STRANGE MESONS
($S = \pm 1$, $C = B = 0$)

$K^+ = u\bar{s}$, $K^0 = d\bar{s}$, $\overline{K}^0 = \bar{d}s$, $K^- = \bar{u}s$, similarly for K^*'s

$K^\pm$

$I(J^P) = \frac{1}{2}(0^-)$

Mass $m = 493.677 \pm 0.016$ MeV [u] (S = 2.8)
Mean life $\tau = (1.2386 \pm 0.0024) \times 10^{-8}$ s (S = 2.0)
$c\tau = 3.713$ m

Slope parameter g [v]

(See Particle Listings for quadratic coefficients)

$K^+ \to \pi^+\pi^+\pi^- = -0.2154 \pm 0.0035$ (S = 1.4)
$K^- \to \pi^-\pi^-\pi^+ = -0.217 \pm 0.007$ (S = 2.5)
$K^\pm \to \pi^\pm\pi^0\pi^0 = 0.594 \pm 0.019$ (S = 1.3)

$K^\pm$ decay form factors [a,w]

K^+_{e3} $\lambda_+ = 0.0286 \pm 0.0022$
$K^+_{\mu 3}$ $\lambda_+ = 0.032 \pm 0.008$ (S = 1.6)
$K^+_{\mu 3}$ $\lambda_0 = 0.006 \pm 0.007$ (S = 1.6)
K^+_{e3} $|f_S/f_+| = 0.084 \pm 0.023$ (S = 1.2)
K^+_{e3} $|f_T/f_+| = 0.38 \pm 0.11$ (S = 1.1)
$K^+_{\mu 3}$ $|f_T/f_+| = 0.02 \pm 0.12$
$K^+ \to e^+\nu_e\gamma$ $|F_A + F_V| = 0.148 \pm 0.010$
$K^+ \to \mu^+\nu_\mu\gamma$ $|F_A + F_V| < 0.23$, CL = 90%
$K^+ \to e^+\nu_e\gamma$ $|F_A - F_V| < 0.49$
$K^+ \to \mu^+\nu_\mu\gamma$ $|F_A - F_V| = -2.2$ to 0.3

K^- modes are charge conjugates of the modes below.

K^+ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\mu^+\nu_\mu$	(63.51±0.18) %	S=1.3	236
$e^+\nu_e$	(1.55±0.07) × 10^{-5}		247
$\pi^+\pi^0$	(21.16±0.14) %	S=1.1	205
$\pi^+\pi^+\pi^-$	(5.59±0.05) %	S=1.8	125
$\pi^+\pi^0\pi^0$	(1.73±0.04) %	S=1.2	133
$\pi^0\mu^+\nu_\mu$	(3.18±0.08) %	S=1.5	215
Called $K^+_{\mu 3}$.			

$\pi^0 e^+ \nu_e$		(4.82±0.06) %		S=1.3	228
Called K^+_{e3}.					
$\pi^0 \pi^0 e^+ \nu_e$		(2.1 ±0.4) × 10^{-5}			206
$\pi^+ \pi^- e^+ \nu_e$		(3.91±0.17) × 10^{-5}			203
$\pi^+ \pi^- \mu^+ \nu_\mu$		(1.4 ±0.9) × 10^{-5}			151
$\pi^0 \pi^0 \pi^0 e^+ \nu_e$		< 3.5	× 10^{-6}	CL=90%	135
$\pi^+ \gamma \gamma$	[x]	(1.10±0.32) × 10^{-6}			227
$\pi^+ 3\gamma$	[x]	< 1.0	× 10^{-4}	CL=90%	227
$\mu^+ \nu_\mu \nu \overline{\nu}$		< 6.0	× 10^{-6}	CL=90%	236
$e^+ \nu_e \nu \overline{\nu}$		< 6	× 10^{-5}	CL=90%	247
$\mu^+ \nu_\mu e^+ e^-$		(1.3 ±0.4) × 10^{-7}			236
$e^+ \nu_e e^+ e^-$		(3.0 $^{+3.0}_{-1.5}$) × 10^{-8}			247
$\mu^+ \nu_\mu \mu^+ \mu^-$		< 4.1	× 10^{-7}	CL=90%	185
$\mu^+ \nu_\mu \gamma$	[x,y]	(5.50±0.28) × 10^{-3}			236
$\pi^+ \pi^0 \gamma$	[x,y]	(2.75±0.15) × 10^{-4}			205
$\pi^+ \pi^0 \gamma$(DE)	[x,z]	(1.8 ±0.4) × 10^{-5}			205
$\pi^+ \pi^+ \pi^- \gamma$	[x,y]	(1.04±0.31) × 10^{-4}			125
$\pi^+ \pi^0 \pi^0 \gamma$	[x,y]	(7.5 $^{+5.5}_{-3.0}$) × 10^{-6}			133
$\pi^0 \mu^+ \nu_\mu \gamma$	[x,y]	< 6.1	× 10^{-5}	CL=90%	215
$\pi^0 e^+ \nu_e \gamma$	[x,y]	(2.62±0.20) × 10^{-4}			228
$\pi^0 e^+ \nu_e \gamma$(SD)	[aa]	< 5.3	× 10^{-5}	CL=90%	228
$\pi^0 \pi^0 e^+ \nu_e \gamma$		< 5	× 10^{-6}	CL=90%	206

