

# Λ BARYONS

## (S = -1, I = 0)

$$\Lambda^0 = uds$$



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

Mass  $m = 1115.683 \pm 0.006$  MeV

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

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

$$p\pi^- \quad \alpha_- = 0.732 \pm 0.014 \quad (S = 2.3)$$

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

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

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

$$" \quad \gamma_- = 0.76 \text{ [a]}$$

$$" \quad \Delta_- = (8 \pm 4)^\circ \text{ [a]}$$

$$\bar{\alpha}_0 / \alpha_+ \text{ in } \bar{\Lambda} \rightarrow \bar{n}\pi^0, \bar{\Lambda} \rightarrow \bar{p}\pi^+ = 0.913 \pm 0.030$$

$$R = |G_E/G_M| \text{ in } \Lambda \rightarrow p\pi^-, \bar{\Lambda} \rightarrow \bar{p}\pi^+ = 0.96 \pm 0.14$$

$$\Delta\Phi = \Phi_E - \Phi_M \text{ in } \Lambda \rightarrow p\pi^-, \bar{\Lambda} \rightarrow \bar{p}\pi^+ = 37 \pm 13 \text{ degrees}$$

$$n\pi^0 \quad \alpha_0 = 0.74 \pm 0.05$$

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

Λ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$\rho$ (MeV/c)
$p\pi^-$	(63.9 ± 0.5) %		101
$n\pi^0$	(35.8 ± 0.5) %		104
$n\gamma$	(1.75 ± 0.15) × 10 <sup>-3</sup>		162
$p\pi^- \gamma$	[c] (8.4 ± 1.4) × 10 <sup>-4</sup>		101
$pe^- \bar{\nu}_e$	(8.32 ± 0.14) × 10 <sup>-4</sup>		163
$p\mu^- \bar{\nu}_\mu$	(1.57 ± 0.35) × 10 <sup>-4</sup>		131

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

$\pi^+ e^-$	L, B	< 6	× 10 <sup>-7</sup>	90%	549
$\pi^+ \mu^-$	L, B	< 6	× 10 <sup>-7</sup>	90%	544
$\pi^- e^+$	L, B	< 4	× 10 <sup>-7</sup>	90%	549
$\pi^- \mu^+$	L, B	< 6	× 10 <sup>-7</sup>	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  $m = 1405.1^{+1.3}_{-1.0}$  MeV

Full width  $\Gamma = 50.5 \pm 2.0$  MeV

Below  $\bar{K}N$  threshold

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

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

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

Mass  $m = 1518$  to  $1520$  ( $\approx 1519$ ) MeV [d]

Full width  $\Gamma = 15$  to  $17$  ( $\approx 16$ ) MeV [d]

$\Lambda(1520)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N \bar{K}$	(45 $\pm 1$ ) %	242
$\Sigma \pi$	(42 $\pm 1$ ) %	268
$\Lambda \pi \pi$	(10 $\pm 1$ ) %	259
$\Sigma \pi \pi$	(0.9 $\pm 0.1$ ) %	168
$\Lambda \gamma$	(0.85 $\pm 0.15$ ) %	350

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

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

Mass  $m = 1570$  to  $1630$  ( $\approx 1600$ ) MeV

Full width  $\Gamma = 150$  to  $250$  ( $\approx 200$ ) MeV

$\Lambda(1600)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N \bar{K}$	15–30 %	343
$\Sigma \pi$	10–60 %	338
$\Lambda \sigma$	(19 $\pm 4$ ) %	–
$\Sigma(1385) \pi$	(9 $\pm 4$ ) %	158

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

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

Mass  $m = 1670$  to  $1678$  ( $\approx 1674$ ) MeVFull width  $\Gamma = 25$  to  $35$  ( $\approx 30$ ) MeV

<b><math>\Lambda(1670)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	20–30 %	418
$\Sigma\pi$	25–55 %	398
$\Lambda\eta$	10–25 %	88
$\Sigma(1385)\pi$ , $D$ -wave	( $6.0 \pm 2.0$ ) %	235
$N\bar{K}^*(892)$ , $S=3/2$ , $D$ -wave	( $5 \pm 4$ ) %	†
$\Lambda\sigma$	( $20 \pm 8$ ) %	–

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

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

Mass  $m = 1685$  to  $1695$  ( $\approx 1690$ ) MeVFull width  $\Gamma = 60$  to  $80$  ( $\approx 70$ ) MeV

