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 $m = 1968.34 \pm 0.07$ MeV
$m_{D_s^\pm} - m_{D^\pm} = 98.69 \pm 0.05$ MeV
Mean life $\tau = (504 \pm 4) \times 10^{-15}$ s (S = 1.2)
$c\tau = 151.2$ μm

CP-violating decay-rate asymmetries

$A_{CP}(\mu^\pm\nu) = (5 \pm 6)\%$
$A_{CP}(K^\pm K_S^0) = (0.08 \pm 0.26)\%$
$A_{CP}(K^+K^-\pi^\pm) = (-0.5 \pm 0.9)\%$
$A_{CP}(\phi\pi^\pm) = (-0.38 \pm 0.27)\%$
$A_{CP}(K^\pm K_S^0\pi^0) = (-2 \pm 6)\%$
$A_{CP}(2K_S^0\pi^\pm) = (3 \pm 5)\%$
$A_{CP}(K^+K^-\pi^\pm\pi^0) = (0.0 \pm 3.0)\%$
$A_{CP}(K^\pm K_S^0\pi^+\pi^-) = (-6 \pm 5)\%$
$A_{CP}(K_S^0 K^\mp 2\pi^\pm) = (4.1 \pm 2.8)\%$
$A_{CP}(\pi^+\pi^-\pi^\pm) = (-0.7 \pm 3.1)\%$
$A_{CP}(\pi^\pm\eta) = (1.1 \pm 3.1)\%$
$A_{CP}(\pi^\pm\eta') = (-0.9 \pm 0.5)\%$
$A_{CP}(\eta\pi^\pm\pi^0) = (-1 \pm 4)\%$
$A_{CP}(\eta'\pi^\pm\pi^0) = (0 \pm 8)\%$
$A_{CP}(K^\pm\pi^0) = (-27 \pm 24)\%$
$A_{CP}(\overline{K}^0/K^0\pi^\pm) = (0.4 \pm 0.5)\%$
$A_{CP}(K_S^0\pi^\pm) = (3.1 \pm 2.6)\%$ (S = 1.7)
$A_{CP}(K^\pm\pi^+\pi^-) = (4 \pm 5)\%$
$A_{CP}(K^\pm\eta) = (9 \pm 15)\%$
$A_{CP}(K^\pm\eta'(958)) = (6 \pm 19)\%$

CP violating asymmetries of *P*-odd (*T*-odd) moments

$A_T(K_S^0 K^\pm\pi^+\pi^-) = (-14 \pm 8) \times 10^{-3}$ [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]	(10.3 ±1.4) %	S=1.1	–
$f_0(980)$ 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				
$e^+\nu_e$		< 8.3 $\times 10^{-5}$	CL=90%	984
$\mu^+\nu_\mu$		(5.50±0.23) $\times 10^{-3}$		981
$\tau^+\nu_\tau$		(5.48±0.23) %		182
$K^+K^-e^+\nu_e$		—		851
$\phi e^+\nu_e$	[e]	(2.39±0.16) %	S=1.3	720
$\phi\mu^+\nu_\mu$		(1.9 ±0.5) %		715
$\eta e^+\nu_e + \eta'(958) e^+\nu_e$	[e]	(3.03±0.24) %		–
$\eta e^+\nu_e$	[e]	(2.29±0.19) %		908
$\eta'(958) e^+\nu_e$	[e]	(7.4 ±1.4) $\times 10^{-3}$		751
$\eta\mu^+\nu_\mu$		(2.4 ±0.5) %		905
$\eta'(958)\mu^+\nu_\mu$		(1.1 ±0.5) %		747
$\omega e^+\nu_e$	[f]	< 2.0 $\times 10^{-3}$	CL=90%	829
$K^0 e^+\nu_e$		(3.9 ±0.9) $\times 10^{-3}$		921
$K^*(892)^0 e^+\nu_e$	[e]	(1.8 ±0.4) $\times 10^{-3}$		782

