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

$K^+ = u\overline{s}$, $K^0 = d\overline{s}$, $\overline{K}^0 = \overline{d}s$, $K^- = \overline{u}s$, 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)
$K^\pm \to \pi^\pm\pi^0\pi^0 = 0.652 \pm 0.031$ (S = 2.7)

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

K^+_{e3} $\lambda_+ = 0.0276 \pm 0.0021$
$K^+_{\mu 3}$ $\lambda_+ = 0.031 \pm 0.008$ (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 $K^+_{\mu 3}$.			

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

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*	$< 1.2 \times 10^{-8}$	CL=90%	203
$\pi^+ \pi^+ \mu^- \overline{\nu}_\mu$	*SQ*	$< 3.0 \times 10^{-6}$	CL=95%	151
$\pi^+ e^+ e^-$	*S1*	$(\ 2.88 \pm 0.13) \times 10^{-7}$		227
$\pi^+ \mu^+ \mu^-$	*S1*	$(\ 7.6\ \pm 2.1\ ) \times 10^{-8}$	S=3.4	172
$\pi^+ \nu \overline{\nu}$	*S1*	$(\ 1.5\ ^{+3.4}_{-1.2}\ ) \times 10^{-10}$		227
$\mu^- \nu e^+ e^+$	*LF*	$< 2.0 \times 10^{-8}$	CL=90%	236
$\mu^+ \nu_e$	*LF*	[d] $< 4 \times 10^{-3}$	CL=90%	236
$\pi^+ \mu^+ e^-$	*LF*	$< 2.1 \times 10^{-10}$	CL=90%	214
$\pi^+ \mu^- e^+$	*LF*	$< 7 \times 10^{-9}$	CL=90%	214
$\pi^- \mu^+ e^+$	*L*	$< 7 \times 10^{-9}$	CL=90%	214
$\pi^- e^+ e^+$	*L*	$< 1.0 \times 10^{-8}$	CL=90%	227
$\pi^- \mu^+ \mu^+$	*L*	[d] $< 1.5 \times 10^{-4}$	CL=90%	172
$\mu^+ \overline{\nu}_e$	*L*	[d] $< 3.3 \times 10^{-3}$	CL=90%	236
$\pi^0 e^+ \overline{\nu}_e$	*L*	$< 3 \times 10^{-3}$	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]

T-violation parameters in K^0-$\overline{K}^0$ mixing [w]

Asymmetry A_T in K^0-$\overline{K}^0$ mixing $= (6.6 \pm 1.6) \times 10^{-3}$

CPT-violation parameters in K^0-$\overline{K}^0$ mixing [w]

Re $\Delta = (2.9 \pm 2.7) \times 10^{-4}$

Im $\Delta = (-0.8 \pm 3.1) \times 10^{-3}$

K^0_S

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

Mean life $\tau = (0.8935 \pm 0.0008) \times 10^{-10}$ s

$c\tau = 2.6786$ cm

CP-violation parameters [cc]

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

$\text{Im}(\eta_{000}) = -0.05 \pm 0.13$

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
$\pi^+\pi^-\gamma$	[x,dd]	(1.78±0.05) × 10^{-3}		206
$\gamma\gamma$		(2.4 ±0.9) × 10^{-6}		249
$\pi^+\pi^-\pi^0$		(3.2 $^{+1.2}_{-1.0}$) × 10^{-7}		133
$3\pi^0$		< 1.4 × 10^{-5}	CL=90%	139
$\pi^\pm e^\mp \nu_e$	[ee]	(7.2 ±1.4) × 10^{-4}		229
$\Delta S = 1$ weak neutral current (*S1*) modes				
$\mu^+\mu^-$	*S1*	< 3.2 × 10^{-7}	CL=90%	225
e^+e^-	*S1*	< 1.4 × 10^{-7}	CL=90%	249
$\pi^0 e^+ e^-$	*S1*	< 1.1 × 10^{-6}	CL=90%	231

K_L^0

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

$m_{K_L} - m_{K_S} = (0.5300 \pm 0.0012) \times 10^{10}\ \hbar\ \mathrm{s}^{-1}$
$= (3.489 \pm 0.008) \times 10^{-12}$ 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)

$K_L^0 \to \pi^+\pi^-\pi^0 = 0.678 \pm 0.008$ (S = 1.5)

K_L decay form factors [w]

K_{e3}^0 $\lambda_+ = 0.0288 \pm 0.0015$ (S = 1.3)

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

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

$K_L \to e^+e^-\gamma$: $\alpha_{K^*} = -0.33 \pm 0.05$

CP-violation parameters [cc]

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

$|\eta_{00}| = (2.262 \pm 0.017) \times 10^{-3}$

$|\eta_{+-}| = (2.276 \pm 0.017) \times 10^{-3}$

$|\eta_{00}/\eta_{+-}| = 0.9936 \pm 0.0014$ [ff] (S = 1.6)

