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

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

$D_s^\pm$
was $F^\pm$

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

Mass $m = 1968.2 \pm 0.5$ MeV   (S = 1.1)
$m_{D_s^\pm} - m_{D^\pm} = 98.85 \pm 0.30$ MeV   (S = 1.4)
Mean life $\tau = (500 \pm 7) \times 10^{-15}$ s   (S = 1.3)
$c\tau = 149.9$ μm

T-violation decay-rate asymmetry

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

D_s^+ form factors

$r_2 = 1.32 \pm 0.24$ (S = 1.2)
$r_v = 1.72 \pm 0.21$
$\Gamma_L/\Gamma_T = 0.72 \pm 0.18$

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			
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) %		−
e^+ anything	(8 $^{+6}_{-5}$) %		−
ϕ anything	(18 $^{+15}_{-10}$) %		−

Leptonic and semileptonic modes

$\mu^+ \nu_\mu$		$(\ 6.1\ \pm\ 1.9\ ) \times 10^{-3}$	S=1.4	981
$\tau^+ \nu_\tau$		$(\ 6.4\ \pm\ 1.5\ )\ \%$		182
$\phi \ell^+ \nu_\ell$	[a]	$(\ 2.4\ \pm\ 0.4\ )\ \%$	S=1.1	720
$\eta \ell^+ \nu_\ell +\ \eta'(958)\ell^+ \nu_\ell$	[a]	$(\ 4.2\ \pm\ 0.8\ )\ \%$		$-$
$\quad \eta \ell^+ \nu_\ell$	[a]	$(\ 3.1\ \pm\ 0.6\ )\ \%$		908
$\quad \eta'(958)\ell^+ \nu_\ell$	[a]	$(\ 1.08 \pm\ 0.35)\ \%$		751

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

$K^+ \overline{K}{}^0$		$(\ 4.4\ \pm\ 0.9\ )\ \%$			850
$K^+ K^- \pi^+$	[b]	$(\ 5.2\ \pm\ 0.9\ )\ \%$	S=1.1		805
$\quad \phi \pi^+$	[c]	$(\ 4.4\ \pm\ 0.6\ )\ \%$	S=1.1		711
$\qquad \phi \pi^+,\ \phi \to\ K^+ K^-$		$(\ 2.16 \pm\ 0.28)\ \%$	S=1.1		712
$\quad K^+ \overline{K}{}^*(892)^0,\ \overline{K}{}^{*0} \to$ $K^- \pi^+$		$(\ 2.5\ \pm\ 0.5\ )\ \%$			416
$\quad f_0(980)\pi^+,\ f_0 \to\ K^+ K^-$		$(\ 5.7\ \pm\ 2.5\ ) \times 10^{-3}$			732
$\quad K^+ \overline{K}{}_0^*(1430)^0,\ \overline{K}{}_0^* \to$ $K^- \pi^+$		$(\ 4.8\ \pm\ 2.5\ ) \times 10^{-3}$			218
$K^0 \overline{K}{}^0 \pi^+$		$-$			802
$\quad K^*(892)^+ \overline{K}{}^0$	[c]	$(\ 5.3\ \pm\ 1.3\ )\ \%$			683
$K^+ K^- \pi^+ \pi^0$		$-$			748
$\quad \phi \pi^+ \pi^0$	[c]	$(11\ \ \pm\ 5\ \ )\ \%$			686
$\quad \phi \rho^+$	[c]	$(\ 8.2\ {}^{+\ 2.0}_{-\ 2.4}\ )\ \%$			401
$\quad \phi \pi^+ \pi^0\ \text{3-body}$	[c]	$<\ 3.1\ \ \ \%$	CL=90%		686
$\quad K^+ K^- \pi^+ \pi^0\ \text{non-}\phi$		$<\ 11\ \ \ \%$	CL=90%		748
$K^+ \overline{K}{}^0 \pi^+ \pi^-$		$(\ 3.1\ \pm\ 0.9\ )\ \%$			744
$K^0 K^- \pi^+ \pi^+$		$(\ 5.3\ \pm\ 1.4\ )\ \%$			744
$\quad K^*(892)^+ \overline{K}{}^*(892)^0$	[c]	$(\ 7.0\ \pm\ 2.7\ )\ \%$			416
$\quad K^0 K^- \pi^+ \pi^+\ (\text{non-}K^{*+} \overline{K}{}^{*0})$		$<\ 3.5\ \ \ \%$	CL=90%		744
$K^+ K^- \pi^+ \pi^+ \pi^-$		$(\ 8.3\ \pm\ 2.0\ ) \times 10^{-3}$			673
$\quad \phi \pi^+ \pi^+ \pi^-$	[c]	$(\ 1.18 \pm\ 0.20)\ \%$			640
$\quad K^+ K^- \rho^0 \pi^+\ \text{non-}\phi$		$<\ 2.5\ \ \ \times 10^{-4}$	CL=90%		248
$\quad \phi \rho^0 \pi^+$	[c]	$(\ 1.24 \pm\ 0.33)\ \%$			181
$\quad \phi a_1(1260)^+$	[c]	$(\ 2.9\ \pm\ 0.7\ )\ \%$			†
$\quad K^+ K^- \pi^+ \pi^+ \pi^-\ \text{nonresonant}$		$(\ 8\ \ \pm\ 7\ \ ) \times 10^{-4}$			673
$K^0_S K^0_S \pi^+ \pi^+ \pi^-$		$(\ 2.7\ \pm\ 1.3\ ) \times 10^{-3}$			669