Lepton Family number (*LF*), Lepton number (*L*), $\Delta S = \Delta Q$ (*SQ*) violating modes, or $\Delta S = 1$ weak neutral current (*S1*) modes

$\pi^+ \pi^+ e^- \overline{\nu}_e$	*SQ*	< 1.2	× 10^{-8}	CL=90%	203
$\pi^+ \pi^+ \mu^- \overline{\nu}_\mu$	*SQ*	< 3.0	× 10^{-6}	CL=95%	151
$\pi^+ e^+ e^-$	*S1*	(2.74±0.23) × 10^{-7}			227
$\pi^+ \mu^+ \mu^-$	*S1*	(5.0 ±1.0) × 10^{-8}			172
$\pi^+ \nu \overline{\nu}$	*S1*	(4.2 $^{+9.7}_{-3.5}$) × 10^{-10}			227
$\mu^- \nu e^+ e^+$	*LF*	< 2.0	× 10^{-8}	CL=90%	236
$\mu^+ \nu_e$	*LF*	[d] < 4	× 10^{-3}	CL=90%	236
$\pi^+ \mu^+ e^-$	*LF*	< 2.1	× 10^{-10}	CL=90%	214
$\pi^+ \mu^- e^+$	*LF*	< 7	× 10^{-9}	CL=90%	214
$\pi^- \mu^+ e^+$	*L*	< 7	× 10^{-9}	CL=90%	214
$\pi^- e^+ e^+$	*L*	< 1.0	× 10^{-8}	CL=90%	227
$\pi^- \mu^+ \mu^+$	*L*	[d] < 1.5	× 10^{-4}	CL=90%	172
$\mu^+ \overline{\nu}_e$	*L*	[d] < 3.3	× 10^{-3}	CL=90%	236
$\pi^0 e^+ \overline{\nu}_e$	*L*	< 3	× 10^{-3}	CL=90%	228

K^0

$I(J^P) = \frac{1}{2}(0^-)$

50% K_S, 50% K_L

Mass $m = 497.672 \pm 0.031$ MeV

$m_{K^0} - m_{K^\pm} = 3.995 \pm 0.034$ MeV (S = 1.1)

$\left|m_{K^0} - m_{\overline{K}^0}\right| / m_{\text{average}} < 10^{-18}$ [bb]

K^0_S

$I(J^P) = \frac{1}{2}(0^-)$

Mean life $\tau = (0.8934 \pm 0.0008) \times 10^{-10}$ s

$c\tau = 2.6783$ cm

CP-violation parameters [cc]

