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

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

$D_s^\pm$

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

Mass $m = 1968.47 \pm 0.33$ MeV (S = 1.3)
$m_{D_s^\pm} - m_{D^\pm} = 98.88 \pm 0.30$ 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

$A_{CP}(\mu^\pm \nu) = 0.05 \pm 0.06$
$A_{CP}(K^\pm K_S^0) = 0.049 \pm 0.023$
$A_{CP}(K^+ K^- \pi^\pm) = 0.003 \pm 0.014$
$A_{CP}(K^+ K^- \pi^\pm \pi^0) = -0.06 \pm 0.04$
$A_{CP}(K_S^0 K^\mp 2\pi^\pm) = -0.01 \pm 0.04$
$A_{CP}(\pi^+ \pi^- \pi^\pm) = 0.02 \pm 0.05$
$A_{CP}(\pi^\pm \eta) = -0.08 \pm 0.05$
$A_{CP}(\pi^\pm \eta') = -0.06 \pm 0.04$
$A_{CP}(K^\pm \pi^0) = 0.02 \pm 0.29$
$A_{CP}(K_S^0 \pi^\pm) = 0.27 \pm 0.11$
$A_{CP}(K^\pm \pi^+ \pi^-) = 0.11 \pm 0.07$
$A_{CP}(K^\pm \eta) = -0.20 \pm 0.18$
$A_{CP}(K^\pm \eta'(958)) = -0.2 \pm 0.4$

T-violating decay-rate asymmetry

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

$D_s^+ \to \phi \ell^+ \nu_\ell$ 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)	Scale factor/ Confidence level	p (MeV/c)
Inclusive modes				
e^+ semileptonic	[b]	(6.5 ±0.4) %		–
π^+ anything		(119.3 ±1.4) %		–
π^- anything		(43.2 ±0.9) %		–
π^0 anything		(123 ±7) %		–
K^- anything		(18.7 ±0.5) %		–
K^+ anything		(28.9 ±0.7) %		–
K_S^0 anything		(19.0 ±1.1) %		–
η anything	[c]	(29.9 ±2.8) %		–
ω anything		(6.1 ±1.4) %		–
η' anything	[d]	(11.7 ±1.8) %		–
$f_0(980)$ anything, $f_0 \to \pi^+\pi^-$		< 1.3 %	CL=90%	–
ϕ anything		(15.7 ±1.0) %		–
K^+K^- anything		(15.8 ±0.7) %		–
$K_S^0 K^+$ anything		(5.8 ±0.5) %		–
$K_S^0 K^-$ anything		(1.9 ±0.4) %		–
$2K_S^0$ anything		(1.70±0.32) %		–
$2K^+$ anything		< 2.6 $\times 10^{-3}$	CL=90%	–
$2K^-$ anything		< 6 $\times 10^{-4}$	CL=90%	–
Leptonic and semileptonic modes				
$e^+\nu_e$		< 1.2 $\times 10^{-4}$	CL=90%	984
$\mu^+\nu_\mu$		(5.8 ±0.4) $\times 10^{-3}$		981
$\tau^+\nu_\tau$		(5.6 ±0.4) %		182
$K^+K^-e^+\nu_e$		—		851
$\phi e^+\nu_e$	[e]	(2.49±0.14) %		720
$\eta e^+\nu_e + \eta'(958) e^+\nu_e$	[e]	(3.66±0.37) %		–
$\eta e^+\nu_e$	[e]	(2.67±0.29) %	S=1.1	908
$\eta'(958) e^+\nu_e$	[e]	(9.9 ±2.3) $\times 10^{-3}$		751
$K^0 e^+\nu_e$		(3.7 ±1.0) $\times 10^{-3}$		921
$K^*(892)^0 e^+\nu_e$	[e]	(1.8 ±0.7) $\times 10^{-3}$		782
$f_0(980) e^+\nu_e$, $f_0 \to \pi^+\pi^-$		(2.00±0.32) $\times 10^{-3}$		–
Hadronic modes with a $K\overline{K}$ pair				
$K^+K_S^0$		(1.49±0.08) %		850
$K^+K^-\pi^+$	[f]	(5.50±0.27) %		805
$\phi\pi^+$	[e,g]	(4.5 ±0.4) %		712
$\phi\pi^+$, $\phi \to K^+K^-$	[g]	(2.32±0.14) %		712