Hadronic modes without K's

$\pi^+ \pi^+ \pi^-$		$(\ 1.22 \pm\ 0.23)\ \%$	S=1.2		959
$\quad \pi^+ (\pi^+ \pi^-)_{S-\text{wave}}$	[d]	$(\ 1.06 \pm\ 0.22)\ \%$			959
$\quad f_2(1270)\pi^+,\ f_2 \to\ \pi^+ \pi^-$		$(\ 1.2\ \pm\ 0.7\ ) \times 10^{-3}$			559
$\quad \rho(1450)^0 \pi^+,\ \rho^0 \to\ \pi^+ \pi^-$		$(\ 8\ \ \pm\ 7\ \ ) \times 10^{-4}$			421
$\pi^+ \pi^+ \pi^- \pi^0$		$<\ 15\ \ \ \%$	CL=90%		935
$\quad \eta \pi^+$	[c]	$(\ 2.11 \pm\ 0.35)\ \%$			902
$\quad \omega \pi^+$	[c]	$(\ 3.4\ \pm\ 1.2\ ) \times 10^{-3}$			822

$3\pi^+ 2\pi^-$		$(7.6 \pm 1.6) \times 10^{-3}$		899
$\pi^+ \pi^+ \pi^- \pi^0 \pi^0$		—		902
$\eta \rho^+$	[c]	$(13.1 \pm 2.6)\%$		724
$\eta \pi^+ \pi^0$ 3-body	[c]	$< 5 \quad \%$	CL=90%	885
$3\pi^+ 2\pi^- \pi^0$		$(4.9 \pm 3.2)\%$		856
$\eta'(958)\pi^+$	[c]	$(4.7 \pm 0.7)\%$		743
$3\pi^+ 2\pi^- 2\pi^0$		—		803
$\eta'(958)\rho^+$	[c]	$(12.2 \pm 2.4)\%$		464
$\eta'(958)\pi^+ \pi^0$ 3-body	[c]	$< 1.8 \quad \%$	CL=90%	720

Modes with one or three K's

$K^0 \pi^+$		$< 9 \quad \times 10^{-3}$	CL=90%	916
$K^+ \pi^+ \pi^-$		$(6.6 \pm 1.4) \times 10^{-3}$		900
$K^+ \rho^0$		$(2.6 \pm 0.7) \times 10^{-3}$		744
$K^+ \rho(1450)^0, \rho^0 \to \pi^+ \pi^-$		$(7.0 \pm 2.9) \times 10^{-4}$		–
$K^*(892)^0 \pi^+, K^{*0} \to K^+ \pi^-$		$(1.4 \pm 0.4) \times 10^{-3}$		775
$K^*(1410)^0 \pi^+, K^{*0} \to K^+ \pi^-$		$(1.2 \pm 0.4) \times 10^{-3}$		–
$K^*(1430)^0 \pi^+, K^{*0} \to K^+ \pi^-$		$(5 \pm 4) \times 10^{-4}$		–
$K^+ \pi^+ \pi^-$ nonresonant		$(1.0 \pm 0.4) \times 10^{-3}$		900
$K^+ K^+ K^-$		$(4.6 \pm 1.8) \times 10^{-4}$		627
ϕK^+	[c]	$< 6 \quad \times 10^{-4}$	CL=90%	606

Doubly Cabibbo-suppressed modes

$K^+ K^+ \pi^-$	$(2.7 \pm 1.2) \times 10^{-4}$		805

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

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

$$\boxed{D_s^{*\pm}} \qquad\qquad I(J^P) = 0(?^?)$$

J^P is natural, width and decay modes consistent with 1^-.

Mass $m = 2112.0 \pm 0.6$ MeV $\quad$ (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

$$\boxed{D_{s0}^*(2317)^{\pm}} \qquad\qquad I(J^P) = 0(0^+)$$

J, P need confirmation.

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

Mass $m = 2317.3 \pm 0.6$ MeV

$m_{D_{s0}^*(2317)^{\pm}} - m_{D_s^{\pm}} = 349.1 \pm 0.6$ MeV

Full width $\Gamma < 4.6$ MeV, CL = 90%

$$\boxed{D_{s1}(2460)^{\pm}} \qquad\qquad I(J^P) = 0(1^+)$$

Mass $m = 2458.9 \pm 0.9$ MeV $\quad$ (S = 1.1)

$m_{D_{s1}(2460)^{\pm}} - m_{D_s^{*\pm}} = 346.9 \pm 1.0$ MeV $\quad$ (S = 1.2)

$m_{D_{s1}(2460)^{\pm}} - m_{D_s^{\pm}} = 490.7 \pm 0.9$ MeV $\quad$ (S = 1.2)

Full width $\Gamma < 5.5$ MeV, CL = 90%

$$\boxed{D_{s1}(2536)^{\pm}} \qquad\qquad I(J^P) = 0(1^+)$$

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	150
$D^*(2007)^0 K^+$	seen	168
$D^+ K^0$	not seen	382
$D^0 K^+$	not seen	392
$D_s^{*+} \gamma$	possibly seen	388

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

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

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

Mass $m = 2573.5 \pm 1.7$ MeV
Full width $\Gamma = 15^{+5}_{-4}$ 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	436
$D^*(2007)^0 K^+$	not seen	246

NOTES

[a] 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*.

[b] 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.

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

[d] 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.

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

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