

# 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

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

$$\text{Mean life } \tau = (2.617 \pm 0.010) \times 10^{-10} \text{ s} \quad (S = 1.5)$$

$$(\tau_\Lambda - \tau_{\bar{\Lambda}}) / \tau_\Lambda = (0.9 \pm 3.2) \times 10^{-3}$$

$$c\tau = 7.845 \text{ cm}$$

$$\text{Magnetic moment } \mu = -0.613 \pm 0.004 \mu_N$$

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

### Decay parameters

$$p\pi^- \quad \alpha_- = 0.749 \pm 0.008 \quad (S = 2.4)$$

$$\bar{p}\pi^+ \quad \alpha_+ = -0.758 \pm 0.005 \quad (S = 1.2)$$

$$\bar{n}\pi^0 \quad \bar{\alpha}_0 = -0.675 \pm 0.011 \quad (S = 1.2)$$

$$n\pi^0 \quad \alpha_0 = 0.670 \pm 0.012$$

$$n\gamma \quad \alpha_\gamma = -0.16 \pm 0.11$$

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

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

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

$$\bar{\alpha}_0 / \alpha_+ \text{ in } \bar{\Lambda} \rightarrow \bar{n}\pi^0, \bar{\Lambda} \rightarrow \bar{p}\pi^+ = 0.876^{+0.022}_{-0.020} \quad (S = 1.4)$$

$$(\alpha_0 + \bar{\alpha}_0) / (\alpha_0 - \bar{\alpha}_0) \text{ in } \Lambda \rightarrow n\pi^0, \bar{\Lambda} \rightarrow \bar{n}\pi^0 = (0.1^{+1.0}_{-1.1}) \times 10^{-2}$$

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

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

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

### Λ DECAY MODES

|                        | Fraction ( $\Gamma_i / \Gamma$ )     | Confidence level | $\frac{p}{\text{MeV}/c}$ |
|------------------------|--------------------------------------|------------------|--------------------------|
| $p\pi^-$               | (64.1 ± 0.5) %                       |                  | 101                      |
| $n\pi^0$               | (35.9 ± 0.5) %                       |                  | 104                      |
| $n\gamma$              | ( 8.3 ± 0.7 ) × 10 <sup>-4</sup>     |                  | 162                      |
| $p\pi^- \gamma$        | [c] ( 8.5 ± 1.4 ) × 10 <sup>-4</sup> |                  | 101                      |
| $pe^- \bar{\nu}_e$     | ( 8.34 ± 0.14 ) × 10 <sup>-4</sup>   |                  | 163                      |
| $p\mu^- \bar{\nu}_\mu$ | ( 1.51 ± 0.19 ) × 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   | × 10 <sup>-6</sup> | 90% | 449 |
| $K^+ \mu^-$    | L, B | < 3   | × 10 <sup>-6</sup> | 90% | 441 |
| $K^- e^+$      | L, B | < 2   | × 10 <sup>-6</sup> | 90% | 449 |
| $K^- \mu^+$    | L, B | < 3   | × 10 <sup>-6</sup> | 90% | 441 |
| $K_S^0 \nu$    | L, B | < 2   | × 10 <sup>-5</sup> | 90% | 447 |
| $\bar{p}\pi^+$ | B    | < 9   | × 10 <sup>-7</sup> | 90% | 101 |
| invisible      |      | < 7.4 | × 10 <sup>-5</sup> | 90% | —   |