$K^+\overline{K}^*(892)^0$, $\overline{K}^{*0} \to K^-\pi^+$		(2.60±0.15) %			416
$f_0(980)\pi^+$, $f_0 \to K^+K^-$		(1.55±0.16) %			732
$f_0(1370)\pi^+$, $f_0 \to K^+K^-$		(2.4 ±0.4) × 10^{-3}			–
$f_0(1710)\pi^+$, $f_0 \to K^+K^-$		(1.87±0.33) × 10^{-3}			198
$K^+\overline{K}_0^*(1430)^0$, $\overline{K}_0^* \to K^-\pi^+$		(2.1 ±0.4) × 10^{-3}			218
$K^0\overline{K}^0\pi^+$		—			802
$K^*(892)^+\overline{K}^0$	[e]	(5.4 ±1.2) %			683
$K^+K^-\pi^+\pi^0$		(5.6 ±0.5) %			748
$\phi\rho^+$	[e]	(8.4 $^{+1.9}_{-2.3}$) %			401
$K_S^0K^-2\pi^+$		(1.64±0.12) %			744
$K^*(892)^+\overline{K}^*(892)^0$	[e]	(7.2 ±2.6) %			417
$K^+K_S^0\pi^+\pi^-$		(9.6 ±1.3) × 10^{-3}			744
$K^+K^-2\pi^+\pi^-$		(8.8 ±1.6) × 10^{-3}			673
$\phi2\pi^+\pi^-$	[e]	(1.21±0.16) %			640
$K^+K^-\rho^0\pi^+$ non-ϕ		< 2.6 × 10^{-4}		CL=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}			†
$K^+K^-2\pi^+\pi^-$ nonresonant		(9 ±7) × 10^{-4}			673
$2K_S^0\,2\pi^+\pi^-$		(8.4 ±3.5) × 10^{-4}			669

Hadronic modes without K's

$\pi^+\pi^0$		< 6 × 10^{-4}		CL=90%	975
$2\pi^+\pi^-$		(1.10±0.06) %			959
$\rho^0\pi^+$		(2.0 ±1.2) × 10^{-4}			825
$\pi^+(\pi^+\pi^-)_{S-\text{wave}}$	[h]	(9.2 ±0.6) × 10^{-3}			959
$f_2(1270)\pi^+$, $f_2 \to \pi^+\pi^-$		(1.11±0.20) × 10^{-3}			559
$\rho(1450)^0\pi^+$, $\rho^0 \to \pi^+\pi^-$		(3.0 ±2.0) × 10^{-4}			421
$\pi^+2\pi^0$		(6.5 ±1.3) × 10^{-3}			961
$2\pi^+\pi^-\pi^0$		—			935
$\eta\pi^+$	[e]	(1.56±0.20) %			902
$\omega\pi^+$	[e]	(2.3 ±0.6) × 10^{-3}			822
$3\pi^+2\pi^-$		(8.0 ±0.9) × 10^{-3}			899
$2\pi^+\pi^-2\pi^0$		—			902
$\eta\rho^+$	[e]	(8.9 ±0.8) %			724
$\eta\pi^+\pi^0$ 3-body	[e]	< 5 %		CL=90%	886
$\omega\pi^+\pi^0$	[e]	(2.8 ±0.7) %			802
$3\pi^+2\pi^-\pi^0$		(4.9 ±3.2) %			856
$\omega2\pi^+\pi^-$	[e]	(1.6 ±0.5) %			766
$\eta'(958)\pi^+$	[d,e]	(3.8 ±0.4) %			743
$3\pi^+2\pi^-2\pi^0$		—			803

