

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)
 $(\mu_{\Sigma^+} + \mu_{\Sigma^-}) / \mu_{\Sigma^+} = 0.014 \pm 0.015$
 $\Gamma(\Sigma^+ \rightarrow n l^+ \nu) / \Gamma(\Sigma^- \rightarrow n l^- \bar{\nu}_l) < 0.043$

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

$p e^+ e^-$	$S1$	< 7	$\times 10^{-6}$	225
$p \mu^+ \mu^-$	$S1$	$(2.4^{+1.7}_{-1.3})$	$\times 10^{-8}$	121

Σ^0

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

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

Σ^-

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

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)	Confidence level	p (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 ± 0.27) × 10 ⁻⁵		79
$\Sigma^+ \chi$	< 1.2 × 10 ⁻⁴	90%	–
Lepton number (L) violating modes			
$pe^- e^-$	L < 6.7 × 10 ⁻⁵	90%	231

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

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

$\Sigma(1385)^+$ mass $m = 1382.80 \pm 0.35$ 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 $\Gamma = 36.0 \pm 0.7$ 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 ± 1.5) %		208
$\Sigma\pi$	(11.7 ± 1.5) %		129
$\Lambda\gamma$	(1.25 ^{+0.13} _{-0.12}) %		241
$\Sigma^+ \gamma$	(7.0 ± 1.7) × 10 ⁻³		180
$\Sigma^- \gamma$	< 2.4 × 10 ⁻⁴	90%	173

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

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

Re(pole position) = 1585 ± 20 MeV

–2Im(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 ± 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) MeVFull 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) MeVFull 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) MeVFull 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
$\Lambda(1520)\pi$, <i>P</i> -wave	17–23%	202

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

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

was $\Sigma(1940)$ Mass $m = 1870$ to 1950 (≈ 1910) MeVFull 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
$N\bar{K}^*(892)$, $S=1/2$, <i>D</i> -wave	(1.0 \pm 1.0) %	274

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

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

Mass $m = 1900$ to 1935 (≈ 1915) MeVFull 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
$\Sigma(1385)\pi$, <i>P</i> -wave	(2.0 \pm 2.0) %	443
$\Sigma(1385)\pi$, <i>F</i> -wave	(4.0 \pm 2.0) %	443
$\Sigma(1385)\pi$	<5 %	443
$\Lambda(1520)\pi$, <i>D</i> -wave	(8.0 \pm 2.0) %	334
$N\bar{K}^*(892)$, $S=1/2$, <i>F</i> -wave	(5.0 \pm 3.0) %	282
$N\bar{K}^*(892)$, $S=3/2$, <i>F</i> -wave	(5.0 \pm 2.0) %	282
$\Delta\bar{K}$, <i>P</i> -wave	(16 \pm 5) %	383
$\Delta\bar{K}$, <i>F</i> -wave	(5.0 \pm 3.0) %	383

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

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

Mass $m = 2025$ to 2040 (≈ 2030) MeVFull 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
$N\bar{K}^*(892)$	<5 %	439
$N\bar{K}^*(892)$, $S=3/2$, F -wave	(14 ± 8) %	439

 $\Sigma(2250)$

$$I(J^P) = 1(?^?)$$

Mass $m = 2210$ to 2280 (≈ 2250) MeVFull width $\Gamma = 60$ to 150 (≈ 100) MeV

$\Sigma(2250)$ 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.