

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)

$(\mu_{\Sigma^+} + \mu_{\Sigma^-}) / \mu_{\Sigma^+} = 0.014 \pm 0.015$

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

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	^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 (SI) modes

$ne^+\nu_e$	SQ	< 5	× 10 ⁻⁶	90%	224
$n\mu^+\nu_\mu$	SQ	< 3.0	× 10 ⁻⁵	90%	202
pe^+e^-	SI	< 7	× 10 ⁻⁶		225
$p\mu^+\mu^-$	SI	(2.4 ^{+1.7} _{-1.3})	× 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

 $n\pi^- \quad \alpha_- = -0.068 \pm 0.008$

 " $\phi_- = (10 \pm 15)^\circ$

 " $\gamma_- = 0.98$ [a]

 " $\Delta_- = (249_{-120}^{+12})^\circ$ [a]

 $ne^- \bar{\nu}_e \quad g_A/g_V = 0.340 \pm 0.017$ [d]

 " $f_2(0)/f_1(0) = 0.97 \pm 0.14$

 " $D = 0.11 \pm 0.10$
 $\Lambda e^- \bar{\nu}_e \quad g_V/g_A = 0.01 \pm 0.10$ [d] (S = 1.5)

 " $g_{WM}/g_A = 2.4 \pm 1.7$ [d]

Σ^- DECAY MODES	Fraction (Γ_i/Γ)	ρ (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

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

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

$$\Sigma(1385)^+ \text{ mass } m = 1382.80 \pm 0.35 \text{ MeV} \quad (S = 1.9)$$

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

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

$$\Sigma(1385)^+ \text{ full width } \Gamma = 36.0 \pm 0.7 \text{ MeV}$$

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

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

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

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

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

$$\text{Mass } m = 1630 \text{ to } 1690 (\approx 1660) \text{ MeV}$$

$$\text{Full width } \Gamma = 40 \text{ to } 200 (\approx 100) \text{ MeV}$$

$\Sigma(1660)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\bar{K}$	10–30 %	405
$\Lambda\pi$	seen	440
$\Sigma\pi$	seen	387

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

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

$$\text{Mass } m = 1665 \text{ to } 1685 (\approx 1670) \text{ MeV}$$

$$\text{Full width } \Gamma = 40 \text{ to } 80 (\approx 60) \text{ MeV}$$

$\Sigma(1670)$ 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

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

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

Mass $m = 1730$ to 1800 (≈ 1750) MeVFull width $\Gamma = 60$ to 160 (≈ 90) MeV

$\Sigma(1750)$ 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 %	98
$N\bar{K}^*(892)$, $S=1/2$	(8 ± 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%	201

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

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

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)
$N\bar{K}$	5–15 %	618
$\Lambda\pi$	seen	623
$\Sigma\pi$	seen	577
$\Sigma(1385)\pi$	<5 %	443

$\Sigma(1940) 3/2^-$

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

 Mass $m = 1900$ to 1950 (≈ 1940) MeV

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

$\Sigma(1940)$ 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

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

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

 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
$\Lambda(1520)\pi$	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

$\Sigma(2250)$ 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 $\overline{B}_f[\gamma_\lambda(g_V + g_A\gamma_5) + i(g_{WM}/m_{B_i}) \sigma_{\lambda\nu} q^\nu]B_i$, 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.