Λ(1405) 1/2<sup>-</sup>

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

Mass  $m = 1405.1^{+1.3}_{-1.0}$  MeV

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

Below  $\bar{K}N$  threshold

NODE=BXXX020

NODE=S018

NODE=S018M;DTYPE=M

NODE=S018DM;DTYPE=x

NODE=S018T;DTYPE=T

NODE=S018DT;DTYPE=t

NODE=S018CTA;DTYPE=C;OUR EVAL

NODE=S018MM;DTYPE=m

NODE=S018EDM;DTYPE=e

CLUMP=D

NODE=S018A-;DTYPE=d;CLUMP=D

NODE=S018A+;DTYPE=d;CLUMP=D

NODE=S018A00;DTYPE=d;CLUMP=D

NODE=S018A06;DTYPE=d;CLUMP=D

NODE=S018A04;DTYPE=d;CLUMP=D

NODE=S018F-;DTYPE=d;CLUMP=D

NODE=S018G-;DTYPE=d;CLUMP=D;OUR

EVAL; → UNCHECKED ←

NODE=S018D-;DTYPE=d;CLUMP=D;OUR

EVAL; → UNCHECKED ←

NODE=S018A1;DTYPE=d;CLUMP=D

NODE=S018A07;DTYPE=d;CLUMP=D

NODE=S018A02;DTYPE=d;CLUMP=D

NODE=S018A03;DTYPE=d;CLUMP=D

NODE=S018AV;DTYPE=d;CLUMP=D

NODE=S018235;DESIG=1

DESIG=2

DESIG=6

DESIG=5

DESIG=4

DESIG=3

NODE=S018;CLUMP=A

DESIG=7

DESIG=8

DESIG=9

DESIG=10

DESIG=11

DESIG=12

DESIG=13

DESIG=14

DESIG=15

DESIG=16

DESIG=103

NODE=B037

NODE=B037M1;DTYPE=M

NODE=B037W1;DTYPE=G

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

NODE=B037215;DESIG=1;OUR EST

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

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

Mass  $m = 1518$  to  $1520$  ( $\approx 1519$ ) MeV <sup>[d]</sup>  
 Full width  $\Gamma = 15$  to  $17$  ( $\approx 16$ ) MeV <sup>[d]</sup>

NODE=B038

NODE=B038M;DTYPE=M;OUR EST;  
 → UNCHECKED ←  
 NODE=B038W;DTYPE=G;OUR EST;  
 → UNCHECKED ←

| $\Lambda(1520)$ 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         |

NODE=B038215;DESIG=1;OUR EST  
 DESIG=2;OUR EST  
 DESIG=3;OUR EST  
 DESIG=6;OUR EST  
 DESIG=4;OUR EST

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

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

Mass  $m = 1570$  to  $1630$  ( $\approx 1600$ ) MeV  
 Full width  $\Gamma = 150$  to  $250$  ( $\approx 200$ ) MeV

NODE=B101

NODE=B101M;DTYPE=M;OUR EST;  
 → UNCHECKED ←  
 NODE=B101W;DTYPE=G;OUR EST;  
 → UNCHECKED ←

| $\Lambda(1600)$ 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         |

NODE=B101215;DESIG=1;OUR EST  
 DESIG=2;OUR EST  
 DESIG=5  
 DESIG=3

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

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

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

NODE=B040

NODE=B040M;DTYPE=M;OUR EST;  
 → UNCHECKED ←  
 NODE=B040W;DTYPE=G;OUR EST;  
 → UNCHECKED ←

| $\Lambda(1670)$ DECAY MODES             | 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 $\pm 8$ ) %                | –           |

NODE=B040215;DESIG=1;OUR EST  
 DESIG=3;OUR EST  
 DESIG=2;OUR EST  
 DESIG=4  
 DESIG=5  
 DESIG=10

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

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

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

NODE=B055

NODE=B055M;DTYPE=M;OUR EST;  
 → UNCHECKED ←  
 NODE=B055W;DTYPE=G;OUR EST;  
 → UNCHECKED ←

| $\Lambda(1690)$ DECAY MODES   | 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         |

NODE=B055215;DESIG=1;OUR EST  
DESIG=2;OUR EST  
DESIG=14  
DESIG=3;OUR EST  
DESIG=4;OUR EST  
DESIG=5  
DESIG=9

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

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

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

NODE=B036

NODE=B036M;DTYPE=M;OUR EST;  
→ UNCHECKED ←  
NODE=B036W;DTYPE=G;OUR EST;  
→ UNCHECKED ←

| $\Lambda(1800)$ DECAY MODES | Fraction ( $\Gamma_i/\Gamma$ ) | $p$ (MeV/c) |
|-----------------------------|--------------------------------|-------------|
| $N\bar{K}$                  | 25–40 %                        | 528         |
| $\Sigma\pi$                 | $(27 \pm 6)$ %                 | 494         |
| $\Lambda\sigma$             | $(15 \pm 4)$ %                 | –           |
| $\Sigma(1385)\pi$           | $(9 \pm 4)$ %                  | 349         |
| $\Lambda\eta$               | 0.01 to 0.10                   | 326         |
| $N\bar{K}^*(892)$           | seen                           | †           |

