

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

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

D_s^\pm
was F^\pm

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

$$\text{Mass } m = 1968.2 \pm 0.5 \text{ MeV} \quad (S = 1.1)$$

$$m_{D_s^\pm} - m_{D^\pm} = 98.85 \pm 0.30 \text{ MeV} \quad (S = 1.4)$$

$$\text{Mean life } \tau = (500 \pm 7) \times 10^{-15} \text{ s} \quad (S = 1.3)$$

$$c\tau = 149.9 \mu\text{m}$$

T-violation decay-rate asymmetry

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

D_s^+ form factors

$$r_2 = 1.32 \pm 0.24 \quad (S = 1.2)$$

$$r_V = 1.72 \pm 0.21$$

$$\Gamma_L/\Gamma_T = 0.72 \pm 0.18$$

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 $\begin{smallmatrix} +14 \\ -12 \end{smallmatrix}$) %		—
\bar{K}^0 anything + K^0 anything	(39 ± 28) %		—
K^+ anything	(20 $\begin{smallmatrix} +18 \\ -14 \end{smallmatrix}$) %		—
(non- K \bar{K}) anything	(64 ± 17) %		—
e^+ anything	(8 $\begin{smallmatrix} + 6 \\ - 5 \end{smallmatrix}$) %		—
ϕ anything	(18 $\begin{smallmatrix} +15 \\ -10 \end{smallmatrix}$) %		—

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) %		—
$\eta \ell^+ \nu_\ell$	[a] (3.1 \pm 0.6) %		908
$\eta'(958) \ell^+ \nu_\ell$	[a] (1.08 \pm 0.35) %		751

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

$K^+ \bar{K}^0$	(4.4 \pm 0.9) %		850
$K^+ K^- \pi^+$	[b] (5.2 \pm 0.9) %	S=1.1	805
$\phi \pi^+$	[c] (4.4 \pm 0.6) %	S=1.1	711
$\phi \pi^+, \phi \rightarrow K^+ K^-$	(2.16 \pm 0.28) %	S=1.1	712
$K^+ \bar{K}^*(892)^0, \bar{K}^{*0} \rightarrow K^- \pi^+$	(2.5 \pm 0.5) %		416
$f_0(980) \pi^+, f_0 \rightarrow K^+ K^-$	(5.7 \pm 2.5) $\times 10^{-3}$		732
$K^+ \bar{K}_0^*(1430)^0, \bar{K}_0^* \rightarrow K^- \pi^+$	(4.8 \pm 2.5) $\times 10^{-3}$		218
$K^0 \bar{K}^0 \pi^+$	—		802
$K^*(892)^+ \bar{K}^0$	[c] (5.3 \pm 1.3) %		683
$K^+ K^- \pi^+ \pi^0$	—		748
$\phi \pi^+ \pi^0$	[c] (11 \pm 5) %		686
$\phi \rho^+$	[c] (8.2 $^{+2.0}_{-2.4}$) %		401
$\phi \pi^+ \pi^0$ 3-body	[c] < 3.1 %	CL=90%	686
$K^+ K^- \pi^+ \pi^0$ non- ϕ	< 11 %	CL=90%	748
$K^+ \bar{K}^0 \pi^+ \pi^-$	(3.1 \pm 0.9) %		744
$K^0 K^- \pi^+ \pi^+$	(5.3 \pm 1.4) %		744
$K^*(892)^+ \bar{K}^*(892)^0$	[c] (7.0 \pm 2.7) %		416
$K^0 K^- \pi^+ \pi^+$ (non- $K^* + \bar{K}^{*0}$)	< 3.5 %	CL=90%	744
$K^+ K^- \pi^+ \pi^+ \pi^-$	(8.3 \pm 2.0) $\times 10^{-3}$		673
$\phi \pi^+ \pi^+ \pi^-$	[c] (1.18 \pm 0.20) %		640
$K^+ K^- \rho^0 \pi^+$ non- ϕ	< 2.5 $\times 10^{-4}$	CL=90%	248
$\phi \rho^0 \pi^+$	[c] (1.24 \pm 0.33) %		181
$\phi a_1(1260)^+$	[c] (2.9 \pm 0.7) %		†
$K^+ K^- \pi^+ \pi^+ \pi^-$ nonresonant	(8 \pm 7) $\times 10^{-4}$		673
$K_S^0 K_S^0 \pi^+ \pi^+ \pi^-$	(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
$\pi^+ (\pi^+ \pi^-)_{S\text{-wave}}$	[d] (1.06 \pm 0.22) %		959
$f_2(1270) \pi^+, f_2 \rightarrow \pi^+ \pi^-$	(1.2 \pm 0.7) $\times 10^{-3}$		559
$\rho(1450)^0 \pi^+, \rho^0 \rightarrow \pi^+ \pi^-$	(8 \pm 7) $\times 10^{-4}$		421
$\pi^+ \pi^+ \pi^- \pi^0$	< 15 %	CL=90%	935
$\eta \pi^+$	[c] (2.11 \pm 0.35) %		902
$\omega \pi^+$	[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]	$< 5 \%$	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]	$< 1.8 \%$	CL=90%	720

Modes with one or three K's

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

Doubly Cabibbo-suppressed modes

$K^+ K^+ \pi^-$		$(2.7 \pm 1.2) \times 10^{-4}$		805
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$\Delta C = 1$ weak neutral current (C1) modes, Lepton family number (LF), or Lepton number (L) violating modes

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

$$\text{Mass } m = 2112.0 \pm 0.6 \text{ MeV} \quad (S = 1.1)$$

$$m_{D_s^{*\pm}} - m_{D_s^\pm} = 143.8 \pm 0.4 \text{ MeV}$$

$$\text{Full width } \Gamma < 1.9 \text{ MeV, CL} = 90\%$$

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^+ .

$$\text{Mass } m = 2317.3 \pm 0.6 \text{ MeV}$$

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

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

$D_{s1}(2460)^\pm$

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

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

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

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

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

$D_{s1}(2536)^\pm$

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

J, P need confirmation.

$$\text{Mass } m = 2535.35 \pm 0.34 \pm 0.5 \text{ MeV}$$

$$\text{Full width } \Gamma < 2.3 \text{ MeV, CL} = 90\%$$

$D_{s1}(2536)^-$ 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 $\Gamma = 15_{-4}^{+5}$ 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.