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

$A_{CP}(\mu^\pm\nu) = (5 \pm 6)\%$
$A_{CP}(K^\pm K_S^0) = (0.09 \pm 0.26)\%$
$A_{CP}(K^\pm K_L^0)$ in $D_s^\pm \to K^\pm K_L^0 = (-1.1 \pm 2.7) \times 10^{-2}$
$A_{CP}(K^+K^-\pi^\pm) = (-0.5 \pm 0.9)\%$
$A_{CP}(\phi\pi^\pm) = (-0.38 \pm 0.27)\%$
$A_{CP}(K^\pm K_S^0\pi^0) = (-2 \pm 6)\%$
$A_{CP}(2K_S^0\pi^\pm) = (3 \pm 5)\%$
$A_{CP}(K^+K^-\pi^\pm\pi^0) = (0.0 \pm 3.0)\%$
$A_{CP}(K^\pm K_S^0\pi^+\pi^-) = (-6 \pm 5)\%$
$A_{CP}(K_S^0 K^\mp 2\pi^\pm) = (4.1 \pm 2.8)\%$
$A_{CP}(\pi^+\pi^-\pi^\pm) = (-0.7 \pm 3.1)\%$
$A_{CP}(\pi^\pm\eta) = (1.1 \pm 3.1)\%$
$A_{CP}(\pi^\pm\eta') = (-0.9 \pm 0.5)\%$
$A_{CP}(\eta\pi^\pm\pi^0) = (-1 \pm 4)\%$
$A_{CP}(\eta'\pi^\pm\pi^0) = (0 \pm 8)\%$
$A_{CP}(K^\pm\pi^0) = (-27 \pm 24)\%$
$A_{CP}(\overline{K}^0/K^0\pi^\pm) = (0.4 \pm 0.5)\%$
$A_{CP}(K_S^0\pi^\pm) = (0.20 \pm 0.18)\%$
$A_{CP}(K^\pm\pi^+\pi^-) = (4 \pm 5)\%$
$A_{CP}(K^\pm\eta) = (9 \pm 15)\%$
$A_{CP}(K^\pm\eta'(958)) = (6 \pm 19)\%$

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)
$r_v = 1.80 \pm 0.08$
$\Gamma_L/\Gamma_T = 0.72 \pm 0.18$
$f_+(0)\,|V_{cs}|$ in $D_s^+ \to \eta e^+ \nu_e = 0.446 \pm 0.007$
$f_+(0)\,|V_{cs}|$ in $D_s^+ \to \eta' e^+ \nu_e = 0.48 \pm 0.05$

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

$f_+(0)|V_{cd}|$ in $D_s^+ \to K^0 e^+ \nu_e = 0.162 \pm 0.019$
$r_v \equiv V(0)/A_1(0)$ in $D_s^+ \to K^*(892)^0 e^+ \nu_e = 1.7 \pm 0.4$
$r_2 \equiv A_2(0)/A_1(0)$ in $D_s^+ \to K^*(892)^0 e^+ \nu_e = 0.77 \pm 0.29$
$f_{D_s^+}\,|V_{cs}|$ in $D_s^+ \to \mu^+ \nu_\mu = 246 \pm 5$ MeV

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

$e^+\nu_e$		$<$	8.3×10^{-5}	CL=90%	984
$\mu^+\nu_\mu$		(	$5.49\pm0.16) \times 10^{-3}$		981
$\tau^+\nu_\tau$		(	$5.48\pm0.23)$ %		182
$\gamma e^+\nu_e$		$<$	1.3×10^{-4}	CL=90%	984
$K^+K^-e^+\nu_e$			—		851
$\phi e^+\nu_e$	[e]	(	$2.39\pm0.16)$ %	S=1.3	720
$\phi\mu^+\nu_\mu$		(	1.9 ± 0.5)%		715
$\eta e^+\nu_e$ + $\eta'(958)e^+\nu_e$	[e]	(	$3.03\pm0.24)$ %		–
$\eta e^+\nu_e$	[e]	(	$2.32\pm0.08)$ %		908
$\eta'(958)e^+\nu_e$	[e]	(	8.0 ± 0.7) $\times 10^{-3}$		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]	$<$	2.0×10^{-3}	CL=90%	829
$K^0e^+\nu_e$		(	3.4 ± 0.4) $\times 10^{-3}$		921
$K^*(892)^0e^+\nu_e$	[e]	(	$2.15\pm0.28) \times 10^{-3}$	S=1.1	782

