}) = 115 \text{ to } 120$ (≈ 118) MeV

$\Delta(1620)$ 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 %	†
$N\gamma$	0.004–0.044 %	545
$N\gamma$, helicity=1/2	0.004–0.044 %	545

 $\Delta(1700) D_{33}$

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

Breit-Wigner mass = 1670 to 1750 (≈ 1700) MeVBreit-Wigner full width = 200 to 400 (≈ 300) MeV

$$p_{\text{beam}} = 1.05 \text{ GeV}/c \quad 4\pi\lambda^2 = 14.5 \text{ mb}$$

Re(pole position) = 1620 to 1680 (≈ 1650) MeV $-2\text{Im}(\text{pole position}) = 160 \text{ to } 240$ (≈ 200) MeV

$\Delta(1700)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	10–20 %	581
$N\pi\pi$	80–90 %	550
$\Delta\pi$	30–60 %	386
$N\rho$	30–55 %	†
$N\gamma$	0.12–0.26 %	591
$N\gamma$, helicity=1/2	0.08–0.16 %	591
$N\gamma$, helicity=3/2	0.025–0.12 %	591

 $\Delta(1905) F_{35}$

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

Breit-Wigner mass = 1865 to 1915 (≈ 1890) MeVBreit-Wigner full width = 270 to 400 (≈ 330) MeV

$$p_{\text{beam}} = 1.42 \text{ GeV}/c \quad 4\pi\lambda^2 = 9.89 \text{ mb}$$

Re(pole position) = 1825 to 1835 (≈ 1830) MeV $-2\text{Im}(\text{pole position}) = 265 \text{ to } 300$ (≈ 280) MeV

$\Delta(1905)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	0.09 to 0.15	704
$N\pi\pi$	85–95 %	680
$\Delta\pi$	<25 %	531
$N\rho$	>60 %	397
$N\gamma$	0.01–0.03 %	712
$N\gamma$, helicity=1/2	0.0–0.1 %	712
$N\gamma$, helicity=3/2	0.004–0.03 %	712

$\Delta(1910) P_{31}$

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

Breit-Wigner mass = 1870 to 1920 (≈ 1910) MeV
 Breit-Wigner full width = 190 to 270 (≈ 250) MeV
 $p_{\text{beam}} = 1.46 \text{ GeV}/c$ $4\pi\lambda^2 = 9.54 \text{ mb}$
 Re(pole position) = 1830 to 1880 (≈ 1855) MeV
 $-2\text{Im}(\text{pole position}) = 200$ to 500 (≈ 350) MeV

$\Delta(1910)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	15–30 %	717
$N\gamma$	0.0–0.2 %	725
$N\gamma$, helicity=1/2	0.0–0.2 %	725

$\Delta(1920) P_{33}$

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

Breit-Wigner mass = 1900 to 1970 (≈ 1920) MeV
 Breit-Wigner full width = 150 to 300 (≈ 200) MeV
 $p_{\text{beam}} = 1.48 \text{ GeV}/c$ $4\pi\lambda^2 = 9.37 \text{ mb}$
 Re(pole position) = 1850 to 1950 (≈ 1900) MeV
 $-2\text{Im}(\text{pole position}) = 200$ to 400 (≈ 300) MeV

$\Delta(1920)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	5–20 %	723
ΣK	(2.10 ± 0.30) %	431

$\Delta(1930) D_{35}$

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

Breit-Wigner mass = 1900 to 2020 (≈ 1960) MeV
 Breit-Wigner full width = 220 to 500 (≈ 360) MeV
 $p_{\text{beam}} = 1.56 \text{ GeV}/c$ $4\pi\lambda^2 = 8.76 \text{ mb}$
 Re(pole position) = 1840 to 1960 (≈ 1900) MeV
 $-2\text{Im}(\text{pole position}) = 175 \text{ to } 360$ (≈ 270) MeV

$\Delta(1930)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
N_π	0.05 to 0.15	748
N_γ	0.0–0.02 %	755
N_γ , helicity=1/2	0.0–0.01 %	755
N_γ , helicity=3/2	0.0–0.01 %	755

 $\Delta(1950) F_{37}$

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

Breit-Wigner mass = 1915 to 1950 (≈ 1930) MeV
 Breit-Wigner full width = 235 to 335 (≈ 285) MeV
 $p_{\text{beam}} = 1.50 \text{ GeV}/c$ $4\pi\lambda^2 = 9.21 \text{ mb}$
 Re(pole position) = 1870 to 1890 (≈ 1880) MeV
 $-2\text{Im}(\text{pole position}) = 220 \text{ to } 260$ (≈ 240) MeV

$\Delta(1950)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
N_π	0.35 to 0.45	729
$N_{\pi\pi}$		706
$\Delta\pi$	20–30 %	560
N_ρ	<10 %	442
N_γ	0.08–0.13 %	737
N_γ , helicity=1/2	0.03–0.055 %	737
N_γ , helicity=3/2	0.05–0.075 %	737

