

Σ BARYONS

(S = -1, I = 1)

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

Σ⁺

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

Mass $m = 1189.37 \pm 0.07$ MeV (S = 2.2)
 Mean life $\tau = (0.8018 \pm 0.0026) \times 10^{-10}$ s
 $c\tau = 2.404$ cm
 $(\tau_{\Sigma^+} - \tau_{\Sigma^-}) / \tau_{\Sigma^+} = -0.0006 \pm 0.0012$
 Magnetic moment $\mu = 2.458 \pm 0.010 \mu_N$ (S = 2.1)
 $(\mu_{\Sigma^+} + \mu_{\Sigma^-}) / \mu_{\Sigma^+} = 0.014 \pm 0.015$
 $\Gamma(\Sigma^+ \rightarrow n\ell^+\nu) / \Gamma(\Sigma^- \rightarrow n\ell^-\bar{\nu}_\ell) < 0.043$

Decay parameters

$p\pi^0$ $\alpha_0 = -0.982 \pm 0.014$
 $\bar{\alpha}_0$ FOR $\Sigma^- \rightarrow \bar{p}\pi^0 = 0.99 \pm 0.04$
 $(\alpha_0 + \bar{\alpha}_0) / (\alpha_0 - \bar{\alpha}_0) = 0.00 \pm 0.04$
 " $\phi_0 = (36 \pm 34)^\circ$
 " $\gamma_0 = 0.16$ [a]
 " $\Delta_0 = (187 \pm 6)^\circ$ [a]
 $n\pi^+$ $\alpha_+ = 0.068 \pm 0.013$
 " $\phi_+ = (167 \pm 20)^\circ$ (S = 1.1)
 " $\gamma_+ = -0.97$ [a]
 " $\Delta_+ = (-73_{-10}^{+133})^\circ$ [a]
 $p\gamma$ $\alpha_\gamma = -0.76 \pm 0.08$

| Σ ⁺ DECAY MODES | Fraction (Γ _i /Γ) | Confidence level | ^p (MeV/c) |
|----------------------------|-------------------------------------|------------------|-------------------------|
| $p\pi^0$ | (51.57±0.30) % | | 189 |
| $n\pi^+$ | (48.31±0.30) % | | 185 |
| $p\gamma$ | (1.23±0.05) × 10 ⁻³ | | 225 |
| $n\pi^+\gamma$ | [b] (4.5 ±0.5) × 10 ⁻⁴ | | 185 |
| $\Lambda e^+\nu_e$ | (2.0 ±0.5) × 10 ⁻⁵ | | 71 |

**ΔS = ΔQ (SQ) violating modes or
 ΔS = 1 weak neutral current (S1) modes**

| | | | | | |
|-----------------|----|--------------------------------------------------------------|--------------------|-----|-----|
| $ne^+\nu_e$ | SQ | < 5 | × 10 ⁻⁶ | 90% | 224 |
| $n\mu^+\nu_\mu$ | SQ | < 3.0 | × 10 ⁻⁵ | 90% | 202 |
| pe^+e^- | S1 | < 7 | × 10 ⁻⁶ | | 225 |
| $p\mu^+\mu^-$ | S1 | (2.4 $\begin{smallmatrix} +1.7 \\ -1.3 \end{smallmatrix}$) | × 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 | ρ (MeV/c) |
|------------------------|--------------------------------|------------------|-------------------|
| $\Lambda\gamma$ | 100 % | | 74 |
| $\Lambda\gamma\gamma$ | < 3 % | 90% | 74 |
| $\Lambda e^+ e^-$ | [c] 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

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

| Σ^- DECAY MODES | Fraction (Γ_i/Γ) | Confidence level | ρ (MeV/c) |
|------------------------|-------------------------------------|------------------|-------------------|
| $n\pi^-$ | (99.848±0.005) % | | 193 |
| $n\pi^- \gamma$ | [b] (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 |

| | | | |
|---------------------------|------------------------------------|-----|----|
| $\Lambda e^- \bar{\nu}_e$ | $(5.73 \pm 0.27) \times 10^{-5}$ | | 79 |
| $\Sigma^+ X$ | $< 1.2 \times 10^{-4}$ | 90% | – |

