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

$D_s^+ = c\bar{s}$, $D_s^- = \bar{c}s$,   similarly for D_s^*'s

$D_s^\pm$

$I(J^P) = 0(0^-)$

Mass $m = 1968.49 \pm 0.34$ MeV   (S = 1.3)

$m_{D_s^\pm} - m_{D^\pm} = 98.87 \pm 0.30$ MeV   (S = 1.4)

Mean life $\tau = (500 \pm 7) \times 10^{-15}$ s   (S = 1.3)

$c\tau = 149.9$ μm

CP-violating decay-rate asymmetries

$A_{CP}(K^\pm K_S^0) = 0.049 \pm 0.023$

$A_{CP}(K^+ K^- \pi^\pm) = 0.003 \pm 0.014$

$A_{CP}(K^+ K^- \pi^\pm \pi^0) = -0.06 \pm 0.04$

$A_{CP}(K_S^0 K^\mp 2\pi^\pm) = -0.01 \pm 0.04$

$A_{CP}(\pi^+ \pi^- \pi^\pm) = 0.02 \pm 0.05$

$A_{CP}(\pi^\pm \eta) = -0.08 \pm 0.05$

$A_{CP}(\pi^\pm \eta') = -0.06 \pm 0.04$

$A_{CP}(K^\pm \pi^0) = 0.02 \pm 0.29$

$A_{CP}(K_S^0 \pi^\pm) = 0.27 \pm 0.11$

$A_{CP}(K^\pm \pi^+ \pi^-) = 0.11 \pm 0.07$

$A_{CP}(K^\pm \eta) = -0.20 \pm 0.18$

$A_{CP}(K^\pm \eta'(958)) = -0.2 \pm 0.4$

T-violating decay-rate asymmetry

$A_T(K_S^0 K^\pm \pi^+ \pi^-) = -0.04 \pm 0.07$ [a]

D_s^+ form factors

$r_2 = 0.84 \pm 0.11$ (S = 2.4)

$r_v = 1.80 \pm 0.08$

$\Gamma_L/\Gamma_T = 0.72 \pm 0.18$

Unless otherwise noted, the branching fractions for modes with a resonance in the final state include all the decay modes of the resonance. D_s^- modes are charge conjugates of the modes below.

D_s^+ DECAY MODES		Fraction (Γ_i/Γ)		Confidence level	p (MeV/c)
Inclusive modes					
K^- anything		$(13 \;^{+14}_{-12})$ %			−
$\overline{K}^0$ anything + K^0 anything		(39 ± 28) %			−
K^+ anything		$(20 \;^{+18}_{-14})$ %			−
(non-$K\overline{K}$) anything		(64 ± 17) %			−
η anything	[b]	(24 ± 4) %			−
η' anything		(8.7 ± 2.1) %			−
ϕ anything		(16.1 ± 1.6) %			−
e^+ anything		$(8 \;^{+6}_{-5})$ %			−
Leptonic and semileptonic modes					
$e^+\nu_e$		< 1.3	$\times 10^{-4}$	90%	984
$\mu^+\nu_\mu$		$(6.3 \pm 0.5)\times 10^{-3}$			981
$\tau^+\nu_\tau$		(6.6 ± 0.6) %			182
$\phi e^+\nu_e$		(2.61 ± 0.17) %			720
$\eta\ell^+\nu_\ell + \eta'(958)\ell^+\nu_\ell$	[c]	(4.4 ± 0.7) %			−
$\eta\ell^+\nu_\ell$	[c]	(3.2 ± 0.5) %			908
$\eta'(958)\ell^+\nu_\ell$	[c]	(1.12 ± 0.35) %			751
Hadronic modes with a $K\overline{K}$ pair					
$K^+K^0_S$		(1.49 ± 0.09) %			850
$K^+K^-\pi^+$	[d]	(5.50 ± 0.28) %			805
$\phi\pi^+$	[e,f]	(4.39 ± 0.34) %			712
$\phi\pi^+, \phi \to K^+K^-$	[e]	(2.18 ± 0.33) %			712
$K^+\overline{K}^*(892)^0, \overline{K}^{*0} \to K^-\pi^+$		(2.6 ± 0.4) %			416
$f_0(980)\pi^+, f_0 \to K^+K^-$		$(6.0 \pm 2.4)\times 10^{-3}$			732
$K^+\overline{K}^*_0(1430)^0, \overline{K}^*_0 \to K^-\pi^+$		$(5.1 \pm 2.5)\times 10^{-3}$			218
$K^0\overline{K}^0\pi^+$		—			802
$K^*(892)^+\overline{K}^0$	[f]	(5.3 ± 1.2) %			683
$K^+K^-\pi^+\pi^0$		(5.6 ± 0.5) %			748
$\phi\rho^+, \phi \to K^+K^-$		$(4.0 \;^{+1.1}_{-1.2})$ %			400
$\phi\pi^+\pi^0$ 3-body, $\phi \to K^+K^-$		< 1.5 %		90%	686
$K^+K^-\pi^+\pi^0$ non-ϕ		< 11 %		90%	748