 $\Delta(2420) H_{3,11}$

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

Breit-Wigner mass = 2300 to 2500 (≈ 2420) MeV
 Breit-Wigner full width = 300 to 500 (≈ 400) MeV
 $p_{\text{beam}} = 2.64 \text{ GeV}/c$ $4\pi\lambda^2 = 4.68 \text{ mb}$
 Re(pole position) = 2260 to 2400 (≈ 2330) MeV
 $-2\text{Im}(\text{pole position}) = 350 \text{ to } 750$ (≈ 550) MeV

$\Delta(2420)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
N_π	5–15 %	1023

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

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

$$\text{Mean life } \tau = (2.631 \pm 0.020) \times 10^{-10} \text{ s} \quad (S = 1.6)$$

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

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

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

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

Decay parameters

$$p\pi^- \quad \alpha_- = 0.642 \pm 0.013$$

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

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

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

$$n\pi^0 \quad \alpha_0 = 0.65 \pm 0.04$$

$$pe^- \bar{\nu}_e \quad g_A/g_V = -0.718 \pm 0.015 [f]$$

Λ DECAY MODES	Fraction (Γ_i/Γ)	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
$p\pi^- \gamma$	$[j] (8.4 \pm 1.4) \times 10^{-4}$	101
$pe^- \bar{\nu}_e$	$(8.32 \pm 0.14) \times 10^{-4}$	163
$p\mu^- \bar{\nu}_\mu$	$(1.57 \pm 0.35) \times 10^{-4}$	131

Λ(1405) S₀₁

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

Mass $m = 1406 \pm 4$ MeV

Full width $\Gamma = 50 \pm 2$ MeV

Below $\bar{K}N$ threshold

Λ(1405) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Sigma \pi$	100 %	157

$\Lambda(1520) D_{03}$

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

Mass $m = 1519.5 \pm 1.0$ MeV [*k*]

Full width $\Gamma = 15.6 \pm 1.0$ MeV [*k*]

$$p_{\text{beam}} = 0.39 \text{ GeV}/c \quad 4\pi\lambda^2 = 82.8 \text{ mb}$$

$\Lambda(1520)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/ <i>c</i>)
$N\bar{K}$	$45 \pm 1\%$	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

$\Lambda(1600) P_{01}$

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

Mass $m = 1560$ to 1700 (≈ 1600) MeV

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

$$p_{\text{beam}} = 0.58 \text{ GeV}/c \quad 4\pi\lambda^2 = 41.6 \text{ mb}$$

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

$\Lambda(1670) S_{01}$

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

Mass $m = 1660$ to 1680 (≈ 1670) MeV

Full width $\Gamma = 25$ to 50 (≈ 35) MeV

$$p_{\text{beam}} = 0.74 \text{ GeV}/c \quad 4\pi\lambda^2 = 28.5 \text{ mb}$$

$\Lambda(1670)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/ <i>c</i>)
$N\bar{K}$	20–30 %	414
$\Sigma\pi$	25–55 %	394
$\Lambda\eta$	10–25 %	71

$\Lambda(1690) D_{03}$

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

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

$$p_{\text{beam}} = 0.78 \text{ GeV}/c \quad 4\pi\lambda^2 = 26.1 \text{ mb}$$

$\Lambda(1690)$ 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

 $\Lambda(1800) S_{01}$

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

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

$$p_{\text{beam}} = 1.01 \text{ GeV}/c \quad 4\pi\lambda^2 = 17.5 \text{ mb}$$

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

 $\Lambda(1810) P_{01}$

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

Mass $m = 1750$ to 1850 (≈ 1810) MeVFull width $\Gamma = 50$ to 250 (≈ 150) MeV

$$p_{\text{beam}} = 1.04 \text{ GeV}/c \quad 4\pi\lambda^2 = 17.0 \text{ mb}$$

$\Lambda(1810)$ 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 %	†

$\Lambda(1820) F_{05}$

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

Mass $m = 1815$ to 1825 (≈ 1820) MeVFull width $\Gamma = 70$ to 90 (≈ 80) MeV

$$p_{\text{beam}} = 1.06 \text{ GeV}/c \quad 4\pi\lambda^2 = 16.5 \text{ mb}$$

$\Lambda(1820)$ 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

 $\Lambda(1830) D_{05}$

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

Mass $m = 1810$ to 1830 (≈ 1830) MeVFull width $\Gamma = 60$ to 110 (≈ 95) MeV

$$p_{\text{beam}} = 1.08 \text{ GeV}/c \quad 4\pi\lambda^2 = 16.0 \text{ mb}$$

$\Lambda(1830)$ 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

 $\Lambda(1890) P_{03}$

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

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

$$p_{\text{beam}} = 1.21 \text{ GeV}/c \quad 4\pi\lambda^2 = 13.6 \text{ mb}$$

$\Lambda(1890)$ 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

$\Lambda(2100) G_{07}$

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

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

$$p_{\text{beam}} = 1.68 \text{ GeV}/c \quad 4\pi\lambda^2 = 8.68 \text{ mb}$$

$\Lambda(2100)$ 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

 $\Lambda(2110) F_{05}$

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

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

$$p_{\text{beam}} = 1.70 \text{ GeV}/c \quad 4\pi\lambda^2 = 8.53 \text{ mb}$$

$\Lambda(2110)$ 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

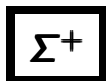
 $\Lambda(2350) H_{09}$

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

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

$$p_{\text{beam}} = 2.29 \text{ GeV}/c \quad 4\pi\lambda^2 = 5.85 \text{ mb}$$

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



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

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

$(\tau_{\Sigma^+} - \tau_{\Sigma^-}) / \tau_{\Sigma^+} = (-0.6 \pm 1.2) \times 10^{-3}$