Lepton number (L) violating modes

| | | | | |
|-------------|-----|------------------------|-----|-----|
| $p e^- e^-$ | L | $< 6.7 \times 10^{-5}$ | 90% | 231 |
|-------------|-----|------------------------|-----|-----|

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

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

$\Sigma(1385)^+$ mass $m = 1382.83 \pm 0.34$ MeV (S = 1.9)

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

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

$\Sigma(1385)^+$ full width $\Gamma = 36.2 \pm 0.7$ MeV

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

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

Below $\bar{K}N$ threshold

| $\Sigma(1385)$ DECAY MODES | Fraction (Γ_i/Γ) | Confidence level | p (MeV/c) |
|----------------------------------------------|----------------------------------|------------------|-------------|
| $\Lambda\pi$ | $(87.0 \pm 1.5) \%$ | | 208 |
| $\Sigma\pi$ | $(11.7 \pm 1.5) \%$ | | 129 |
| $\Lambda\gamma$ | $(1.25^{+0.13}_{-0.12}) \%$ | | 241 |
| $\Sigma^+\gamma$ | $(7.0 \pm 1.7) \times 10^{-3}$ | | 180 |
| $\Sigma^-\gamma$ | $< 2.4 \times 10^{-4}$ | 90% | 173 |

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

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

Re(pole position) = 1585 ± 20 MeV

$-2\text{Im}(\text{pole position}) = 290^{+140}_{-40}$ MeV

Mass $m = 1640$ to 1680 (≈ 1660) MeV

Full width $\Gamma = 100$ to 300 (≈ 200) MeV

| $\Sigma(1660)$ DECAY MODES | Fraction (Γ_i/Γ) | p (MeV/c) |
|----------------------------------------------|--------------------------------|-------------|
| $N\bar{K}$ | 0.05 to 0.15 (≈ 010) | 405 |
| $\Lambda\pi$ | $(35 \pm 12) \%$ | 440 |
| $\Sigma\pi$ | $(37 \pm 10) \%$ | 387 |
| $\Sigma\sigma$ | $(20 \pm 8) \%$ | – |
| $\Lambda(1405)\pi$ | $(4.0 \pm 2.0) \%$ | 199 |

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

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

Mass $m = 1665$ to 1685 (≈ 1675) MeV

Full width $\Gamma = 40$ to 100 (≈ 70) MeV

| $\Sigma(1670)$ DECAY MODES | Fraction (Γ_i/Γ) | p (MeV/c) |
|----------------------------------------------|--------------------------------|-------------|
| $N\bar{K}$ | 0.06 to 0.12 | 419 |
| $\Lambda\pi$ | 5–15 % | 452 |
| $\Sigma\pi$ | 30–60 % | 398 |
| $\Sigma\sigma$ | (7.0 \pm 3.0) % | – |

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

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

Mass $m = 1700$ to 1800 (≈ 1750) MeV

Full width $\Gamma = 100$ to 200 (≈ 150) MeV

| $\Sigma(1750)$ DECAY MODES | Fraction (Γ_i/Γ) | p (MeV/c) |
|----------------------------------------------|--------------------------------|-------------|
| $N\bar{K}$ | 0.06 to 0.12 | 486 |
| $\Lambda\pi$ | (14 \pm 5) % | 507 |
| $\Sigma\pi$ | (16 \pm 4) % | 456 |
| $\Sigma\eta$ | 15–55 % | 98 |
| $\Sigma(1385)\pi$, D -wave | < 1 % | 305 |
| $\Lambda(1520)\pi$ | (2.0 \pm 1.0) % | 175 |
| $N\bar{K}^*(892)$, $S=1/2$ | (8 \pm 4) % | † |