$K^0_S K^- \pi^+ \pi^+$		(1.64± 0.12) %		744
$K^*(892)^+ \overline{K}^*(892)^0$	[f]	(7.0 ± 2.5) %		417
$K^0 K^- 2\pi^+$ (non-$K^{*+} \overline{K}^{*0}$)		< 3.5 %	90%	744
$K^+ K^0_S \pi^+ \pi^-$		(9.6 ± 1.3) × 10^{-3}		744
$K^+ K^- \pi^+ \pi^+ \pi^-$		(8.8 ± 1.6) × 10^{-3}		673
$\phi \pi^+ \pi^+ \pi^-$, $\phi \to K^+ K^-$		(5.9 ± 1.1) × 10^{-3}		640
$K^+ K^- \rho^0 \pi^+$ non-ϕ		< 2.6 × 10^{-4}	90%	249
$\phi \rho^0 \pi^+$, $\phi \to K^+ K^-$		(6.6 ± 1.3) × 10^{-3}		181
$\phi a_1(1260)^+$, $\phi \to$ $K^+ K^-$, $a_1^+ \to \rho^0 \pi^+$		(7.5 ± 1.3) × 10^{-3}		†
$K^+ K^- \pi^+ \pi^+ \pi^-$ nonresonant		(9 ± 7) × 10^{-4}		673
$K^0_S K^0_S \pi^+ \pi^+ \pi^-$		(8.4 ± 3.5) × 10^{-4}		669

Hadronic modes without K's

$\pi^+ \pi^0$		< 6 × 10^{-4}	90%	975
$\pi^+ \pi^+ \pi^-$		(1.11± 0.08) %		959
$\rho^0 \pi^+$		not seen		825
$\pi^+ (\pi^+ \pi^-)_{S-\text{wave}}$	[g]	(9.7 ± 1.1) × 10^{-3}		959
$f_2(1270) \pi^+$, $f_2 \to \pi^+ \pi^-$		(1.1 ± 0.6) × 10^{-3}		559
$\rho(1450)^0 \pi^+$, $\rho^0 \to \pi^+ \pi^-$		(7 ± 6) × 10^{-4}		421
$\pi^+ \pi^+ \pi^- \pi^0$		< 15 %	90%	935
$\eta \pi^+$	[f]	(1.58± 0.21) %		902
$\omega \pi^+$	[f]	(2.5 ± 0.9) × 10^{-3}		822
$3\pi^+ 2\pi^-$		(8.0 ± 0.9) × 10^{-3}		899
$\pi^+ \pi^+ \pi^- \pi^0 \pi^0$		—		902
$\eta \rho^+$	[f]	(13.1 ± 2.2) %		724
$\eta \pi^+ \pi^0$ 3-body	[f]	< 5 %	90%	886
$3\pi^+ 2\pi^- \pi^0$		(4.9 ± 3.2) %		856
$\eta'(958) \pi^+$	[f]	(3.8 ± 0.4) %		743
$3\pi^+ 2\pi^- 2\pi^0$		—		803
$\eta'(958) \rho^+$	[f]	(12.2 ± 2.0) %		465
$\eta'(958) \pi^+ \pi^0$ 3-body	[f]	< 1.8 %	90%	720