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

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

Decay parameters

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

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
$n\pi^+\gamma$	$[j] (4.5 \pm 0.5) \times 10^{-4}$		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



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

Mass $m = 1192.642 \pm 0.024$ MeV

$m_{\Sigma^-} - m_{\Sigma^0} = 4.807 \pm 0.035$ MeV (S = 1.1)

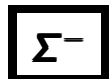
$m_{\Sigma^0} - m_\Lambda = 76.959 \pm 0.023$ MeV

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
$\Lambda e^+ e^-$	[l] 5×10^{-3}		74



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

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

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

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

$\Sigma(1385) P_{13}$

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

$$\Sigma(1385)^+ \text{ mass } m = 1382.8 \pm 0.4 \text{ MeV} \quad (S = 2.0)$$

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

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

$$\Sigma(1385)^+ \text{ full width } \Gamma = 35.8 \pm 0.8 \text{ MeV}$$

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

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

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
$\Lambda\gamma$	$(1.3 \pm 0.4) \%$		241
$\Sigma^-\gamma$	$< 2.4 \times 10^{-4}$	90%	173

 $\Sigma(1660) P_{11}$

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

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

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

$$p_{\text{beam}} = 0.72 \text{ GeV}/c \quad 4\pi\tilde{\chi}^2 = 29.9 \text{ mb}$$

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

 $\Sigma(1670) D_{13}$

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

$$\text{Mass } m = 1665 \text{ to } 1685 (\approx 1670) \text{ MeV}$$

$$\text{Full width } \Gamma = 40 \text{ to } 80 (\approx 60) \text{ MeV}$$

$$p_{\text{beam}} = 0.74 \text{ GeV}/c \quad 4\pi\tilde{\chi}^2 = 28.5 \text{ mb}$$

$\Sigma(1670)$ 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

$\Sigma(1750) S_{11}$

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

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

$$p_{\text{beam}} = 0.91 \text{ GeV}/c \quad 4\pi\lambda^2 = 20.7 \text{ mb}$$

$\Sigma(1750)$ 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 %	99

 $\Sigma(1775) D_{15}$

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

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

$$p_{\text{beam}} = 0.96 \text{ GeV}/c \quad 4\pi\lambda^2 = 19.0 \text{ mb}$$

$\Sigma(1775)$ 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
$\Lambda(1520)\pi$	17–23%	201

 $\Sigma(1915) F_{15}$

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

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

$$p_{\text{beam}} = 1.26 \text{ GeV}/c \quad 4\pi\lambda^2 = 12.8 \text{ mb}$$

$\Sigma(1915)$ 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

$\Sigma(1940) D_{13}$

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

Mass $m = 1900$ to 1950 (≈ 1940) MeVFull width $\Gamma = 150$ to 300 (≈ 220) MeV

$$p_{\text{beam}} = 1.32 \text{ GeV}/c \quad 4\pi\lambda^2 = 12.1 \text{ mb}$$

$\Sigma(1940)$ 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

 $\Sigma(2030) F_{17}$

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

Mass $m = 2025$ to 2040 (≈ 2030) MeVFull width $\Gamma = 150$ to 200 (≈ 180) MeV

$$p_{\text{beam}} = 1.52 \text{ GeV}/c \quad 4\pi\lambda^2 = 9.93 \text{ mb}$$

$\Sigma(2030)$ 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) MeVFull width $\Gamma = 60$ to 150 (≈ 100) MeV

$$p_{\text{beam}} = 2.04 \text{ GeV}/c \quad 4\pi\lambda^2 = 6.76 \text{ mb}$$

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



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

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

Mass $m = 1314.83 \pm 0.20$ MeV

$m_{\Xi^-} - m_{\Xi^0} = 6.48 \pm 0.24$ 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

$\Lambda\pi^0$ $\alpha = -0.411 \pm 0.022$ ($S = 2.1$)

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

" $\gamma = 0.85$ [i]

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

$\Lambda\gamma$ $\alpha = -0.73 \pm 0.17$

$\Sigma^0\gamma$ $\alpha = -0.63 \pm 0.09$

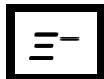
$\Sigma^+ e^- \bar{\nu}_e$ $g_1(0)/f_1(0) = 1.32^{+0.22}_{-0.18}$

$\Sigma^+ e^- \bar{\nu}_e$ $f_2(0)/f_1(0) = 2.0 \pm 1.3$

Ξ^0 DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\Lambda\pi^0$	(99.523 \pm 0.013) %		135
$\Lambda\gamma$	(1.17 \pm 0.07) $\times 10^{-3}$		184
$\Sigma^0\gamma$	(3.33 \pm 0.10) $\times 10^{-3}$		117
$\Sigma^+ e^- \bar{\nu}_e$	(2.7 \pm 0.4) $\times 10^{-4}$		119
$\Sigma^+ \mu^- \bar{\nu}_\mu$	(4.9 $^{+2.1}_{-1.6}$) $\times 10^{-6}$		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
$p e^- \bar{\nu}_e$	S2	< 1.3	$\times 10^{-3}$		323
$p \mu^- \bar{\nu}_\mu$	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.