$\text{Im}(\eta_{+-0}) = -0.002 \pm 0.009$

$\text{Im}(\eta_{000})^2 < 0.1$, CL = 90%

K^0_S DECAY MODES		Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\pi^+\pi^-$		(68.61±0.28) %	S=1.2	206
$\pi^0\pi^0$		(31.39±0.28) %	S=1.2	209
$\pi^+\pi^-\gamma$	[y,dd]	(1.78±0.05) $\times 10^{-3}$		206
$\gamma\gamma$		(2.4 ±0.9) $\times 10^{-6}$		249
$\pi^+\pi^-\pi^0$		(3.4 $^{+1.1}_{-0.9}$) $\times 10^{-7}$		133
$3\pi^0$		< 3.7 $\times 10^{-5}$	CL=90%	139
$\pi^\pm e^\mp \nu$	[ee]	(6.70±0.07) $\times 10^{-4}$	S=1.1	229
$\pi^\pm \mu^\mp \nu$	[ee]	(4.69±0.06) $\times 10^{-4}$	S=1.1	216
$\Delta S = 1$ weak neutral current ($S1$) modes				
$\mu^+\mu^-$	S1	< 3.2 $\times 10^{-7}$	CL=90%	225
e^+e^-	S1	< 1.4 $\times 10^{-7}$	CL=90%	249
$\pi^0 e^+ e^-$	S1	< 1.1 $\times 10^{-6}$	CL=90%	231

K_L^0

$I(J^P) = \frac{1}{2}(0^-)$

$m_{K_L} - m_{K_S} = (0.5301 \pm 0.0014) \times 10^{10}\ \hbar\ \mathrm{s}^{-1}$
$= (3.489 \pm 0.009) \times 10^{-12}$ MeV

Mean life $\tau = (5.17 \pm 0.04) \times 10^{-8}$ s (S = 1.1)

$c\tau = 15.51$ m

Slope parameter g [v]

(See Particle Listings for quadratic coefficients)

$K_L^0 \to \pi^+\pi^-\pi^0 = 0.670 \pm 0.014$ (S = 1.6)

K_L decay form factors [w]

K_{e3}^0 $\lambda_+ = 0.0300 \pm 0.0016$ (S = 1.2)

$K_{\mu 3}^0$ $\lambda_+ = 0.034 \pm 0.005$ (S = 2.3)

$K_{\mu 3}^0$ $\lambda_0 = 0.025 \pm 0.006$ (S = 2.3)

K_{e3}^0 $|f_S/f_+| < 0.04$, CL = 68%

K_{e3}^0 $|f_T/f_+| < 0.23$, CL = 68%

$K_{\mu 3}^0$ $|f_T/f_+| = 0.12 \pm 0.12$

$K_L \to e^+e^-\gamma$: $\alpha_{K^*} = -0.28 \pm 0.08$

***CP*-violation parameters** [cc]

$\delta = (0.327 \pm 0.012)\%$

$|\eta_{00}| = (2.275 \pm 0.019) \times 10^{-3}$ (S = 1.1)

$|\eta_{+-}| = (2.285 \pm 0.019) \times 10^{-3}$

$|\eta_{00}/\eta_{+-}| = 0.9956 \pm 0.0023$ [ff] (S = 1.8)

$\epsilon'/\epsilon = (1.5 \pm 0.8) \times 10^{-3}$ [ff] (S = 1.8)

$\phi_{+-} = (43.5 \pm 0.6)^\circ$

$\phi_{00} = (43.4 \pm 1.0)^\circ$

$\phi_{00} - \phi_{+-} = (-0.1 \pm 0.8)^\circ$

j for $K_L^0 \to \pi^+\pi^-\pi^0 = 0.0011 \pm 0.0008$

$|\eta_{+-\gamma}| = (2.35 \pm 0.07) \times 10^{-3}$

$\phi_{+-\gamma} = (44 \pm 4)^\circ$

$|\epsilon'_{+-\gamma}|/\epsilon < 0.3$, CL = 90%

$\Delta S = -\Delta Q$ in $K^0_{\ell 3}$ decay

Re $x = 0.006 \pm 0.018$ (S = 1.3)
Im $x = -0.003 \pm 0.026$ (S = 1.2)