Modes with one or three K's

$K^+ \pi^0$	(8.2 ± 2.2) × 10^{-4}		917
$K^0_S \pi^+$	(1.25± 0.15) × 10^{-3}		916
$K^+ \eta$	(1.41± 0.31) × 10^{-3}		835
$K^+ \eta'(958)$	(1.6 ± 0.5) × 10^{-3}		646
$K^+ \pi^+ \pi^-$	(6.9 ± 0.5) × 10^{-3}		900
$K^+ \rho^0$	(2.7 ± 0.5) × 10^{-3}		745
$K^+ \rho(1450)^0$, $\rho^0 \to \pi^+ \pi^-$	(7.4 ± 2.6) × 10^{-4}		–
$K^*(892)^0 \pi^+$, $K^{*0} \to K^+ \pi^-$	(1.50± 0.26) × 10^{-3}		775
$K^*(1410)^0 \pi^+$, $K^{*0} \to K^+ \pi^-$	(1.30± 0.31) × 10^{-3}		–

$K^*(1430)^0\pi^+$, $K^{*0}\to$ $K^+\pi^-$		(5 $\pm$ 4) $\times 10^{-4}$		–
$K^+\pi^+\pi^-$ nonresonant		(1.1 $\pm$ 0.4) $\times 10^{-3}$		900
$K^0_S\pi^+\pi^-$		(3.0 $\pm$ 1.1) $\times 10^{-3}$		870
$K^+K^+K^-$		(4.9 $\pm$ 1.7) $\times 10^{-4}$		628
ϕK^+, $\phi\to K^+K^-$		< 2.8 $\times 10^{-4}$	90%	607

Doubly Cabibbo-suppressed modes

$K^+K^+\pi^-$		(2.9 $\pm$ 1.1) $\times 10^{-4}$		805

Baryon-antibaryon mode

$p\overline{n}$		(1.3 $\pm$ 0.4) $\times 10^{-3}$		295

$\Delta C = 1$ weak neutral current ($C1$) modes, Lepton family number (LF), or Lepton number (L) violating modes

$\pi^+e^+e^-$		[h] < 2.7	$\times 10^{-4}$	90%	979
$\pi^+\mu^+\mu^-$		[h] < 2.6	$\times 10^{-5}$	90%	968
$K^+e^+e^-$	C1	< 1.6	$\times 10^{-3}$	90%	922
$K^+\mu^+\mu^-$	C1	< 3.6	$\times 10^{-5}$	90%	909
$K^*(892)^+\mu^+\mu^-$	C1	< 1.4	$\times 10^{-3}$	90%	765
$\pi^+e^\pm\mu^\mp$	LF	[i] < 6.1	$\times 10^{-4}$	90%	976
$K^+e^\pm\mu^\mp$	LF	[i] < 6.3	$\times 10^{-4}$	90%	919
$\pi^-e^+e^+$	L	< 6.9	$\times 10^{-4}$	90%	979
$\pi^-\mu^+\mu^+$	L	< 2.9	$\times 10^{-5}$	90%	968
$\pi^-e^+\mu^+$	L	< 7.3	$\times 10^{-4}$	90%	976
$K^-e^+e^+$	L	< 6.3	$\times 10^{-4}$	90%	922
$K^-\mu^+\mu^+$	L	< 1.3	$\times 10^{-5}$	90%	909
$K^-e^+\mu^+$	L	< 6.8	$\times 10^{-4}$	90%	919
$K^*(892)^-\mu^+\mu^+$	L	< 1.4	$\times 10^{-3}$	90%	765

$$\boxed{D_s^{*\pm}} \qquad\qquad I(J^P) = 0(?^?)$$
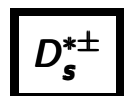
J^P is natural, width and decay modes consistent with 1^-.

Mass $m = 2112.3 \pm 0.5$ MeV   (S = 1.1)

$m_{D_s^{*\pm}} - m_{D_s^{\pm}} = 143.8 \pm 0.4$ MeV

Full width Γ < 1.9 MeV, CL = 90%

D_s^{*-} modes are charge conjugates of the modes below.

D_s^{*+} DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$D_s^+ \gamma$	(94.2 ± 0.7) %	139
$D_s^+ \pi^0$	(5.8 ± 0.7) %	48

$D_{s0}^*(2317)^\pm$

$I(J^P) = 0(0^+)$
J, P need confirmation.
J^P is natural, low mass consistent with 0^+.

