

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

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

$$(\tau_{\Sigma^+} - \tau_{\bar{\Sigma}^-}) / \tau_{\Sigma^+} = -0.0006 \pm 0.0012$$

$$\text{Magnetic moment } \mu = 2.458 \pm 0.010 \mu_N \quad (S = 2.1)$$

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

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

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]
$n\pi^+$	$\alpha_+ = 0.068 \pm 0.013$
"	$\phi_+ = (167 \pm 20)^\circ \quad (S = 1.1)$
"	$\gamma_+ = -0.97$ [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	(MeV/c)
$p\pi^0$	$(51.57 \pm 0.30) \%$		189
$n\pi^+$	$(48.31 \pm 0.30) \%$		185
$p\gamma$	$(1.23 \pm 0.05) \times 10^{-3}$		225
$n\pi^+\gamma$	$[b] \quad (4.5 \pm 0.5) \times 10^{-4}$		185
$\Lambda e^+\nu_e$	$(2.0 \pm 0.5) \times 10^{-5}$		71

$\Delta S = \Delta Q$ (SQ) violating modes or
 $\Delta S = 1$ weak neutral current (S1) modes

$ne^+\nu_e$	SQ	< 5	$\times 10^{-6}$	90%	224
$n\mu^+\nu_\mu$	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

$$\Sigma^0 \quad I(J^P) = 1(\frac{1}{2}^+)$$

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

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

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 ± 0.005) %	193
$n\pi^-\gamma$	[b] (4.6 ± 0.6) $\times 10^{-4}$	193
$ne^-\bar{\nu}_e$	(1.017 ± 0.034) $\times 10^{-3}$	230
$n\mu^-\bar{\nu}_\mu$	(4.5 ± 0.4) $\times 10^{-4}$	210
$\Lambda e^-\bar{\nu}_e$	(5.73 ± 0.27) $\times 10^{-5}$	79

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

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

 $\Sigma(1385)^+ \text{ mass } m = 1382.80 \pm 0.35 \text{ MeV } (S = 1.9)$ $\Sigma(1385)^0 \text{ mass } m = 1383.7 \pm 1.0 \text{ MeV } (S = 1.4)$ $\Sigma(1385)^- \text{ mass } m = 1387.2 \pm 0.5 \text{ MeV } (S = 2.2)$ $\Sigma(1385)^+ \text{ full width } \Gamma = 36.0 \pm 0.7 \text{ MeV}$ $\Sigma(1385)^0 \text{ full width } \Gamma = 36 \pm 5 \text{ MeV}$ $\Sigma(1385)^- \text{ full width } \Gamma = 39.4 \pm 2.1 \text{ MeV } (S = 1.7)$ Below $\bar{K}N$ threshold

$\Sigma(1385) \text{ DECAY MODES}$	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

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

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

 $\text{Re}(\text{pole position}) = 1585 \pm 20 \text{ MeV}$ $-2\text{Im}(\text{pole position}) = 290^{+140}_{-40} \text{ MeV}$ $\text{Mass } m = 1640 \text{ to } 1680 (\approx 1660) \text{ MeV}$ $\text{Full width } \Gamma = 100 \text{ to } 300 (\approx 200) \text{ MeV}$

$\Sigma(1660) \text{ DECAY MODES}$	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

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

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

was $\Sigma(1940)$

- Full width $\Gamma = 0.03 \pm 0.02$
 Full width $\Gamma = 0.16 \pm 0.04$
 Full width $\Gamma = 0.04 \pm 0.03$
 Full width $\Gamma = 0.01 \pm 0.01$
 Full width $\Gamma = 0.01 \pm 0.01$
 Full width $\Gamma = 0.03 \pm 0.01$
 Full width $\Gamma = 0.03 \pm 0.02$
 Full width $\Gamma = 0.02 \pm 0.01$
 Full width $\Gamma = 0.01 \pm 0.01$
 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

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

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

- 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
$\Sigma(1385)\pi$	<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
$\Sigma(1385)\pi$, <i>F</i> -wave	(1.0 \pm 1.0) %	532
$\Lambda(1520)\pi$	10–20 %	431
$\Delta(1232)\bar{K}$	10–20 %	498
$\Delta(1232)\bar{K}$, <i>F</i> -wave	(15 \pm 5) %	498
$\Delta(1232)\bar{K}$, <i>H</i> -wave	(1.0 \pm 1.0) %	498
$N\bar{K}^*(892)$	<5 %	439
$N\bar{K}^*(892)$, $S=3/2$, <i>F</i> -wave	(14 \pm 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 $\overline{B}_f[\gamma_\lambda(g_V + g_A\gamma_5) + i(g_{WM}/m_{B_i}) \sigma_{\lambda\nu} q^\nu]B_i$, 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.