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 $m = 1968.49 \pm 0.32$ MeV (S = 1.3)
$m_{D_s^\pm} - m_{D^\pm} = 98.87 \pm 0.29$ 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

$A_{CP}(\mu^\pm \nu) = (5 \pm 6)\%$
$A_{CP}(K^\pm K_S^0) = (0.3 \pm 0.4)\%$
$A_{CP}(K^+ K^- \pi^\pm) = (0.3 \pm 1.4)\%$
$A_{CP}(K^+ K^- \pi^\pm \pi^0) = (-6 \pm 4)\%$
$A_{CP}(K_S^0 K^\mp 2\pi^\pm) = (-1 \pm 4)\%$
$A_{CP}(\pi^+ \pi^- \pi^\pm) = (2 \pm 5)\%$
$A_{CP}(\pi^\pm \eta) = (-4.6 \pm 2.9)\%$
$A_{CP}(\pi^\pm \eta') = (-6.1 \pm 3.0)\%$
$A_{CP}(K^\pm \pi^0) = (-27 \pm 24)\%$
$A_{CP}(K_S^0 \pi^\pm) = (6.6 \pm 3.3)\%$ (S = 1.4)
$A_{CP}(K^\pm \pi^+ \pi^-) = (11 \pm 7)\%$
$A_{CP}(K^\pm \eta) = (9 \pm 15)\%$
$A_{CP}(K^\pm \eta'(958)) = (6 \pm 19)\%$

T-violating decay-rate asymmetry

$A_T(K_S^0 K^\pm \pi^+ \pi^-) = (-14 \pm 8) \times 10^{-3}$ [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
$\mu^+\nu_\mu$		(5.90±0.33) $\times 10^{-3}$		981
$\tau^+\nu_\tau$		(5.43±0.31) %		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
$\omega e^+\nu_e$	[f]	< 2.0 $\times 10^{-3}$	CL=90%	829
$K^0 e^+\nu_e$		(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

$K^+ K^0_S$		(1.48 ± 0.08) %			850
$K^+ K^- \pi^+$	[g]	(5.49 ± 0.27) %			805
$\phi\pi^+$	[e,h]	(4.5 ± 0.4) %			712
$\phi\pi^+$, $\phi \to K^+ K^-$	[h]	(2.28 ± 0.12) %			712
$K^+ \overline{K}^*(892)^0$, $\overline{K}^{*0} \to K^- \pi^+$		(2.63 ± 0.13) %			416
$f_0(980)\pi^+$, $f_0 \to K^+ K^-$		(1.16 ± 0.32) %			732
$f_0(1370)\pi^+$, $f_0 \to K^+ K^-$		(7 ± 5) × 10^{-4}			–
$f_0(1710)\pi^+$, $f_0 \to K^+ K^-$		(6.7 ± 2.9) × 10^{-4}			198
$K^+ \overline{K}^*_0(1430)^0$, $\overline{K}^*_0 \to K^- \pi^+$		(1.9 ± 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
$K^0_S K^- 2\pi^+$		(1.64 ± 0.12) %			744
$K^*(892)^+ \overline{K}^*(892)^0$	[e]	(7.2 ± 2.6) %			417
$K^+ K^0_S \pi^+ \pi^-$		(9.6 ± 1.3) × 10^{-3}			744
$K^+ K^- 2\pi^+ \pi^-$		(8.8 ± 1.6) × 10^{-3}			673
$\phi 2\pi^+ \pi^-$	[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
$2K^0_S 2\pi^+ \pi^-$		(8.3 ± 3.5) × 10^{-4}			669

Hadronic modes without K's

$\pi^+ \pi^0$		< 3.4 × 10^{-4}		CL=90%	975
$2\pi^+ \pi^-$		(1.10 ± 0.06) %			959
$\rho^0 \pi^+$		(2.0 ± 1.2) × 10^{-4}			825
$\pi^+ (\pi^+ \pi^-)_{S-\text{wave}}$	[i]	(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]	(1.83 ± 0.15) %			902
$\omega\pi^+$	[e]	(2.5 ± 0.7) × 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
$\omega 2\pi^+\pi^-$	[e]	(1.6 ±0.5) %			766
$\eta'(958)\pi^+$	[d,e]	(3.94±0.33) %			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