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

$K^+K^0_S$		(	$1.46\pm0.04)$ %	S=1.1	850
$K^+K^0_L$		(	$1.49\pm0.06)$ %		850
$K^+\overline{K}^0$		(	$2.95\pm0.14)$ %		850
$K^+K^-\pi^+$	[g]	(	$5.39\pm0.15)$ %	S=1.2	805
$\phi\pi^+$	[e,h]	(	4.5 ± 0.4)%		712
$\phi\pi^+$, $\phi\to K^+K^-$	[h]	(	$2.24\pm0.08)$ %		712
$K^+\overline{K}^*(892)^0$, $\overline{K}^{*0}\to K^-\pi^+$		(	$2.58\pm0.08)$ %		416
$f_0(980)\pi^+$, $f_0\to K^+K^-$		(	$1.14\pm0.31)$ %		732
$f_0(1370)\pi^+$, $f_0\to K^+K^-$		(	7 ± 5) $\times 10^{-4}$		–
$f_0(1710)\pi^+$, $f_0\to K^+K^-$		(	6.6 ± 2.8) $\times 10^{-4}$		198
$K^+\overline{K}^*_0(1430)^0$, $\overline{K}^*_0\to K^-\pi^+$		(	1.8 ± 0.4) $\times 10^{-3}$		218
$K^+K^0_S\pi^0$		(	$1.52\pm0.22)$ %		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
$K^+K^-\pi^+\pi^0$		(	6.2 ± 0.6)%	S=1.1	748
$\phi\rho^+$	[e]	(	$8.4\ ^{+1.9}_{-2.3}$)%		401
$K^0_SK^-2\pi^+$		(	$1.65\pm0.10)$ %		744
$K^*(892)^+\overline{K}^*(892)^0$	[e]	(	7.2 ± 2.6)%		417
$K^+K^0_S\pi^+\pi^-$		(	9.9 ± 0.8) $\times 10^{-3}$		744
$K^+K^-2\pi^+\pi^-$		(	8.6 ± 1.5) $\times 10^{-3}$		673
$\phi2\pi^+\pi^-$	[e]	(	$1.21\pm0.16)$ %		640
$\phi\rho^0\pi^+$, $\phi\to K^+K^-$		(	6.5 ± 1.3) $\times 10^{-3}$		181

$\phi a_1(1260)^+,\ \phi \to K^+K^-,\ a_1^+ \to \rho^0\pi^+$		(7.4 ±1.2) × 10^{-3}			†
$\phi 2\pi^+\pi^-$ non-ρ, $\phi \to K^+K^-$		(1.8 ±0.7) × 10^{-3}			–
$K^+K^-\rho^0\pi^+$ non-ϕ		< 2.6 × 10^{-4}		CL=90%	249
$K^+K^-2\pi^+\pi^-$ nonresonant		(9 ±7) × 10^{-4}			673
$2K_S^0 2\pi^+\pi^-$		(8.4 ±3.5) × 10^{-4}			669

Hadronic modes without K's

$\pi^+\pi^0$		< 3.4 × 10^{-4}		CL=90%	975
$2\pi^+\pi^-$		(1.08±0.04) %		S=1.1	959
$\rho^0\pi^+$		(1.9 ±1.2) × 10^{-4}			825
$\pi^+(\pi^+\pi^-)_{S-\text{wave}}$	[i]	(9.0 ±0.4) × 10^{-3}			959
$f_2(1270)\pi^+,\ f_2 \to \pi^+\pi^-$		(1.09±0.20) × 10^{-3}			559
$\rho(1450)^0\pi^+,\ \rho^0 \to \pi^+\pi^-$		(3.0 ±1.9) × 10^{-4}			421
$\pi^+ 2\pi^0$		(6.5 ±1.3) × 10^{-3}			961
$2\pi^+\pi^-\pi^0$		—			935
$\eta\pi^+$	[e]	(1.68±0.10) %		S=1.2	902
$\omega\pi^+$	[e]	(1.92±0.30) × 10^{-3}			822
$3\pi^+ 2\pi^-$		(7.9 ±0.8) × 10^{-3}			899
$2\pi^+\pi^- 2\pi^0$		—			902
$\eta\rho^+$	[e]	(8.9 ±0.8) %			724
$\eta\pi^+\pi^0$		(9.5 ±0.5) %			885
$\eta(\pi^+\pi^0)_{\ P-wave}$		(5.1 ±3.1) × 10^{-3}			885
$a_0(980)^{+0}\pi^{0+},\ a_0(980)^{+0} \to \eta\pi^{+0}$		(2.2 ±0.4) %			–
$\omega\pi^+\pi^0$	[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

$K^+\pi^0$		(6.1 ±2.1) × 10^{-4}			917
$K_S^0\pi^+$		(1.19±0.05) × 10^{-3}			916
$K^+\eta$	[e]	(1.72±0.34) × 10^{-3}			835
$K^+\omega$	[e]	(8.7 ±2.5) × 10^{-4}			741
$K^+\eta'(958)$	[e]	(1.7 ±0.5) × 10^{-3}			646
$K^+\pi^+\pi^-$		(6.5 ±0.4) × 10^{-3}			900
$K^+\rho^0$		(2.5 ±0.4) × 10^{-3}			745