$$\text{Mass } m = 1321.31 \pm 0.13 \text{ MeV}$$

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

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

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

Decay parameters

$$\Lambda\pi^- \quad \alpha = -0.458 \pm 0.012 \quad (S = 1.8)$$

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

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

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

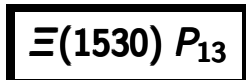
$$" \quad \Delta = (175.9 \pm 1.5)^\circ [i]$$

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

Ξ^- DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	P (MeV/c)
$\Lambda\pi^-$	$(99.887 \pm 0.035) \%$		139
$\Sigma^- \gamma$	$(1.27 \pm 0.23) \times 10^{-4}$		118
$\Lambda e^- \bar{\nu}_e$	$(5.63 \pm 0.31) \times 10^{-4}$		190
$\Lambda\mu^- \bar{\nu}_\mu$	$(3.5 \begin{smallmatrix} +3.5 \\ -2.2 \end{smallmatrix}) \times 10^{-4}$		163
$\Sigma^0 e^- \bar{\nu}_e$	$(8.7 \pm 1.7) \times 10^{-5}$		122
$\Sigma^0 \mu^- \bar{\nu}_\mu$	$< 8 \times 10^{-4}$	90%	70
$\Xi^0 e^- \bar{\nu}_e$	$< 2.3 \times 10^{-3}$	90%	6

$\Delta S = 2$ forbidden (S_2) modes

$n\pi^-$	S_2	$< 1.9 \times 10^{-5}$	90%	303
$ne^- \bar{\nu}_e$	S_2	$< 3.2 \times 10^{-3}$	90%	327
$n\mu^- \bar{\nu}_\mu$	S_2	$< 1.5 \%$	90%	313
$p\pi^- \pi^-$	S_2	$< 4 \times 10^{-4}$	90%	223
$p\pi^- e^- \bar{\nu}_e$	S_2	$< 4 \times 10^{-4}$	90%	304
$p\pi^- \mu^- \bar{\nu}_\mu$	S_2	$< 4 \times 10^{-4}$	90%	250
$p\mu^- \mu^-$	L	$< 4 \times 10^{-8}$	90%	272



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

$$\Xi(1530)^0 \text{ mass } m = 1531.80 \pm 0.32 \text{ MeV} \quad (S = 1.3)$$

$$\Xi(1530)^- \text{ mass } m = 1535.0 \pm 0.6 \text{ MeV}$$

$$\Xi(1530)^0 \text{ full width } \Gamma = 9.1 \pm 0.5 \text{ MeV}$$

$$\Xi(1530)^- \text{ full width } \Gamma = 9.9 \begin{smallmatrix} +1.7 \\ -1.9 \end{smallmatrix} \text{ MeV}$$

$\Xi(1530)$ 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 [k]

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	214

 $\Xi(1820) D_{13}$

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

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

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

$\Xi(1820)$ 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 [k]

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

$\Xi(1950)$ 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 [k]
 Full width $\Gamma = 20_{-5}^{+15}$ MeV [k]

$\Xi(2030)$ 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 is not yet measured; $\frac{3}{2}^+$ is the quark model prediction.

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
 $(\tau_{\Omega^-} - \tau_{\bar{\Omega}^+}) / \tau_{\Omega^-} = -0.002 \pm 0.040$
 Magnetic moment $\mu = -2.02 \pm 0.05 \mu_N$

Decay parameters

ΛK^- $\alpha = 0.0175 \pm 0.0024$
 $\frac{1}{2}[\alpha(\Lambda K^-) + \alpha(\bar{\Lambda} K^+)] = 0.00 \pm 0.04$
 $\Xi^0 \pi^-$ $\alpha = 0.09 \pm 0.14$
 $\Xi^- \pi^0$ $\alpha = 0.05 \pm 0.21$

Ω^- DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
ΛK^-	$(67.8 \pm 0.7) \%$		211
$\Xi^0 \pi^-$	$(23.6 \pm 0.7) \%$		294
$\Xi^- \pi^0$	$(8.6 \pm 0.4) \%$		290
$\Xi^- \pi^+ \pi^-$	$(4.3^{+3.4}_{-1.3}) \times 10^{-4}$		190
$\Xi(1530)^0 \pi^-$	$(6.4^{+5.1}_{-2.0}) \times 10^{-4}$		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			
$\Lambda \pi^-$	$S_2 < 2.9 \times 10^{-6}$	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 ($C = +1$)

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

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

Λ_c^+

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

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 ($S = 1.6$)