$\epsilon'/\epsilon = (2.1 \pm 0.5) \times 10^{-3}$ [ff] (S = 1.6)

$\phi_{+-} = (43.3 \pm 0.5)^\circ$

$\phi_{00} = (43.2 \pm 1.0)^\circ$

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

CP asymmetry A in $K_L^0 \to \pi^+\pi^-e^+e^- = (13.6 \pm 2.8)\%$

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

f for $K_L^0 \to \pi^+\pi^-\pi^0 = 0.004 \pm 0.006$

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

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

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

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

Re $x = -0.002 \pm 0.006$
Im $x = 0.0012 \pm 0.0019$

K^0_L DECAY MODES		Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$3\pi^0$		(21.13 ±0.27) %	S=1.1	139
$\pi^+\pi^-\pi^0$		(12.55 ±0.20) %	S=1.7	133
$\pi^\pm\mu^\mp\nu_\mu$	[*ee*]	(27.18 ±0.25) %	S=1.1	216
Called $K^0_{\mu 3}$.				
$\pi^\pm e^\mp\nu_e$	[*ee*]	(38.78 ±0.28) %	S=1.1	229
Called K^0_{e3}.				
2γ		(5.86 ±0.15) $\times 10^{-4}$		249
3γ		$<$ 2.4 $\times 10^{-7}$	CL=90%	249
$\pi^0 2\gamma$	[*gg*]	(1.68 ±0.10) $\times 10^{-6}$		231
$\pi^0\pi^\pm e^\mp\nu$	[*ee*]	(5.18 ±0.29) $\times 10^{-5}$		207
$(\pi\mu\,\text{atom})\nu$		(1.06 ±0.11) $\times 10^{-7}$		–
$\pi^\pm e^\mp\nu_e\gamma$	[*x*,*ee*,*gg*]	(3.62 $^{+0.26}_{-0.21}$) $\times 10^{-3}$		229
$\pi^\pm\mu^\mp\nu_\mu\gamma$		(5.7 $^{+0.6}_{-0.7}$) $\times 10^{-4}$		–
$\pi^+\pi^-\gamma$	[*x*,*gg*]	(4.61 ±0.14) $\times 10^{-5}$		206
$\pi^0\pi^0\gamma$		$<$ 5.6 $\times 10^{-6}$		209
$\mu^+\mu^-\gamma$		(3.25 ±0.28) $\times 10^{-7}$		225
$e^+e^-\gamma$		(10.0 ±0.5) $\times 10^{-6}$	S=1.5	249
$e^+e^-\gamma\gamma$	[*gg*]	(6.9 ±1.0) $\times 10^{-7}$		249
$\pi^0\gamma e^+e^-$		$<$ 7.1 $\times 10^{-7}$	CL=90%	–

Charge conjugation × Parity (*CP*, *CPV*) or Lepton Family number (*LF*) violating modes, or $\Delta S = 1$ weak neutral current (*S1*) modes

$\pi^+\pi^-$	*CPV*		(2.056±0.033) $\times 10^{-3}$		206
$\pi^0\pi^0$	*CPV*		(9.27 ±0.19) $\times 10^{-4}$		209
$\mu^+\mu^-$	*S1*		(7.15 ±0.16) $\times 10^{-9}$		225
e^+e^-	*S1*		(9 $^{+6}_{-4}$) $\times 10^{-12}$		249
$\pi^+\pi^-e^+e^-$	*S1*	[*gg*]	(3.5 ±0.6) $\times 10^{-7}$		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*	[*hh*]	$<$ 5.1 $\times 10^{-9}$	CL=90%	177
$\pi^0 e^+e^-$	*CP*,*S1*	[*hh*]	$<$ 4.3 $\times 10^{-9}$	CL=90%	231
$\pi^0\nu\overline{\nu}$	*CP*,*S1*	[*ii*]	$<$ 5.9 $\times 10^{-7}$	CL=90%	231
$e^\pm\mu^\mp$	*LF*	[*ee*]	$<$ 4.7 $\times 10^{-12}$	CL=90%	238
$e^\pm e^\pm\mu^\mp\mu^\mp$	*LF*	[*ee*]	$<$ 6.1 $\times 10^{-9}$	CL=90%	–
$\pi^0\mu^\pm e^\mp$	*LF*	[*ee*]	$<$ 6.2 $\times 10^{-9}$	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 $m = 896.10 \pm 0.27$ MeV (S = 1.4)
$K^*(892)^\pm$ full width $\Gamma = 50.8 \pm 0.9$ MeV
$K^*(892)^0$ full width $\Gamma = 50.7 \pm 0.6$ 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

$K_0^*(1430)$ [ij]

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

Mass $m = 1412 \pm 6$ MeV
Full width $\Gamma = 294 \pm 23$ 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

$K_2(1770)$ [kk]

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

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

$K_2(1820)$ [*l*]

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

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