

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

$$c\tau = 2.404 \text{ cm}$$

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

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

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

Decay parameters

| | |
|-----------|---|
| $p\pi^0$ | $\alpha_0 = -0.980^{+0.017}_{-0.015}$ |
| " | $\phi_0 = (36 \pm 34)^\circ$ |
| " | $\gamma_0 = 0.16$ [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] |
| " | $\Delta_+ = (-73^{+133}_{-10})^\circ$ [a] |
| $p\gamma$ | $\alpha_\gamma = -0.76 \pm 0.08$ |

| Σ ⁺ DECAY MODES | Fraction (Γ_i/Γ) | Confidence level | ρ (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 |



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

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 |
| $\Lambda e^+ e^-$ | [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]
 " $\Delta_- = (249^{+12}_{-120})^\circ$ [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) | p (MeV/c) |
|------------------------|------------------------------------|-------------|
| $n\pi^-$ | $(99.848 \pm 0.005) \%$ | 193 |
| $n\pi^- \gamma$ | [b] $(4.6 \pm 0.6) \times 10^{-4}$ | 193 |

| | | |
|---------------------------|------------------------------------|-----|
| $n e^- \bar{\nu}_e$ | $(1.017 \pm 0.034) \times 10^{-3}$ | 230 |
| $n \mu^- \bar{\nu}_\mu$ | $(4.5 \pm 0.4) \times 10^{-4}$ | 210 |
| $\Lambda e^- \bar{\nu}_e$ | $(5.73 \pm 0.27) \times 10^{-5}$ | 79 |

$\Sigma(1385) P_{13}$

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

$\Sigma(1385)^+$ mass $m = 1382.8 \pm 0.4$ MeV (S = 2.0)
 $\Sigma(1385)^0$ 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 $\Gamma = 35.8 \pm 0.8$ 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) | p (MeV/c) |
|--|--------------------------------|-------------|
| $\Lambda\pi$ | 88±2 % | 208 |
| $\Sigma\pi$ | 12±2 % | 129 |

$\Sigma(1660) P_{11}$

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

Mass $m = 1630$ to 1690 (≈ 1660) MeV
 Full width $\Gamma = 40$ to 200 (≈ 100) MeV
 $p_{\text{beam}} = 0.72$ GeV/c $4\pi\lambda^2 = 29.9$ 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 |

$\Sigma(1670) D_{13}$

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

Mass $m = 1665$ to 1685 (≈ 1670) MeV
 Full width $\Gamma = 40$ to 80 (≈ 60) MeV
 $p_{\text{beam}} = 0.74$ GeV/c $4\pi\lambda^2 = 28.5$ 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) MeV

Full 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) MeV

Full 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) MeV

Full 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) MeV

Full 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) MeV

Full 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) MeV

Full 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 |

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.