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

Decay asymmetry parameters

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

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

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

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

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

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 $B(\Lambda_c^+ \rightarrow pK^-\pi^+)$ 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			
$p\bar{K}^0$	(2.3 \pm 0.6) %		873
$pK^-\pi^+$	[<i>m</i>] (5.0 \pm 1.3) %		823
$p\bar{K}^*(892)^0$	[<i>n</i>] (1.6 \pm 0.5) %		685
$\Delta(1232)^{++}K^-$	(8.6 \pm 3.0) $\times 10^{-3}$		710
$\Lambda(1520)\pi^+$	[<i>n</i>] (1.8 \pm 0.6) %		627
$pK^-\pi^+$ nonresonant	(2.8 \pm 0.8) %		823
$p\bar{K}^0\pi^0$	(3.3 \pm 1.0) %		823
$p\bar{K}^0\eta$	(1.2 \pm 0.4) %		568
$p\bar{K}^0\pi^+\pi^-$	(2.6 \pm 0.7) %		754
$pK^-\pi^+\pi^0$	(3.4 \pm 1.0) %		759
$pK^*(892)^-\pi^+$	[<i>n</i>] (1.1 \pm 0.5) %		580
$p(K^-\pi^+)_{\text{nonresonant}}\pi^0$	(3.6 \pm 1.2) %		759
$\Delta(1232)\bar{K}^*(892)$	seen		419
$pK^-\pi^+\pi^+\pi^-$	(1.1 \pm 0.8) $\times 10^{-3}$		671
$pK^-\pi^+\pi^0\pi^0$	(8 \pm 4) $\times 10^{-3}$		678
Hadronic modes with a p: $S = 0$ final states			
$p\pi^+\pi^-$	(3.5 \pm 2.0) $\times 10^{-3}$		927
$pf_0(980)$	[<i>n</i>] (2.8 \pm 1.9) $\times 10^{-3}$		622
$p\pi^+\pi^+\pi^-\pi^-$	(1.8 \pm 1.2) $\times 10^{-3}$		852
pK^+K^-	(7.7 \pm 3.5) $\times 10^{-4}$		616
$p\phi$	[<i>n</i>] (8.2 \pm 2.7) $\times 10^{-4}$		590
pK^+K^- non- ϕ	(3.5 \pm 1.7) $\times 10^{-4}$		616

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

$\Lambda\pi^+$	(1.01 ± 0.28) %	864
$\Lambda\pi^+\pi^0$	(3.6 ± 1.3) %	844
$\Lambda\rho^+$	< 5 %	CL=95% 635
$\Lambda\pi^+\pi^+\pi^-$	(2.6 ± 0.7) %	807
$\Sigma(1385)^+\pi^+\pi^-, \Sigma^{*+} \rightarrow$ $\Lambda\pi^+$	(7 ± 4) × 10 ⁻³	688
$\Sigma(1385)^-\pi^+\pi^+, \Sigma^{*-} \rightarrow$ $\Lambda\pi^-$	(5.5 ± 1.7) × 10 ⁻³	688
$\Lambda\pi^+\rho^0$	(1.1 ± 0.5) %	523
$\Sigma(1385)^+\rho^0, \Sigma^{*+} \rightarrow \Lambda\pi^+$	(3.7 ± 3.1) × 10 ⁻³	363
$\Lambda\pi^+\pi^+\pi^-$ nonresonant	< 8 × 10 ⁻³	CL=90% 807
$\Lambda\pi^+\pi^+\pi^-\pi^0$ total	(1.8 ± 0.8) %	757
$\Lambda\pi^+\eta$	[n] (1.8 ± 0.6) %	691
$\Sigma(1385)^+\eta$	[n] (8.5 ± 3.3) × 10 ⁻³	570
$\Lambda\pi^+\omega$	[n] (1.2 ± 0.5) %	517
$\Lambda\pi^+\pi^+\pi^-\pi^0$, no η or ω	< 7 × 10 ⁻³	CL=90% 757
$\Lambda K^+\bar{K}^0$	(6.5 ± 2.0) × 10 ⁻³	443
$\Xi(1690)^0 K^+, \Xi^{*0} \rightarrow \Lambda\bar{K}^0$	(1.9 ± 0.7) × 10 ⁻³	286
$\Sigma^0\pi^+$	(1.04 ± 0.31) %	825
$\Sigma^+\pi^0$	(1.00 ± 0.34) %	827
$\Sigma^+\eta$	(5.5 ± 2.3) × 10 ⁻³	714
$\Sigma^+\pi^+\pi^-$	(3.6 ± 1.0) %	804
$\Sigma^+\rho^0$	< 1.4 %	CL=95% 575
$\Sigma^-\pi^+\pi^+$	(1.9 ± 0.8) %	799
$\Sigma^0\pi^+\pi^0$	(1.8 ± 0.8) %	803
$\Sigma^0\pi^+\pi^+\pi^-$	(8.3 ± 3.1) × 10 ⁻³	763
$\Sigma^+\pi^+\pi^-\pi^0$	—	767
$\Sigma^+\omega$	[n] (2.7 ± 1.0) %	569
$\Sigma^+K^+K^-$	(2.8 ± 0.8) × 10 ⁻³	349
$\Sigma^+\phi$	[n] (3.2 ± 1.0) × 10 ⁻³	295
$\Xi(1690)^0 K^+, \Xi^{*0} \rightarrow$ Σ^+K^-	(8.2 ± 3.1) × 10 ⁻⁴	286
$\Sigma^+K^+K^-$ nonresonant	< 7 × 10 ⁻⁴	CL=90% 349
$\Xi^0 K^+$	(3.9 ± 1.4) × 10 ⁻³	653
$\Xi^- K^+\pi^+$	(4.9 ± 1.7) × 10 ⁻³	566
$\Xi(1530)^0 K^+$	[n] (2.6 ± 1.0) × 10 ⁻³	473