***CPT*-violation parameters**

Re $\Delta = 0.018 \pm 0.020$
Im $\Delta = 0.02 \pm 0.04$

K^0_L DECAY MODES		Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$3\pi^0$		(21.12 ±0.27) %	S=1.1	139
$\pi^+\pi^-\pi^0$		(12.56 ±0.20) %	S=1.7	133
$\pi^\pm\mu^\mp\nu$	[*gg*]	(27.17 ±0.25) %	S=1.1	216
Called $K^0_{\mu 3}$.				
$\pi^\pm e^\mp\nu_e$	[*gg*]	(38.78 ±0.27) %	S=1.1	229
Called K^0_{e3}.				
2γ		(5.92 ±0.15) $\times 10^{-4}$		249
3γ		< 2.4 $\times 10^{-7}$	CL=90%	249
$\pi^0 2\gamma$	[*hh*]	(1.70 ±0.28) $\times 10^{-6}$		231
$\pi^0\pi^\pm e^\mp\nu$	[*gg*]	(5.18 ±0.29) $\times 10^{-5}$		207
$(\pi\mu\text{atom})\nu$		(1.06 ±0.11) $\times 10^{-7}$		–
$\pi^\pm e^\mp\nu_e\gamma$	[*y,gg,hh*]	(3.62 $^{+0.26}_{-0.21}$) $\times 10^{-3}$		229
$\pi^+\pi^-\gamma$	[*y,hh*]	(4.61 ±0.14) $\times 10^{-5}$		206
$\pi^0\pi^0\gamma$		< 5.6 $\times 10^{-6}$		209
Charge conjugation × Parity (*CP*, *CPV*) or Lepton Family number (*LF*) violating modes, or $\Delta S = 1$ weak neutral current (*S1*) modes				
$\pi^+\pi^-$	*CPV*	(2.067±0.035) $\times 10^{-3}$	S=1.1	206
$\pi^0\pi^0$	*CPV*	(9.36 ±0.20) $\times 10^{-4}$		209
$\mu^+\mu^-$	*S1*	(7.2 ±0.5) $\times 10^{-9}$	S=1.4	225
$\mu^+\mu^-\gamma$	*S1*	(3.25 ±0.28) $\times 10^{-7}$		225
e^+e^-	*S1*	< 4.1 $\times 10^{-11}$	CL=90%	249
$e^+e^-\gamma$	*S1*	(9.1 ±0.5) $\times 10^{-6}$		249
$e^+e^-\gamma\gamma$	*S1* [*hh*]	(6.5 ±1.2) $\times 10^{-7}$		249
$\pi^+\pi^-e^+e^-$	*S1* [*hh*]	< 4.6 $\times 10^{-7}$	CL=90%	206
$\mu^+\mu^-e^+e^-$	*S1*	(2.9 $^{+6.7}_{-2.4}$) $\times 10^{-9}$		225
$e^+e^-e^+e^-$	*S1*	(4.1 ±0.8) $\times 10^{-8}$	S=1.2	249
$\pi^0\mu^+\mu^-$	*CP,S1* [*ii*]	< 5.1 $\times 10^{-9}$	CL=90%	177
$\pi^0 e^+e^-$	*CP,S1* [*ii*]	< 4.3 $\times 10^{-9}$	CL=90%	231
$\pi^0\nu\overline{\nu}$	*CP,S1* [*jj*]	< 5.8 $\times 10^{-5}$	CL=90%	231
$e^\pm\mu^\mp$	*LF* [*gg*]	< 3.3 $\times 10^{-11}$	CL=90%	238
$e^\pm e^\pm\mu^\mp\mu^\mp$	*LF* [*gg*]	< 6.1 $\times 10^{-9}$	CL=90%	–

$K^*(892)$

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

$K^*(892)^\pm$ mass $m = 891.66 \pm 0.26$ MeV
$K^*(892)^0$ mass $m = 896.10 \pm 0.28$ MeV (S = 1.4)
$K^*(892)^\pm$ full width $\Gamma = 50.8 \pm 0.9$ MeV
$K^*(892)^0$ full width $\Gamma = 50.5 \pm 0.6$ MeV (S = 1.1)

$K^*(892)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$K\pi$	$\sim$ 100 %		291
$K^0\gamma$	(2.30±0.20) $\times 10^{-3}$		310
$K^\pm\gamma$	(9.9 ±0.9) $\times 10^{-4}$		309
$K\pi\pi$	$<$ 7 $\times 10^{-4}$	95%	224

$K_1(1270)$

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

Mass $m = 1273 \pm 7$ MeV [m]
Full width $\Gamma = 90 \pm 20$ MeV [m]

$K_1(1270)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\rho$	(42 ±6) %	76
$K_0^*(1430)\pi$	(28 ±4) %	–
$K^*(892)\pi$	(16 ±5) %	301
$K\omega$	(11.0±2.0) %	–
$Kf_0(1370)$	(3.0±2.0) %	–

$K_1(1400)$

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

Mass $m = 1402 \pm 7$ MeV
Full width $\Gamma = 174 \pm 13$ MeV (S = 1.6)