$\omega\eta\pi^+$		[e]	< 2.13	%	CL=90%	654
$\eta'(958)\rho^+$		[d,e]	(12.5 ±2.2)	%		465
$\eta'(958)\pi^+\pi^0$ 3-body		[e]	< 1.8	%	CL=90%	720
Modes with one or three K's						
$K^+\pi^0$			(8.2 ±2.2)	$\times 10^{-4}$		917
$K^0_S\pi^+$			(1.20±0.08)	$\times 10^{-3}$		916
$K^+\eta$		[e]	(1.39±0.30)	$\times 10^{-3}$		835
$K^+\omega$		[e]	< 2.4	$\times 10^{-3}$	CL=90%	741
$K^+\eta'(958)$		[e]	(1.6 ±0.5)	$\times 10^{-3}$		646
$K^+\pi^+\pi^-$			(6.9 ±0.5)	$\times 10^{-3}$		900
$K^+\rho^0$			(2.7 ±0.5)	$\times 10^{-3}$		745
$K^+\rho(1450)^0$, $\rho^0\to\pi^+\pi^-$			(7.3 ±2.6)	$\times 10^{-4}$		–
$K^*(892)^0\pi^+$, $K^{*0}\to K^+\pi^-$			(1.50±0.26)	$\times 10^{-3}$		775
$K^*(1410)^0\pi^+$, $K^{*0}\to K^+\pi^-$			(1.30±0.31)	$\times 10^{-3}$		–
$K^*(1430)^0\pi^+$, $K^{*0}\to K^+\pi^-$			(5 ±4)	$\times 10^{-4}$		–
$K^+\pi^+\pi^-$ nonresonant			(1.1 ±0.4)	$\times 10^{-3}$		900
$K^0\pi^+\pi^0$			(1.00±0.18)	%		900
$K^0_S 2\pi^+\pi^-$			(2.9 ±1.1)	$\times 10^{-3}$		870
$K^+\omega\pi^0$		[e]	< 8.2	$\times 10^{-3}$	CL=90%	684
$K^+\omega\pi^+\pi^-$		[e]	< 5.4	$\times 10^{-3}$	CL=90%	603
$K^+\omega\eta$		[e]	< 7.9	$\times 10^{-3}$	CL=90%	367
$2K^+K^-$			(4.9 ±1.7)	$\times 10^{-4}$		628
ϕK^+		[e]	< 6	$\times 10^{-4}$	CL=90%	607
Doubly Cabibbo-suppressed modes						
$2K^+\pi^-$			(1.29±0.18)	$\times 10^{-4}$		805
Baryon-antibaryon mode						
$p\overline{n}$			(1.3 ±0.4)	$\times 10^{-3}$		295
$\Delta C = 1$ weak neutral current ($C1$) modes, Lepton family number (LF), or Lepton number (L) violating modes						
$\pi^+e^+e^-$		[i]	< 2.7	$\times 10^{-4}$	CL=90%	979
$\pi^+\mu^+\mu^-$		[i]	< 2.6	$\times 10^{-5}$	CL=90%	968
$K^+e^+e^-$	$C1$		< 1.6	$\times 10^{-3}$	CL=90%	922
$K^+\mu^+\mu^-$	$C1$		< 3.6	$\times 10^{-5}$	CL=90%	909
$K^*(892)^+\mu^+\mu^-$	$C1$		< 1.4	$\times 10^{-3}$	CL=90%	765
$\pi^+e^\pm\mu^\mp$	LF	[j]	< 6.1	$\times 10^{-4}$	CL=90%	976
$K^+e^\pm\mu^\mp$	LF	[j]	< 6.3	$\times 10^{-4}$	CL=90%	919

$\pi^- 2e^+$	L	$<$	6.9	$\times 10^{-4}$	CL=90%	979
$\pi^- 2\mu^+$	L	$<$	2.9	$\times 10^{-5}$	CL=90%	968
$\pi^- e^+ \mu^+$	L	$<$	7.3	$\times 10^{-4}$	CL=90%	976
$K^- 2e^+$	L	$<$	6.3	$\times 10^{-4}$	CL=90%	922
$K^- 2\mu^+$	L	$<$	1.3	$\times 10^{-5}$	CL=90%	909
$K^- e^+ \mu^+$	L	$<$	6.8	$\times 10^{-4}$	CL=90%	919
$K^*(892)^- 2\mu^+$	L	$<$	1.4	$\times 10^{-3}$	CL=90%	765

$D_s^{*\pm}$

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

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 $\Gamma < 1.9$ 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 $m = 2459.5 \pm 0.6$ 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 ±11) %		297
$D_s^+\gamma$	(18 ± 4) %		442
$D_s^+\pi^+\pi^-$	(4.3± 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 $m = 2535.29 \pm 0.20$ 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
$D^*(2007)^0K^+$	seen	168
D^+K^0	not seen	382
D^0K^+	not seen	391
$D_s^{*+}\gamma$	possibly seen	388
$D_s^+\pi^+\pi^-$	seen	437

$D_{s2}^*(2573)$

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

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^0K^+	seen	435
$D^*(2007)^0K^+$	not seen	244

NOTES

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

[*b*] This is the purely e^+ semileptonic branching fraction: the e^+ fraction from τ^+ decays has been subtracted off. The sum of our (non-τ) e^+ exclusive fractions — an $e^+\nu_e$ with an η, η', ϕ, K^0, K^{*0}, or $f_0(980)$ — is 6.90 $\pm$ 0.4 %

[*c*] This fraction includes η from η' decays.

[*d*] Two times (to include μ decays) the $\eta' e^+\nu_e$ branching fraction, plus the $\eta'\pi^+$, $\eta'\rho^+$, and $\eta' K^+$ fractions, is (18.4 $\pm$ 2.3)%, which considerably exceeds the inclusive η' fraction of (11.7 $\pm$ 1.8)%. Our best guess is that the $\eta'\rho^+$ fraction, (12.5 $\pm$ 2.2)%, is too large.

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

[*f*] 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.

[*g*] 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.

[*h*] This comes from a model-independent and a *K*-matrix parametrization of the $\pi^+\pi^-$ *S*-wave and is a sum over several f_0 mesons.

[*i*] This mode is not a useful test for a ΔC=1 weak neutral current because both quarks must change flavor in this decay.

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