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

ΛK^+	(7.5 ± 2.6) × 10 ⁻⁴	781
$\Sigma^0 K^+$	(5.8 ± 2.4) × 10 ⁻⁴	735
$\Sigma^+ K^+\pi^-$	(1.7 ± 0.7) × 10 ⁻³	670
$\Sigma^+ K^*(892)^0$	[n] (2.8 ± 1.1) × 10 ⁻³	470
$\Sigma^- K^+\pi^+$	< 1.0 × 10 ⁻³	CL=90% 664

Doubly Cabibbo-suppressed modes

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

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

Inclusive modes

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

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

$p\mu^+\mu^-$	C1	< 3.4	$\times 10^{-4}$	CL=90%	937
$\Sigma^-\mu^+\mu^+$	L	< 7.0	$\times 10^{-4}$	CL=90%	812

$\Lambda_c(2593)^+$

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

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

$$\text{Mass } m = 2595.4 \pm 0.6 \text{ MeV} \quad (S = 1.1)$$

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

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

$\Lambda_c^+\pi\pi$ 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.

$\Lambda_c(2593)^+$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda_c^+\pi^+\pi^-$	[q] \approx 67 %	124
$\Sigma_c(2455)^{++}\pi^-$	24 \pm 7 %	28
$\Sigma_c(2455)^0\pi^+$	24 \pm 7 %	28

$\Lambda_c^+ \pi^+ \pi^-$ 3-body	$18 \pm 10 \%$	124
$\Lambda_c^+ \pi^0$	[r] not seen	261
$\Lambda_c^+ \gamma$	not seen	291

$\Lambda_c(2625)^+$

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

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

$$\text{Mass } m = 2628.1 \pm 0.6 \text{ MeV} \quad (S = 1.5)$$

$$m - m_{\Lambda_c^+} = 341.7 \pm 0.6 \text{ MeV} \quad (S = 1.6)$$

$$\text{Full width } \Gamma < 1.9 \text{ MeV, CL} = 90\%$$

$\Lambda_c^+ \pi \pi$ 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	ρ (MeV/c)
$\Lambda_c^+ \pi^+ \pi^-$	[q] $\approx 67\%$		184
$\Sigma_c(2455)^{++} \pi^-$	<5	90%	102
$\Sigma_c(2455)^0 \pi^+$	<5	90%	102
$\Lambda_c^+ \pi^+ \pi^-$ 3-body	large		184
$\Lambda_c^+ \pi^0$	[r] not seen		293
$\Lambda_c^+ \gamma$	not seen		319

$\Sigma_c(2455)$

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

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

$$\Sigma_c(2455)^{++} \text{ mass } m = 2454.02 \pm 0.18 \text{ MeV}$$

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

$$\Sigma_c(2455)^0 \text{ mass } m = 2453.76 \pm 0.18 \text{ MeV}$$

$$m_{\Sigma_c^{++}} - m_{\Lambda_c^+} = 167.56 \pm 0.11 \text{ MeV}$$

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

$$m_{\Sigma_c^0} - m_{\Lambda_c^+} = 167.30 \pm 0.11 \text{ MeV}$$

$$m_{\Sigma_c^{++}} - m_{\Sigma_c^0} = 0.27 \pm 0.11 \text{ MeV} \quad (S = 1.1)$$

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

$$\Sigma_c(2455)^{++} \text{ full width } \Gamma = 2.23 \pm 0.30 \text{ MeV}$$

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

$$\Sigma_c(2455)^0 \text{ full width } \Gamma = 2.2 \pm 0.4 \text{ MeV} \quad (S = 1.4)$$

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

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

$$\Sigma_c(2520)^{++} \text{ mass } m = 2518.4 \pm 0.6 \text{ MeV} \quad (S = 1.4)$$

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

$$\Sigma_c(2520)^0 \text{ mass } m = 2518.0 \pm 0.5 \text{ MeV}$$

$$m_{\Sigma_c(2520)^{++}} - m_{\Lambda_c^+} = 231.9 \pm 0.6 \text{ MeV} \quad (S = 1.5)$$

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

$$m_{\Sigma_c(2520)^0} - m_{\Lambda_c^+} = 231.6 \pm 0.5 \text{ MeV} \quad (S = 1.1)$$

$$m_{\Sigma_c(2520)^{++}} - m_{\Sigma_c(2520)^0} = 0.3 \pm 0.6 \text{ MeV} \quad (S = 1.2)$$

$$\Sigma_c(2520)^{++} \text{ full width } \Gamma = 14.9 \pm 1.9 \text{ MeV}$$

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

$$\Sigma_c(2520)^0 \text{ full width } \Gamma = 16.1 \pm 2.1 \text{ MeV}$$

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

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

$\Sigma_c(2800)$

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

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

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

$$\Sigma_c(2800)^0 \text{ mass } m = 2802_{-7}^{+4}$$

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

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

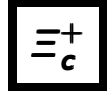
$$m_{\Sigma_c(2800)^0} - m_{\Lambda_c^+} = 515_{-7}^{+4}$$

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

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

$$\Sigma_c(2800)^0 \text{ full width } \Gamma = 61_{-18}^{+28}$$

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



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

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

Mass $m = 2467.9 \pm 0.4$ MeV

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

$c\tau = 132$ μ m

Ξ_c^+ 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 $\Xi^- \pi^+ \pi^+$.