Hadronic modes with a $K\overline{K}$ pair

$K^+ K^0_S$		(1.50±0.05) %		850
$K^+ \overline{K}^0$		(2.95±0.14) %		850
$K^+ K^- \pi^+$	[g]	(5.45±0.17) %	S=1.2	805
$\phi\pi^+$	[e,h]	(4.5 ±0.4) %		712
$\phi\pi^+,\ \phi \to K^+K^-$	[h]	(2.27±0.08) %		712
$K^+\overline{K}^*(892)^0,\ \overline{K}^{*0} \to K^-\pi^+$		(2.61±0.09) %		416
$f_0(980)\pi^+,\ f_0 \to K^+K^-$		(1.15±0.32) %		732
$f_0(1370)\pi^+,\ f_0 \to K^+K^-$		(7 ±5) $\times 10^{-4}$		–
$f_0(1710)\pi^+,\ f_0 \to K^+K^-$		(6.7 ±2.9) $\times 10^{-4}$		198
$K^+\overline{K}^*_0(1430)^0,\ \overline{K}^*_0 \to K^-\pi^+$		(1.9 ±0.4) $\times 10^{-3}$		218
$K^+ K^0_S \pi^0$		(1.52±0.22) %		805
$2K^0_S\pi^+$		(7.7 ±0.6) $\times 10^{-3}$		802
$K^0\overline{K}^0\pi^+$		—		802
$K^*(892)^+\overline{K}^0$	[e]	(5.4 ±1.2) %		683
$K^+K^-\pi^+\pi^0$		(6.3 ±0.6) %		748
$\phi\rho^+$	[e]	(8.4 $^{+1.9}_{-2.3}$) %		401
$K^0_S K^- 2\pi^+$		(1.68±0.10) %		744
$K^*(892)^+\overline{K}^*(892)^0$	[e]	(7.2 ±2.6) %		416
$K^+ K^0_S \pi^+\pi^-$		(1.00±0.08) %		744
$K^+K^-2\pi^+\pi^-$		(8.7 ±1.5) $\times 10^{-3}$		673
$\phi 2\pi^+\pi^-$	[e]	(1.21±0.16) %		640
$K^+K^-\rho^0\pi^+$ non-ϕ		$< 2.6 \times 10^{-4}$	CL=90%	249
$\phi\rho^0\pi^+,\ \phi \to K^+K^-$		(6.5 ±1.3) $\times 10^{-3}$		181
$\phi a_1(1260)^+,\ \phi \to K^+K^-,\ a_1^+ \to \rho^0\pi^+$		(7.5 ±1.2) $\times 10^{-3}$		†
$K^+K^-2\pi^+\pi^-$ nonresonant		(9 ±7) $\times 10^{-4}$		673
$2K^0_S 2\pi^+\pi^-$		(9 ±4) $\times 10^{-4}$		669

Hadronic modes without K's

$\pi^+\pi^0$		$< 3.5 \times 10^{-4}$	CL=90%	975
$2\pi^+\pi^-$		(1.09±0.05) %	S=1.1	959
$\rho^0\pi^+$		(2.0 ±1.2) $\times 10^{-4}$		825
$\pi^+(\pi^+\pi^-)_{S-\text{wave}}$	[i]	(9.1 ±0.4) $\times 10^{-3}$		959
$f_2(1270)\pi^+,\ f_2 \to \pi^+\pi^-$		(1.10±0.20) $\times 10^{-3}$		559
$\rho(1450)^0\pi^+,\ \rho^0 \to \pi^+\pi^-$		(3.0 ±2.0) $\times 10^{-4}$		421
$\pi^+ 2\pi^0$		(6.5 ±1.3) $\times 10^{-3}$		961
$2\pi^+\pi^-\pi^0$		—		935
$\eta\pi^+$	[e]	(1.70±0.09) %	S=1.1	902
$\omega\pi^+$	[e]	(2.4 ±0.6) $\times 10^{-3}$		822
$3\pi^+ 2\pi^-$		(8.0 ±0.8) $\times 10^{-3}$		899

$2\pi^+\pi^-2\pi^0$		—			902
$\eta\rho^+$	[e]	(8.9 ±0.8) %			724
$\eta\pi^+\pi^0$		(9.2 ±1.2) %			885
$\omega\pi^+\pi^0$	[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±0.25) %			743
$3\pi^+2\pi^-2\pi^0$		—			803
$\omega\eta\pi^+$	[e]	< 2.13	%	CL=90%	654
$\eta'(958)\rho^+$	[d,e]	(5.8 ±1.5) %			465
$\eta'(958)\pi^+\pi^0$		(5.6 ±0.8) %			720
$\eta'(958)\pi^+\pi^0$ nonresonant		< 5.1	%	CL=90%	720