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

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

Mass $m = 1770$ to 1780 (≈ 1775) MeV

Full width $\Gamma = 105$ to 135 (≈ 120) MeV

| $\Sigma(1775)$ DECAY MODES | Fraction (Γ_i/Γ) | p (MeV/c) |
|----------------------------------------------|--------------------------------|-------------|
| $N\bar{K}$ | 37–43% | 508 |
| $\Lambda\pi$ | 14–20% | 525 |
| $\Sigma\pi$ | 2–5% | 475 |
| $\Sigma(1385)\pi$ | 8–12% | 327 |
| $\Lambda(1520)\pi$, P -wave | 17–23% | 202 |

$\Sigma(1910) 3/2^-$

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

was $\Sigma(1940)$

Mass $m = 1870$ to 1950 (≈ 1910) MeV

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

| $\Sigma(1910)$ DECAY MODES | Fraction (Γ_i/Γ) | p (MeV/c) |
|----------------------------------------------|---------------------------------|-------------|
| $N\bar{K}$ | 0.01 to 0.05 (≈ 0.02) | 615 |
| $\Lambda\pi$ | (6 \pm 4) % | 619 |
| $\Sigma\pi$ | (86 \pm 21) % | 574 |
| $\Sigma(1385)\pi$ | seen | 439 |
| $\Lambda(1520)\pi$ | seen | 329 |
| $\Delta(1232)\bar{K}$ | (3.0 \pm 1.0) % | 377 |
| $N\bar{K}^*(892)$ | seen | 274 |
| $N\bar{K}^*(892), S=1/2, D$ -wave | (1.0 \pm 1.0) % | 274 |

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

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

Mass $m = 1900$ to 1935 (≈ 1915) MeV

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

| $\Sigma(1915)$ DECAY MODES | Fraction (Γ_i/Γ) | p (MeV/c) |
|----------------------------------------------|--------------------------------|-------------|
| $N\bar{K}$ | 0.05 to 0.15 | 618 |
| $\Lambda\pi$ | (6.0 \pm 2.0) % | 623 |
| $\Sigma\pi$ | (10.0 \pm 2.0) % | 577 |
| $\Sigma(1385)\pi, P$ -wave | (2.0 \pm 2.0) % | 443 |
| $\Sigma(1385)\pi, F$ -wave | (4.0 \pm 2.0) % | 443 |
| $\Lambda(1520)\pi, D$ -wave | (8.0 \pm 2.0) % | 334 |
| $N\bar{K}^*(892), S=1/2, F$ -wave | (5.0 \pm 3.0) % | 282 |
| $N\bar{K}^*(892), S=3/2, F$ -wave | (5.0 \pm 2.0) % | 282 |
| $\Delta\bar{K}, P$ -wave | (16 \pm 5) % | 383 |
| $\Delta\bar{K}, F$ -wave | (5.0 \pm 3.0) % | 383 |

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

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

Mass $m = 2025$ to 2040 (≈ 2030) MeV

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

| $\Sigma(2030)$ DECAY MODES | Fraction (Γ_i/Γ) | p (MeV/c) |
|----------------------------------------------|--------------------------------|-------------|
| $N\bar{K}$ | 17–23 % | 702 |
| $\Lambda\pi$ | 17–23 % | 700 |
| $\Sigma\pi$ | 5–10 % | 657 |
| ΞK | <2 % | 422 |
| $\Sigma(1385)\pi$ | 5–15 % | 532 |
| $\Sigma(1385)\pi$, F -wave | (1.0 ± 1.0) % | 532 |
| $\Lambda(1520)\pi$ | 10–20 % | 431 |
| $\Delta(1232)\bar{K}$ | 10–20 % | 498 |
| $\Delta(1232)\bar{K}$, F -wave | (15 ± 5) % | 498 |
| $\Delta(1232)\bar{K}$, H -wave | (1.0 ± 1.0) % | 498 |
| $N\bar{K}^*(892)$, $S=3/2$, F -wave | (14 ± 8) % | 439 |

NOTES

[a] 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.

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

[c] A theoretical value using QED.

[d] 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.