Cabibbo-favored ($S = -2$) decays

$p K_S^0 K_S^0$	[s]	0.087 ± 0.022		767
$\Lambda \bar{K}^0 \pi^+$		—		852
$\Sigma(1385)^+ \bar{K}^0$	[n,s]	1.0 ± 0.5		746
$\Lambda K^- \pi^+ \pi^+$	[s]	0.323 ± 0.033		787
$\Lambda \bar{K}^*(892)^0 \pi^+$	[n,s]	< 0.2	90%	608
$\Sigma(1385)^+ K^- \pi^+$	[n,s]	< 0.3	90%	678
$\Sigma^+ K^- \pi^+$	[s]	0.94 ± 0.11		811
$\Sigma^+ \bar{K}^*(892)^0$	[n,s]	0.81 ± 0.15		658
$\Sigma^0 K^- \pi^+ \pi^+$	[s]	0.29 ± 0.16		735
$\Xi^0 \pi^+$	[s]	0.55 ± 0.16		877
$\Xi^- \pi^+ \pi^+$	[s]	DEFINED AS 1		851
$\Xi(1530)^0 \pi^+$	[n,s]	< 0.1	90%	750
$\Xi^0 \pi^+ \pi^0$	[s]	2.34 ± 0.68		856
$\Xi^0 \pi^+ \pi^+ \pi^-$	[s]	1.74 ± 0.50		818
$\Xi^0 e^+ \nu_e$	[s]	$2.3 \begin{smallmatrix} +0.7 \\ -0.9 \end{smallmatrix}$		884
$\Omega^- K^+ \pi^+$	[s]	0.07 ± 0.04		399

Cabibbo-suppressed decays

$p K^- \pi^+$	[s]	0.21 ± 0.03		944
$p \bar{K}^*(892)^0$	[n,s]	0.12 ± 0.02		828
$\Sigma^+ K^+ K^-$	[s]	0.15 ± 0.07		580
$\Sigma^+ \phi$	[n,s]	< 0.11	90%	549
$\Xi(1690)^0 K^+, \Xi(1690)^0 \rightarrow \Sigma^+ K^-$	[s]	< 0.05	90%	501



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

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

Mass $m = 2471.0 \pm 0.4$ MeV

$$m_{\Xi_c^0} - m_{\Xi_c^+} = 3.1 \pm 0.5 \text{ MeV}$$

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

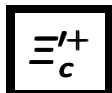
$$c\tau = 33.6 \text{ } \mu\text{m}$$

Decay asymmetry parameters

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

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)
$pK^- K^- \pi^+$	seen	676
$pK^- \bar{K}^*(892)^0$	seen	413
$pK^- K^- \pi^+$ no $\bar{K}^*(892)^0$	seen	676
ΛK_S^0	seen	906
$\Lambda \bar{K}^0 \pi^+ \pi^-$	seen	787
$\Lambda K^- \pi^+ \pi^+ \pi^-$	seen	703
$\Xi^- \pi^+$	seen	875
$\Xi^- \pi^+ \pi^+ \pi^-$	seen	817
$\Omega^- K^+$	seen	523
$\Xi^- e^+ \nu_e$	seen	882
$\Xi^- \ell^+$ anything	seen	—



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

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

Mass $m = 2575.7 \pm 3.1$ MeV

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

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	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 $m = 2578.0 \pm 2.9$ MeV

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

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)
$\Xi_c^{\prime 0} \gamma$	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 $m = 2646.6 \pm 1.4$ MeV (S = 1.6)

$\Xi_c(2645)^0$ mass $m = 2646.1 \pm 1.2$ MeV

$$m_{\Xi_c(2645)^+} - m_{\Xi_c^0} = 175.6 \pm 1.4 \text{ MeV} \quad (S = 1.7)$$

$$m_{\Xi_c(2645)^0} - m_{\Xi_c^+} = 178.2 \pm 1.1 \text{ MeV}$$

$\Xi_c(2645)^+$ full width $\Gamma < 3.1$ MeV, CL = 90%

$\Xi_c(2645)^0$ full width $\Gamma < 5.5$ MeV, CL = 90%

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

$\Xi_c(2645)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Xi_c^0 \pi^+$	seen	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 = 2789.2 ± 3.2 MeV