Modes with one or three K's

$K^+\pi^0$		(6.3 ±2.1) $\times 10^{-4}$			917
$K^0_S\pi^+$		(1.22±0.06) $\times 10^{-3}$			916
$K^+\eta$	[e]	(1.77±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
$K^+\pi^+\pi^-$		(6.6 ±0.4) $\times 10^{-3}$			900
$K^+\rho^0$		(2.5 ±0.4) $\times 10^{-3}$			745
$K^+\rho(1450)^0$, $\rho^0\to\pi^+\pi^-$		(7.0 ±2.4) $\times 10^{-4}$			–
$K^*(892)^0\pi^+$, $K^{*0}\to K^+\pi^-$		(1.42±0.24) $\times 10^{-3}$			775
$K^*(1410)^0\pi^+$, $K^{*0}\to K^+\pi^-$		(1.24±0.29) $\times 10^{-3}$			–
$K^*(1430)^0\pi^+$, $K^{*0}\to K^+\pi^-$		(5.0 ±3.5) $\times 10^{-4}$			–
$K^+\pi^+\pi^-$ nonresonant		(1.04±0.34) $\times 10^{-3}$			900
$K^0\pi^+\pi^0$		(1.00±0.18) %			899
$K^0_S 2\pi^+\pi^-$		(3.0 ±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%	366
$2K^+K^-$		(2.18±0.21) $\times 10^{-4}$			628
ϕK^+, $\phi\to K^+K^-$		(8.9 ±2.0) $\times 10^{-5}$			–

Doubly Cabibbo-suppressed modes

$2K^+\pi^-$		(1.27±0.13) $\times 10^{-4}$			805
$K^+K^*(892)^0$, $K^{*0}\to K^+\pi^-$		(6.0 ±3.4) $\times 10^{-5}$			–

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*]	<	4.1	$\times 10^{-7}$	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
$\pi^- 2e^+$	*L*		<	4.1	$\times 10^{-6}$	CL=90%	979
$\pi^- 2\mu^+$	*L*		<	1.2	$\times 10^{-7}$	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 $m = 2112.2 \pm 0.4$ MeV
$m_{D_s^{*\pm}} - m_{D_s^{\pm}} = 143.8 \pm 0.4$ 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)
$D_s^+ \gamma$	(93.5±0.7) %	139
$D_s^+ \pi^0$	(5.8±0.7) %	48
$D_s^+ e^+ e^-$	(6.7±1.6) $\times 10^{-3}$	139

$D^*_{s0}(2317)^\pm$

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

J^P is natural, low mass consistent with 0^+.

Mass $m = 2317.7 \pm 0.6$ MeV (S = 1.1)
$m_{D^*_{s0}(2317)^\pm} - m_{D_s^\pm} = 349.4 \pm 0.6$ 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)
$m_{D_{s1}(2460)^\pm} - m_{D_s^{*\pm}} = 347.3 \pm 0.7$ MeV (S = 1.2)
$m_{D_{s1}(2460)^\pm} - m_{D_s^\pm} = 491.2 \pm 0.6$ 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 $m = 2535.10 \pm 0.06$ 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)	Confidence level	p (MeV/c)
$D^*(2010)^+ K^0$	0.85 ±0.12		149
$(D^*(2010)^+ K^0)_{S-wave}$	0.61 ±0.09		149
$D^+ \pi^- K^+$	0.028±0.005		176
$D^*(2007)^0 K^+$	**DEFINED AS 1**		167
$D^+ K^0$	<0.34	90%	381
$D^0 K^+$	<0.12	90%	391
$D_s^{*+} \gamma$	possibly seen		388
$D_s^+ \pi^+ \pi^-$	seen		437

$D_{s2}^*(2573)$

$I(J^P) = 0(2^+)$

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

Mass $m = 2569.1 \pm 0.8$ MeV (S = 2.4)
Full width $\Gamma = 16.9 \pm 0.8$ MeV

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

$D_{s2}^*(2573)^+$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$D^0 K^+$	seen	431
$D^*(2007)^0 K^+$	not seen	238

$D_{s1}^*(2700)^{\pm}$

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

Mass $m = 2708.3^{+4.0}_{-3.4}$ MeV
Full width $\Gamma = 120 \pm 11$ MeV

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, or K^{*0} — is 5.99 $\pm$ 0.31 %.

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

[*d*] The sum of our exclusive η' fractions — $\eta' e^+\nu_e$, $\eta'\mu^+\nu_\mu$, $\eta'\pi^+$, $\eta'\rho^+$, and $\eta' K^+$ — is 11.8 $\pm$ 1.6%.

[*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.