

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

$p\pi^0 \quad \alpha_0 = -0.982 \pm 0.014$

$\bar{p}\pi^0 \quad \bar{\alpha}_0 = 0.99 \pm 0.04$

$(\alpha_0 + \bar{\alpha}_0) / (\alpha_0 - \bar{\alpha}_0) = 0.00 \pm 0.04$

$p\pi^0 \quad \phi_0 = (36 \pm 34)^\circ$

" $\gamma_0 = 0.16$ [a]

" $\Delta_0 = (187 \pm 6)^\circ$ [a]

$n\pi^+ \quad \alpha_+ = (4.89 \pm 0.26) \times 10^{-2}$

" $\phi_+ = (167 \pm 20)^\circ$ (S = 1.1)

$\bar{\alpha}_-$ FOR $\bar{\Sigma}^- \rightarrow \bar{n}\pi^- = (-5.7 \pm 0.5) \times 10^{-2}$

$\bar{\alpha}_- / \bar{\alpha}_0 = (-5.7 \pm 0.6) \times 10^{-2}$

$(\alpha_+ + \bar{\alpha}_-) / (\alpha_+ - \bar{\alpha}_-) = (-8 \pm 6) \times 10^{-2}$

" $\gamma_+ = -0.97$ [a]

" $\Delta_+ = (-73_{-10}^{+133})^\circ$ [a]

$p\gamma \quad \alpha_\gamma = -0.69 \pm 0.05$

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
$\Lambda e^+\nu_e$	(2.3 ± 0.4) × 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
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$n\mu^+\nu_\mu$	SQ	< 3.0	$\times 10^{-5}$	90%	202
pe^+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
Λe^+e^-	[c] 5×10^{-3}		74

Σ^-

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

Mass $m = 1197.449 \pm 0.029$ MeV (S = 1.1)

$m_{\Sigma^-} - m_{\Sigma^+} = 8.08 \pm 0.08$ MeV (S = 1.9)

$m_{\Sigma^-} - m_\Lambda = 81.766 \pm 0.029$ MeV (S = 1.1)

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)
$n\pi^-$	$(99.848 \pm 0.005) \%$		193
$n\pi^- \gamma$	[b] $(4.6 \pm 0.6) \times 10^{-4}$		193
$ne^- \bar{\nu}_e$	$(1.017 \pm 0.034) \times 10^{-3}$		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
$\Sigma^+ \chi$	$< 1.2 \times 10^{-4}$	90%	–

Lepton number (L) violating modes

$pe^- e^-$	L	$< 6.7 \times 10^{-5}$	90%	231
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 $\Sigma(1385) 3/2^+$

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

$\Sigma(1385)^+$ 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) 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
$\Lambda(1520)\pi$, 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) 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
$N\bar{K}^*(892)$, $S=1/2$, 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) 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
$\Sigma(1385)\pi$, 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) 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
$N\bar{K}^*(892)$, $S=3/2$, 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.