$\Xi_c(2790)^0$ mass = 2791.9 ± 3.3 MeV

$$m_{\Xi_c(2790)^+} - m_{\Xi_c^0} = 318.2 \pm 3.2 \text{ MeV}$$

$$m_{\Xi_c(2790)^0} - m_{\Xi_c^+} = 324.0 \pm 3.3 \text{ MeV}$$

$\Xi_c(2790)^+$ width < 15 MeV, CL = 90%

$\Xi_c(2790)^0$ width < 12 MeV, CL = 90%

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

$$\Xi_c(2815)^+ \text{ mass } m = 2816.5 \pm 1.2 \text{ MeV}$$

$$\Xi_c(2815)^0 \text{ mass } m = 2818.2 \pm 2.1 \text{ MeV}$$

$$m_{\Xi_c(2815)^+} - m_{\Xi_c^+} = 348.6 \pm 1.2 \text{ MeV}$$

$$m_{\Xi_c(2815)^0} - m_{\Xi_c^0} = 347.2 \pm 2.1 \text{ MeV}$$

$$\Xi_c(2815)^+ \text{ full width } \Gamma < 3.5 \text{ MeV, CL} = 90\%$$

$$\Xi_c(2815)^0 \text{ full width } \Gamma < 6.5 \text{ MeV, CL} = 90\%$$

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

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

Ω_c^0

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

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

$$\text{Mass } m = 2697.5 \pm 2.6 \text{ MeV } (S = 1.2)$$

$$\text{Mean life } \tau = (69 \pm 12) \times 10^{-15} \text{ s}$$

$$c\tau = 21 \text{ } \mu\text{m}$$

No absolute branching fractions have been measured.

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

BOTTOM BARYONS

($B = -1$)

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

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.

$$\text{Mass } m = 5624 \pm 9 \text{ MeV} \quad (S = 1.8)$$

$$\text{Mean life } \tau = (1.230 \pm 0.074) \times 10^{-12} \text{ s}$$

$$c\tau = 369 \mu\text{m}$$

These branching fractions are actually an average over weakly decaying b -baryons weighted by their production rates in Z decay (or high-energy $p\bar{p}$), branching ratios, and detection efficiencies. They scale with the LEP b -baryon production fraction $B(b \rightarrow b\text{-baryon})$ and are evaluated for our value $B(b \rightarrow b\text{-baryon}) = (10.0 \pm 2.0)\%$.

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.

Λ_b^0 DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$J/\psi(1S)\Lambda$	$(4.7 \pm 2.8) \times 10^{-4}$		1744
$\Lambda_c^+ \pi^-$	seen		2345
$\Lambda_c^+ a_1(1260)^-$	seen		2155
$\Lambda_c^+ \ell^- \bar{\nu}_\ell \text{ anything}$	[t] $(9.1 \pm 2.3) \%$		—
$\Lambda_c^+ \ell^- \bar{\nu}_\ell$	$(5.0^{+1.9}_{-1.4}) \%$		2347
$\Lambda_c^+ \pi^+ \pi^- \ell^- \bar{\nu}_\ell$	$(5.6 \pm 3.1) \%$		2337
$p h^-$	[u] $< 2.3 \times 10^{-5}$	90%	2732
$p \pi^-$	$< 5.0 \times 10^{-5}$	90%	2732
$p K^-$	$< 5.0 \times 10^{-5}$	90%	2711
$\Lambda \gamma$	$< 1.3 \times 10^{-3}$	90%	2701

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

$$\text{Mean life } \tau = (1.209 \pm 0.049) \times 10^{-12} \text{ s}$$

These branching fractions are actually an average over weakly decaying b -baryons weighted by their production rates in Z decay (or high-energy $p\bar{p}$), branching ratios, and detection efficiencies. They scale with the LEP b -baryon production fraction $B(b \rightarrow b\text{-baryon})$ and are evaluated for our value $B(b \rightarrow b\text{-baryon}) = (10.0 \pm 2.0)\%$.

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	$(4.9^{+2.1}_{-1.8})\%$	—
$p\ell \bar{\nu}_\ell$ anything	$(4.7 \pm 1.2)\%$	—
p anything	$(59 \pm 21)\%$	—
$\Lambda \ell^- \bar{\nu}_\ell$ anything	$(3.2 \pm 0.7)\%$	—
$\Lambda/\bar{\Lambda}$ anything	$(33 \pm 8)\%$	—
$\Xi^- \ell^- \bar{\nu}_\ell$ anything	$(5.5 \pm 1.6) \times 10^{-3}$	—

NOTES

- [a] The masses of the p and n are most precisely known in u (unified atomic mass units). The conversion factor to MeV, $1 u = 931.494043 \pm 0.000080$ MeV, is less well known than are the masses in u .
- [b] These two results 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 first limit is for $p \rightarrow \text{anything}$ 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.

- [e] 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.
- [f] 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.
- [g] Time-reversal invariance requires this to be 0° or 180° .
- [h] This limit is for γ energies between 35 and 100 keV.
- [i] 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.
- [j] See the Listings for the pion momentum range used in this measurement.
- [k] The error given here is only an educated guess. It is larger than the error on the weighted average of the published values.
- [l] A theoretical value using QED.
- [m] See the note on “ Λ_c^+ Branching Fractions” in the Λ_c^+ Particle Listings.
- [n] This branching fraction includes all the decay modes of the final-state resonance.
- [o] An ℓ indicates an e or a μ mode, not a sum over these modes.
- [p] The value is for the sum of the charge states or particle/antiparticle states indicated.
- [q] Assuming isospin conservation, so that the other third is $\Lambda_c^+\pi^0\pi^0$.
- [r] A test that the isospin is indeed 0, so that the particle is indeed a Λ_c^+ .
- [s] No absolute branching fractions have been measured. The value here is the branching *ratio* relative to $\Xi^-\pi^+\pi^+$.
- [t] Not a pure measurement. See note at head of Λ_b^0 Decay Modes.
- [u] Here h^- means π^- or K^- .