

# $\Xi$ BARYONS

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

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

$\Xi^0$

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

$P$  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

$$\alpha \text{ for } \Xi^0 \rightarrow \Lambda\pi^0 = -0.371 \pm 0.010 \quad (S = 3.0)$$

$$\alpha \text{ for } \Xi^0 \rightarrow \bar{\Lambda}\pi^0 = 0.379 \pm 0.004$$

$$\phi \text{ for } \Xi^0 \rightarrow \Lambda\pi^0 = (0.3 \pm 0.6)^\circ$$

$$\phi \text{ for } \Xi^0 \rightarrow \bar{\Lambda}\pi^0 = (-0.3 \pm 0.6)^\circ$$

$$\Delta\phi_{CP}(\Xi^0) = (\phi_{\Xi^0} + \phi_{\Xi^0})/2 = (0.0 \pm 0.4)^\circ$$

$$A_{CP} \text{ for } \Xi^0 \rightarrow \Lambda\pi^0, \Xi^0 \rightarrow \bar{\Lambda}\pi^0 = (-5 \pm 7) \times 10^{-3}$$

$$\gamma \text{ for } \Xi^0 \rightarrow \Lambda\pi^0 = 0.937 \pm 0.002 \text{ [a]}$$

$$\Delta \text{ for } \Xi^0 \rightarrow \Lambda\pi^0 = (0.8 \pm 1.6)^\circ \text{ [a]}$$

$$\alpha \text{ for } \Xi^0 \rightarrow \Lambda\gamma = -0.72 \pm 0.05$$

$$A_{CP} \text{ for } \Xi^0 \rightarrow \Lambda\gamma, \Xi^0 \rightarrow \bar{\Lambda}\gamma = -0.12 \pm 0.09$$

$$\alpha \text{ for } \Xi^0 \rightarrow \Lambda e^+ e^- = -0.8 \pm 0.2$$

$$\alpha \text{ for } \Xi^0 \rightarrow \Sigma^0 \gamma = -0.69 \pm 0.06$$

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

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

| $\Xi^0$ DECAY MODES            | Fraction ( $\Gamma_i/\Gamma$ )   | Scale factor/<br>Confidence level | $p$<br>(MeV/c) |
|--------------------------------|----------------------------------|-----------------------------------|----------------|
| $\Lambda\pi^0$                 | $(99.517 \pm 0.012) \%$          | S=1.1                             | 135            |
| $\Lambda\gamma$                | $(1.24 \pm 0.07) \times 10^{-3}$ | S=1.3                             | 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            |
| $\Sigma^+ \mu^- \bar{\nu}_\mu$ | $(2.3 \pm 0.4) \times 10^{-6}$   |                                   | 64             |

### $\Delta S = \Delta Q$ (SQ) violating modes or

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

|                      |          |                         |     |
|----------------------|----------|-------------------------|-----|
| $\Sigma^- e^+ \nu_e$ | SQ < 1.6 | $\times 10^{-4}$ CL=90% | 112 |
|----------------------|----------|-------------------------|-----|

|                           |      |         |                  |        |     |
|---------------------------|------|---------|------------------|--------|-----|
| $\Sigma^- \mu^+ \nu_\mu$  | $SQ$ | $< 9$   | $\times 10^{-4}$ | CL=90% | 49  |
| $\rho\pi^-$               | $S2$ | $< 8$   | $\times 10^{-6}$ | CL=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

$$\Lambda\pi^- \quad \alpha = -0.385 \pm 0.008 \quad (S = 2.4)$$

$$\bar{\Lambda}\pi^+ \quad \bar{\alpha} = 0.374^{+0.005}_{-0.006}$$

$$(\alpha + \bar{\alpha}) / (\alpha - \bar{\alpha}) \text{ for } \Xi^- \rightarrow \Lambda\pi^-, \Xi^+ \rightarrow \bar{\Lambda}\pi^+ = (-9^{+11}_{-8}) \times 10^{-3}$$

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

$$\Lambda\pi^- \quad \phi_- = (-1.5 \pm 0.6)^\circ$$

$$\text{"} \quad \gamma = 0.89 \text{ [a]}$$

$$\text{"} \quad \Delta = (175.9 \pm 1.5)^\circ \text{ [a]}$$

$$\bar{\Lambda}\pi^+ \quad \phi_+ = (0.6^{+0.7}_{-1.0})^\circ$$

$$\Delta\phi_{CP} = (\phi_- + \phi_+)/2 = (-0.2^{+0.5}_{-0.6})^\circ$$

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

| $\Xi^-$ DECAY MODES            | Fraction ( $\Gamma_i/\Gamma$ )       | 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         |
| $\Lambda\mu^- \bar{\nu}_\mu$   | $(3.5^{+3.5}_{-2.2}) \times 10^{-4}$ |                  | 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      |
| $\Xi^0 e^- \bar{\nu}_e$        | $< 2.59$                             | $\times 10^{-4}$ | 90% 7       |

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

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

|                            |    |          |                  |     |     |
|----------------------------|----|----------|------------------|-----|-----|
| $p\pi^-\pi^-$              | 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 |
| $\pi^-$ invisible          |    | not seen |                  |     | —   |

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

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

$\Xi(1530)^0$  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

| <b><math>\Xi(1530)</math> DECAY MODES</b> | Fraction ( $\Gamma_i/\Gamma$ ) | Confidence level | $p$ (MeV/c) |
|---|--------------------------------|------------------|-------------|
| $\Xi\pi$                                  | 100 %                          |                  | 158         |
| $\Xi\gamma$                               | <3.7 %                         | 90%              | 202         |

**$\Xi(1690)$**

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

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

Full width  $\Gamma = 20 \pm 15$  MeV

| <b><math>\Xi(1690)</math> DECAY MODES</b> | Fraction ( $\Gamma_i/\Gamma$ ) | $p$ (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 [c]

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

| <b><math>\Xi(1820)</math> DECAY MODES</b> | Fraction ( $\Gamma_i/\Gamma$ ) | $p$ (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 [c]

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

| <b><math>\Xi(1950)</math> DECAY MODES</b> | Fraction ( $\Gamma_i/\Gamma$ ) | $p$ (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 [c]

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

| <b><math>\Xi(2030)</math> DECAY MODES</b> | Fraction ( $\Gamma_i/\Gamma$ ) | $p$ (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         |

### 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] Our estimate. See the Particle Listings for details.