$K_1(1400)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K^*(892)\pi$	(94 ±6) %	401
$K\rho$	(3.0±3.0) %	298
$Kf_0(1370)$	(2.0±2.0) %	–
$K\omega$	(1.0±1.0) %	285
$K_0^*(1430)\pi$	not seen	–

$K^*(1410)$

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

Mass $m = 1414 \pm 15$ MeV (S = 1.3)
Full width $\Gamma = 232 \pm 21$ MeV (S = 1.1)

$K^*(1410)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$K^*(892)\pi$	> 40 %	95%	408
$K\pi$	(6.6±1.3) %		611
$K\rho$	< 7 %	95%	309

$K_0^*(1430)$ [kk]

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

Mass $m = 1429 \pm 6$ MeV
Full width $\Gamma = 287 \pm 23$ MeV

$K_0^*(1430)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\pi$	(93±10) %	621

$K_2^*(1430)$

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

$K_2^*(1430)^\pm$ mass $m = 1425.6 \pm 1.5$ MeV (S = 1.1)
$K_2^*(1430)^0$ mass $m = 1432.4 \pm 1.3$ MeV
$K_2^*(1430)^\pm$ full width $\Gamma = 98.5 \pm 2.7$ MeV (S = 1.1)
$K_2^*(1430)^0$ full width $\Gamma = 109 \pm 5$ MeV (S = 1.9)

$K_2^*(1430)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$K\pi$	(49.9±1.2) %		622
$K^*(892)\pi$	(24.7±1.5) %		423
$K^*(892)\pi\pi$	(13.4±2.2) %		375
$K\rho$	(8.7±0.8) %	S=1.2	331
$K\omega$	(2.9±0.8) %		319
$K^+\gamma$	(2.4±0.5) $\times 10^{-3}$	S=1.1	627
$K\eta$	($1.5^{+3.4}_{-1.0}$) $\times 10^{-3}$	S=1.3	492
$K\omega\pi$	< 7.2 $\times 10^{-4}$	CL=95%	110
$K^0\gamma$	< 9 $\times 10^{-4}$	CL=90%	631

$K^*(1680)$

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

Mass $m = 1717 \pm 27$ MeV (S = 1.4)
Full width $\Gamma = 322 \pm 110$ MeV (S = 4.2)

$K^*(1680)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\pi$	(38.7±2.5) %	779
$K\rho$	$(31.4^{+4.7}_{-2.1})$ %	571
$K^*(892)\pi$	$(29.9^{+2.2}_{-4.7})$ %	615

$K_2(1770)$ [//]

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

Mass $m = 1773 \pm 8$ MeV
Full width $\Gamma = 186 \pm 14$ MeV

$K_2(1770)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\pi\pi$		–
$K_2^*(1430)\pi$	dominant	287
$K^*(892)\pi$	seen	653
$Kf_2(1270)$	seen	–
$K\phi$	seen	441
$K\omega$	seen	608

$K_3^*(1780)$

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

Mass $m = 1776 \pm 7$ MeV (S = 1.1)
Full width $\Gamma = 159 \pm 21$ MeV (S = 1.3)

$K_3^*(1780)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$K\rho$	(31 ± 9) %		612
$K^*(892)\pi$	(20 ± 5) %		651
$K\pi$	(18.8± 1.0) %		810
$K\eta$	(30 ±13) %		715
$K_2^*(1430)\pi$	< 16 %	95%	284

$K_2(1820)$ [mm]

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

Mass $m = 1816 \pm 13$ MeV
Full width $\Gamma = 276 \pm 35$ MeV

$K_2(1820)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K_2^*(1430)\pi$	seen	325
$K^*(892)\pi$	seen	680
$K f_2(1270)$	seen	186
$K\omega$	seen	638

$K_4^*(2045)$

$I(J^P) = \frac{1}{2}(4^+)$

Mass $m = 2045 \pm 9$ MeV (S = 1.1)
Full width $\Gamma = 198 \pm 30$ MeV

$K_4^*(2045)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\pi$	(9.9 ± 1.2) %	958
$K^*(892)\pi\pi$	(9 ± 5) %	800
$K^*(892)\pi\pi\pi$	(7 ± 5) %	764
$\rho K\pi$	(5.7 ± 3.2) %	742
$\omega K\pi$	(5.0 ± 3.0) %	736
$\phi K\pi$	(2.8 ± 1.4) %	591
$\phi K^*(892)$	(1.4 ± 0.7) %	363