Mass $m = 2317.8 \pm 0.6$ MeV   (S = 1.1)
$m_{D_{s0}^*(2317)^\pm} - m_{D_s^\pm} = 349.3 \pm 0.6$ MeV   (S = 1.1)
Full width $\Gamma < 3.8$ MeV, CL = 95%

$D_{s0}^*(2317)^-$ modes are charge conjugates of modes below.

$D_{s0}^*(2317)^\pm$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$D_s^+ \pi^0$	seen	298
$D_s^+ \pi^0 \pi^0$	not seen	205

$D_{s1}(2460)^\pm$

$I(J^P) = 0(1^+)$

Mass $m = 2459.6 \pm 0.6$ MeV   (S = 1.1)
$m_{D_{s1}(2460)^\pm} - m_{D_s^{*\pm}} = 347.2 \pm 0.8$ MeV   (S = 1.2)
$m_{D_{s1}(2460)^\pm} - m_{D_s^\pm} = 491.1 \pm 0.7$ MeV   (S = 1.1)
Full width $\Gamma < 3.5$ MeV, CL = 95%

$D_{s1}(2460)^-$ modes are charge conjugates of the modes below.

$D_{s1}(2460)^+$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$D_s^{*+}\pi^0$	$(48 \pm 11)\%$		297
$D_s^+\gamma$	$(18 \pm 4)\%$		442
$D_s^+\pi^+\pi^-$	$(4.3\pm 1.3)\%$	S=1.1	363
$D_s^{*+}\gamma$	$< 8 \%$	CL=90%	323
$D_{s0}^*(2317)^+\gamma$	$(3.7^{+5.0}_{-2.4})\%$		138

$D_{s1}(2536)^\pm$

$I(J^P) = 0(1^+)$
J, P need confirmation.

Mass $m = 2535.35 \pm 0.34 \pm 0.5$ MeV
Full width $\Gamma < 2.3$ MeV, CL $= 90\%$

$D_{s1}(2536)^-$ modes are charge conjugates of the modes below.

$D_{s1}(2536)^+$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$D^*(2010)^+ K^0$	seen	149
$D^*(2007)^0 K^+$	seen	168
$D^+ K^0$	not seen	382
$D^0 K^+$	not seen	391
$D_s^{*+}\gamma$	possibly seen	388
$D_s^+\pi^+\pi^-$	seen	437

$D_{s2}(2573)^\pm$

$I(J^P) = 0(?^?)$

J^P is natural, width and decay modes consistent with 2^+.

Mass $m = 2572.6 \pm 0.9$ MeV
Full width $\Gamma = 20 \pm 5$ MeV (S = 1.3)

$D_{s2}(2573)^-$ modes are charge conjugates of the modes below.

$D_{s2}(2573)^+$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$D^0 K^+$	seen	435
$D^*(2007)^0 K^+$	not seen	244

NOTES

[a] See the Particle Listings for the (complicated) definition of this quantity.

[b] This fraction includes η from η' decays.

[c] For now, we average together measurements of the $X\,e^+\,\nu_e$ and $X\,\mu^+\,\nu_\mu$ branching fractions. This is the *average*, not the *sum*.

[d] The branching fraction for this mode may differ from the sum of the submodes that contribute to it, due to interference effects. See the relevant papers in the Particle Listings.

[e] We decouple the $D_s^+ \to \phi\pi^+$ branching fraction obtained from mass projections (and used to get some of the other branching fractions) from the $D_s^+ \to \phi\pi^+$, $\phi \to K^+K^-$ branching fraction obtained from the Dalitz-plot analysis of $D_s^+ \to K^+K^-\pi^+$. That is, the ratio of these two branching fractions is not exactly the $\phi \to K^+K^-$ branching fraction 0.491.

[f] This branching fraction includes all the decay modes of the final-state resonance.

[g] This comes from a K-matrix parametrization of the $\pi^+\pi^-$ S-wave and is a sum over the $f_0(980)$, $f_0(1300)$, $f_0(1200-1600)$, $f_0(1500)$, and $f_0(1750)$. Not all of these correspond to particles in our Tables.

[h] This mode is not a useful test for a $\Delta C{=}1$ weak neutral current because both quarks must change flavor in this decay.

[i] The value is for the sum of the charge states or particle/antiparticle states indicated.