$K^+\rho(1450)^0$, $\rho^0 \to \pi^+\pi^-$		(6.9 ±2.4) × 10^{-4}			–
$K^*(892)^0\pi^+$, $K^{*0} \to K^+\pi^-$		(1.41±0.24) × 10^{-3}			775
$K^*(1410)^0\pi^+$, $K^{*0} \to K^+\pi^-$		(1.23±0.28) × 10^{-3}			–
$K^*(1430)^0\pi^+$, $K^{*0} \to K^+\pi^-$		(5.0 ±3.5) × 10^{-4}			–
$K^+\pi^+\pi^-$ nonresonant		(1.03±0.34) × 10^{-3}			900
$K^0\pi^+\pi^0$		(1.00±0.18) %			899
$K^0_S 2\pi^+\pi^-$		(3.0 ±1.1) × 10^{-3}			870
$K^+\omega\pi^0$	[e]	< 8.2	× 10^{-3}	CL=90%	684
$K^+\omega\pi^+\pi^-$	[e]	< 5.4	× 10^{-3}	CL=90%	603
$K^+\omega\eta$	[e]	< 7.9	× 10^{-3}	CL=90%	366
$2K^+K^-$		(2.16±0.20) × 10^{-4}			628
ϕK^+, $\phi \to K^+K^-$		(8.8 ±2.0) × 10^{-5}			–

Doubly Cabibbo-suppressed modes

$2K^+\pi^-$		(1.28±0.04) × 10^{-4}			805
$K^+K^*(892)^0$, $K^{*0} \to K^+\pi^-$		(6.0 ±3.4) × 10^{-5}			–

Baryon-antibaryon mode

$p\overline{n}$		(1.22±0.11) × 10^{-3}			295
$p\overline{p}e^+\nu_e$		< 2.0	× 10^{-4}	CL=90%	296

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

$\pi^+e^+e^-$		[j]	< 1.3	× 10^{-5}	CL=90%	979
$\pi^+\phi$, $\phi \to e^+e^-$		[k]	(6 $^{+8}_{-4}$) × 10^{-6}			–
$\pi^+\mu^+\mu^-$		[j]	< 4.1	× 10^{-7}	CL=90%	968
$K^+e^+e^-$	*C1*		< 3.7	× 10^{-6}	CL=90%	922
$K^+\mu^+\mu^-$	*C1*		< 2.1	× 10^{-5}	CL=90%	909
$K^*(892)^+\mu^+\mu^-$	*C1*		< 1.4	× 10^{-3}	CL=90%	765
$\pi^+e^+\mu^-$	*LF*		< 1.2	× 10^{-5}	CL=90%	976
$\pi^+e^-\mu^+$	*LF*		< 2.0	× 10^{-5}	CL=90%	976
$K^+e^+\mu^-$	*LF*		< 1.4	× 10^{-5}	CL=90%	919
$K^+e^-\mu^+$	*LF*		< 9.7	× 10^{-6}	CL=90%	919
π^-2e^+	*L*		< 4.1	× 10^{-6}	CL=90%	979
$\pi^-2\mu^+$	*L*		< 1.2	× 10^{-7}	CL=90%	968
$\pi^-e^+\mu^+$	*L*		< 8.4	× 10^{-6}	CL=90%	976
K^-2e^+	*L*		< 5.2	× 10^{-6}	CL=90%	922
$K^-2\mu^+$	*L*		< 1.3	× 10^{-5}	CL=90%	909
$K^-e^+\mu^+$	*L*		< 6.1	× 10^{-6}	CL=90%	919
$K^*(892)^-2\mu^+$	*L*		< 1.4	× 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) × 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 $m = 2317.8 \pm 0.5$ MeV
$m_{D_{s0}^*(2317)^{\pm}} - m_{D_s^{\pm}} = 349.4 \pm 0.5$ MeV
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)	Confidence level	p (MeV/c)
$D_s^+\pi^0$	(100^{+0}_{-20}) %		298
$D_s^+\gamma$	< 5 %	90%	323
$D_s^*(2112)^+\gamma$	< 6 %	90%	–
$D_s^+\gamma\gamma$	< 18 %	95%	323
$D_s^*(2112)^+\pi^0$	< 11 %	90%	–
$D_s^+\pi^+\pi^-$	< 4 × 10^{-3}	90%	194
$D_s^+\pi^0\pi^0$	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 $m = 2535.11 \pm 0.06$ 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
$D^*(2007)^0K^+$	**DEFINED AS 1**		167
D^+K^0	<0.34	90%	381
D^0K^+	<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 $\Gamma = 16.9 \pm 0.7$ 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^0K^+	seen	431
$D^*(2007)^0K^+$	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 ± 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 ± 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.