$K^+\pi^0$		(6.2 ±2.1) $\times 10^{-4}$			917
$K^0_S\pi^+$		(1.21±0.08) $\times 10^{-3}$			916
$K^+\eta$	[e]	(1.75±0.35) $\times 10^{-3}$			835
$K^+\omega$	[e]	< 2.4	$\times 10^{-3}$	CL=90%	741
$K^+\eta'(958)$	[e]	(1.8 ±0.6) $\times 10^{-3}$			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
$2K^+K^-$		(2.20±0.23) $\times 10^{-4}$			628
ϕK^+, $\phi\to K^+K^-$		(9.0 ±2.1) $\times 10^{-5}$			–

Doubly Cabibbo-suppressed modes

$2K^+\pi^-$		(1.28±0.14) $\times 10^{-4}$			805
$K^+K^*(892)^0$, $K^{*0}\to K^+\pi^-$		(6.0 ±3.5) $\times 10^{-5}$			–

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

$\pi^+e^+e^-$	[j]	< 1.3	$\times 10^{-5}$	CL=90%	979
$\pi^+\phi$, $\phi\to e^+e^-$	[k]	(6 $^{+8}_{-4}$) $\times 10^{-6}$			–

$\pi^+\mu^+\mu^-$		[j] <	2.6	$\times 10^{-5}$	CL=90%	968
$K^+e^+e^-$	*C1*	<	3.7	$\times 10^{-6}$	CL=90%	922
$K^+\mu^+\mu^-$	*C1*	<	2.1	$\times 10^{-5}$	CL=90%	909
$K^*(892)^+\mu^+\mu^-$	*C1*	<	1.4	$\times 10^{-3}$	CL=90%	765
$\pi^+e^+\mu^-$	*LF*	<	1.2	$\times 10^{-5}$	CL=90%	976
$\pi^+e^-\mu^+$	*LF*	<	2.0	$\times 10^{-5}$	CL=90%	976
$K^+e^+\mu^-$	*LF*	<	1.4	$\times 10^{-5}$	CL=90%	919
$K^+e^-\mu^+$	*LF*	<	9.7	$\times 10^{-6}$	CL=90%	919
π^-2e^+	*L*	<	4.1	$\times 10^{-6}$	CL=90%	979
$\pi^-2\mu^+$	*L*	<	1.4	$\times 10^{-5}$	CL=90%	968
$\pi^-e^+\mu^+$	*L*	<	8.4	$\times 10^{-6}$	CL=90%	976
K^-2e^+	*L*	<	5.2	$\times 10^{-6}$	CL=90%	922
$K^-2\mu^+$	*L*	<	1.3	$\times 10^{-5}$	CL=90%	909
$K^-e^+\mu^+$	*L*	<	6.1	$\times 10^{-6}$	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 $m = 2459.6 \pm 0.6$ MeV (S = 1.1)
$m_{D_{s1}(2460)^\pm} - m_{D_s^{*\pm}} = 347.2 \pm 0.7$ 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 $m = 2535.12 \pm 0.13$ MeV
Full width $\Gamma = 0.92 \pm 0.05$ MeV

$D_{s1}(2536)^-$ 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	167
D^+K^0	not seen	381
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 $m = 2571.9 \pm 0.8$ MeV
Full width $\Gamma = 17 \pm 4$ 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	434
$D^*(2007)^0 K^+$	not seen	243

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 7.0 ± 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 (18.6 ± 2.3)%, which considerably exceeds the inclusive η' fraction of (11.7 ± 1.8)%. Our best guess is that the $\eta'\rho^+$ fraction, (12.5 ± 2.2)%, is too large.

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

[*f*] A test for $u\overline{u}$ or $d\overline{d}$ content in the D_s^+. Neither Cabibbo-favored nor Cabibbo-suppressed decays can contribute, and $\omega-\phi$ mixing is an unlikely explanation for any fraction above about 2×10^{-4}.

[*g*] 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.

[*h*] 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.

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

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

[*k*] This is *not* a test for the ΔC=1 weak neutral current, but leads to the $\pi^+ \ell^+ \ell^-$ final state.