<b><math>\Lambda(1690)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	20–30 %	433
$\Sigma\pi$	20–40 %	410
$\Lambda\sigma$	( $5.0 \pm 2.0$ ) %	–
$\Lambda\pi\pi$	$\sim 25$ %	419
$\Sigma\pi\pi$	$\sim 20$ %	358
$\Sigma(1385)\pi$ , $S$ -wave	( $9 \pm 5$ ) %	251
$\Sigma(1385)\pi$ , $D$ -wave	( $3.0 \pm 2.0$ ) %	251

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

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

Mass  $m = 1750$  to  $1850$  ( $\approx 1800$ ) MeVFull width  $\Gamma = 150$  to  $250$  ( $\approx 200$ ) MeV

<b><math>\Lambda(1800)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	25–40 %	528
$\Sigma\pi$	seen	494
$\Lambda\sigma$	( $15 \pm 4$ ) %	–
$\Sigma(1385)\pi$	seen	349
$\Lambda\eta$	0.01 to 0.10	326
$N\bar{K}^*(892)$	seen	†

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

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

Mass  $m = 1740$  to  $1840$  ( $\approx 1790$ ) MeV

Full width  $\Gamma = 50$  to  $170$  ( $\approx 110$ ) MeV

$\Lambda(1810)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	0.05 to 0.35	520
$\Sigma\pi$	(16 $\pm$ 5) %	487
$\Sigma(1385)\pi$	(40 $\pm$ 15) %	340
$N\bar{K}^*(892)$	30–60 %	†

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

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

Mass  $m = 1815$  to  $1825$  ( $\approx 1820$ ) MeV

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

$\Lambda(1820)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (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 $\pm$ 1.0) %	†

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

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

Mass  $m = 1820$  to  $1830$  ( $\approx 1825$ ) MeV

Full width  $\Gamma = 60$  to  $120$  ( $\approx 90$ ) MeV

$\Lambda(1830)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor	$p$ (MeV/c)
$N\bar{K}$	0.04 to 0.08		549
$\Sigma\pi$	35–75 %		512
$\Sigma(1385)\pi$	>15 %		370
$\Sigma(1385)\pi$ , $D$ -wave	(40 $\pm$ 15) %	3.2	370

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

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

Mass  $m = 1870$  to  $1910$  ( $\approx 1890$ ) MeV

Full width  $\Gamma = 80$  to  $160$  ( $\approx 120$ ) MeV

<b><math>\Lambda(1890)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	0.24 to 0.36	599
$\Sigma\pi$	3–10 %	560
$\Sigma(1385)\pi$	seen	423
$\Sigma(1385)\pi$ , $P$ -wave	$(6.0 \pm 3.0)$ %	423
$\Sigma(1385)\pi$ , $F$ -wave	$(4.0 \pm 2.0)$ %	423
$N\bar{K}^*(892)$	seen	236

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

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

Mass  $m = 2090$  to  $2110$  ( $\approx 2100$ ) MeV

Full width  $\Gamma = 100$  to  $250$  ( $\approx 200$ ) MeV

<b><math>\Lambda(2100)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	25–35 %	751
$\Sigma\pi$	$\sim 5$ %	705
$\Lambda\eta$	$< 3$ %	617
$\Xi K$	$< 3$ %	491
$\Lambda\omega$	$< 8$ %	443
$N\bar{K}^*(892)$	10–20 %	515
$\Sigma(1385)\pi$ , $G$ -wave	$(1.0 \pm 1.0)$ %	584
$N\bar{K}^*(892)$ , $S=3/2$ , $D$ -wave	$(4.0 \pm 2.0)$ %	515

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

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

Mass  $m = 2050$  to  $2130$  ( $\approx 2090$ ) MeV

Full width  $\Gamma = 200$  to  $300$  ( $\approx 250$ ) MeV

<b><math>\Lambda(2110)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	5–25 %	744
$\Sigma\pi$	10–40 %	698
$\Lambda\omega$	seen	432
$\Lambda\omega$ , $S=3/2$ , $P$ -wave	$(5.0 \pm 2.0)$ %	432
$\Sigma(1385)\pi$	seen	576
$N\bar{K}^*(892)$	10–60 %	505

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

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

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

<b><math>\Lambda(2350)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	$\sim 12\%$	915
$\Sigma\pi$	$\sim 10\%$	867

## NOTES

[a] The decay parameters  $\gamma$  and  $\Delta$  are calculated from  $\alpha$  and  $\phi$  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.

[b] 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  $\phi_{AV}$  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.

[c] See the Listings for the pion momentum range used in this measurement.

[d] Our estimate. See the Particle Listings for details.