NODE=B036215;DESIG=1;OUR EST  
DESIG=2  
DESIG=8  
DESIG=3  
DESIG=7  
DESIG=6;OUR EST

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

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

Mass  $m = 1740$  to  $1840$  ( $\approx 1790$ ) MeV  
Full width  $\Gamma = 50$  to  $170$  ( $\approx 110$ ) MeV

NODE=B077

NODE=B077M;DTYPE=M;OUR EST;  
→ UNCHECKED ←  
NODE=B077W;DTYPE=G;OUR EST;  
→ UNCHECKED ←

| $\Lambda(1810)$ 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 %                        | †           |

NODE=B077215;DESIG=1  
DESIG=2  
DESIG=3  
DESIG=6;OUR EST

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

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

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

NODE=B039

NODE=B039M;DTYPE=M;OUR EST;  
→ UNCHECKED ←  
NODE=B039W;DTYPE=G;OUR EST;  
→ UNCHECKED ←

| $\Lambda(1820)$ 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 | $(3.0 \pm 1.0)$ %              | †           |

NODE=B039215;DESIG=1;OUR EST  
DESIG=2;OUR EST  
DESIG=7;OUR EST  
DESIG=8

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

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

Mass  $m = 1820$  to  $1830$  ( $\approx 1825$ ) MeV  
Full width  $\Gamma = 60$  to  $120$  ( $\approx 90$ ) MeV

NODE=B056

NODE=B056M;DTYPE=M;OUR EST;  
→ UNCHECKED ←  
NODE=B056W;DTYPE=G;OUR EST;  
→ UNCHECKED ←

| $\Lambda(1830)$ 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         |

NODE=B056215;DESIG=1  
DESIG=2;OUR EST  
DESIG=3;OUR EST  
DESIG=5

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

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

Mass  $m$  = 1870 to 1910 ( $\approx$  1890) MeV  
Full width  $\Gamma$  = 80 to 160 ( $\approx$  120) MeV

NODE=B060

NODE=B060M;DTYPE=M;OUR EST;  
→ UNCHECKED ←  
NODE=B060W;DTYPE=G;OUR EST;  
→ UNCHECKED ←

| $\Lambda(1890)$ DECAY MODES   | 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         |

NODE=B060215;DESIG=1  
DESIG=2;OUR EST  
DESIG=8;OUR EST  
DESIG=4  
DESIG=5  
DESIG=6;OUR EST

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

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

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

NODE=B041

NODE=B041M;DTYPE=M;OUR EST;  
→ UNCHECKED ←  
NODE=B041W;DTYPE=G;OUR EST;  
→ UNCHECKED ←

| $\Lambda(2100)$ DECAY MODES             | 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         |
| $\Sigma(1385)\pi$ , $G$ -wave           | (1.0 $\pm$ 1.0) %              | 584         |
| $N\bar{K}^*(892)$                       | 10–20 %                        | 515         |
| $N\bar{K}^*(892)$ , $S=3/2$ , $D$ -wave | (4.0 $\pm$ 2.0) %              | 515         |

NODE=B041215;DESIG=1;OUR EST  
DESIG=2;OUR EST  
DESIG=5;OUR EST  
DESIG=3;OUR EST  
DESIG=4;OUR EST  
DESIG=11  
DESIG=8;OUR EST  
DESIG=6

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

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

Mass  $m$  = 2050 to 2130 ( $\approx$  2090) MeV  
Full width  $\Gamma$  = 200 to 300 ( $\approx$  250) MeV

NODE=B035

NODE=B035M;DTYPE=M;OUR EST;  
→ UNCHECKED ←  
NODE=B035W;DTYPE=G;OUR EST;  
→ UNCHECKED ←

| $\Lambda(2110)$ DECAY MODES           | 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         |

NODE=B035215;DESIG=1;OUR EST  
DESIG=2;OUR EST  
DESIG=3;OUR EST  
DESIG=11  
DESIG=4;OUR EST  
DESIG=5;OUR EST

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

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

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

NODE=B042

NODE=B042M;DTYPE=M;OUR EST;  
→ UNCHECKED ←  
NODE=B042W;DTYPE=G;OUR EST;  
→ UNCHECKED ←

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

NODE=B042215;DESIG=1;OUR EST  
DESIG=2;OUR EST

## NOTES

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

LINKAGE=SBE

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

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.

LINKAGE=SBD

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

LINKAGE=SD

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

LINKAGE=BH