

# 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  $F^\pm$

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

Mass  $m = 1968.3 \pm 0.5$  MeV ( $S = 1.2$ )  
 $m_{D_s^\pm} - m_{D^\pm} = 98.87 \pm 0.31$  MeV ( $S = 1.4$ )  
 Mean life  $\tau = (490 \pm 9) \times 10^{-15}$  s ( $S = 1.1$ )  
 $c\tau = 147.0$   $\mu\text{m}$

### $D_s^+$ form factors

$r_2 = 1.60 \pm 0.24$   
 $r_V = 1.92 \pm 0.32$   
 $\Gamma_L/\Gamma_T = 0.72 \pm 0.18$

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 ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
<b>Inclusive modes</b>			
$K^-$ anything	(13 $^{+14}_{-12}$ ) %		—
$\bar{K}^0$ anything + $K^0$ anything	(39 $\pm 28$ ) %		—
$K^+$ anything	(20 $^{+18}_{-14}$ ) %		—
(non- $K$ $\bar{K}$ ) anything	(64 $\pm 17$ ) %		—
$e^+$ anything	( 8 $^{+6}_{-5}$ ) %		—
$\phi$ anything	(18 $^{+15}_{-10}$ ) %		—
<b>Leptonic and semileptonic modes</b>			
$\mu^+ \nu_\mu$	( 5.0 $\pm$ 1.9 ) $\times 10^{-3}$	S=1.3	981
$\tau^+ \nu_\tau$	( 6.4 $\pm$ 1.5 ) %		182
$\phi \ell^+ \nu_\ell$	[a] ( 2.0 $\pm$ 0.5 ) %		720
$\eta \ell^+ \nu_\ell + \eta'(958) \ell^+ \nu_\ell$	[a] ( 3.4 $\pm$ 1.0 ) %		—
$\eta \ell^+ \nu_\ell$	[a] ( 2.5 $\pm$ 0.7 ) %		908
$\eta'(958) \ell^+ \nu_\ell$	[a] ( 8.9 $\pm$ 3.3 ) $\times 10^{-3}$		751

### Hadronic modes with a $K\bar{K}$ pair (including from a $\phi$ )

$K^+\bar{K}^0$	( 3.6 ± 1.1 ) %		850
$K^+K^-\pi^+$	[b] ( 4.4 ± 1.2 ) %		805
$\phi\pi^+$	[c] ( 3.6 ± 0.9 ) %		712
$K^+\bar{K}^*(892)^0$	[c] ( 3.3 ± 0.9 ) %		685
$f_0(980)\pi^+$	[d] ( 4.9 ± 2.3 ) × 10 <sup>-3</sup>		732
× B( $f_0 \rightarrow K^+K^-$ )			
$K^+\bar{K}_0^*(1430)^0$	[c] ( 7 ± 4 ) × 10 <sup>-3</sup>		218
$K^+K^-\pi^+$ nonresonant	( 9 ± 4 ) × 10 <sup>-3</sup>		805
$K^0\bar{K}^0\pi^+$	—		802
$K^*(892)^+\bar{K}^0$	[c] ( 4.3 ± 1.4 ) %		683
$K^+K^-\pi^+\pi^0$	—		748
$\phi\pi^+\pi^0$	[c] ( 9 ± 5 ) %		686
$\phi\rho^+$	[c] ( 6.7 ± 2.3 ) %		400
$\phi\pi^+\pi^0$ 3-body	[c] < 2.6 %	CL=90%	686
$K^+K^-\pi^+\pi^0$ non- $\phi$	< 9 %	CL=90%	748
$K^+\bar{K}^0\pi^+\pi^-$	( 2.5 ± 0.9 ) %		744
$K^0K^-\pi^+\pi^+$	( 4.3 ± 1.5 ) %		744
$K^*(892)^+\bar{K}^*(892)^0$	[c] ( 5.8 ± 2.5 ) %		416
$K^0K^-\pi^+\pi^+$ (non- $K^*\bar{K}^{*0}$ )	< 2.9 %	CL=90%	744
$K^+K^-\pi^+\pi^+\pi^-$	( 7.1 ± 2.2 ) × 10 <sup>-3</sup>		673
$\phi\pi^+\pi^+\pi^-$	[c] ( 9.7 ± 2.6 ) × 10 <sup>-3</sup>		640
$K^+K^-\rho^0\pi^+$ non- $\phi$	< 2.1 × 10 <sup>-4</sup>	CL=90%	248
$\phi\rho^0\pi^+$	[c] ( 1.06 ± 0.35 ) %		180
$\phi a_1(1260)^+$	[c] ( 2.5 ± 0.8 ) %		†
$K^+K^-\pi^+\pi^+\pi^-$ nonresonant	( 7 ± 6 ) × 10 <sup>-4</sup>		673

### Hadronic modes without $K$ 's

$\pi^+\pi^+\pi^-$	( 1.01 ± 0.28 ) %	S=1.1	959
$\rho^0\pi^+$	< 7 × 10 <sup>-4</sup>	CL=90%	824
$f_0(980)\pi^+$	[e] ( 5.7 ± 1.7 ) × 10 <sup>-3</sup>		732
× B( $f_0 \rightarrow \pi^+\pi^-$ )			
$f_2(1270)\pi^+$	[c] ( 3.5 ± 1.2 ) × 10 <sup>-3</sup>		559
$f_0(1370)\pi^+$	[e] ( 3.3 ± 1.2 ) × 10 <sup>-3</sup>		493
× B( $f_0 \rightarrow \pi^+\pi^-$ )			
$\rho(1450)^0\pi^+$	[e] ( 4.4 ± 2.5 ) × 10 <sup>-4</sup>		421
× B( $\rho^0 \rightarrow \pi^+\pi^-$ )			
$\pi^+\pi^+\pi^-$ nonresonant	( 5 $^{+22}_{-5}$ ) × 10 <sup>-5</sup>		959
$\pi^+\pi^+\pi^-\pi^0$	< 12 %	CL=90%	935
$\eta\pi^+$	[c] ( 1.7 ± 0.5 ) %		902
$\omega\pi^+$	[c] ( 2.8 ± 1.1 ) × 10 <sup>-3</sup>		822
$3\pi^+2\pi^-$	( 6.5 ± 1.8 ) × 10 <sup>-3</sup>		899
$\pi^+\pi^+\pi^-\pi^0\pi^0$	—		902

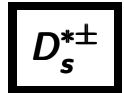
$\eta\rho^+$	[c]	$(10.8 \pm 3.1) \%$		723
$\eta\pi^+\pi^0$ 3-body	[c]	$< 4 \%$	CL=90%	885
$3\pi^+2\pi^-\pi^0$		$(4.9 \pm 3.2) \%$		856
$\eta'(958)\pi^+$	[c]	$(3.9 \pm 1.0) \%$		743
$3\pi^+2\pi^-\pi^0$		—		803
$\eta'(958)\rho^+$	[c]	$(10.1 \pm 2.8) \%$		464
$\eta'(958)\pi^+\pi^0$ 3-body	[c]	$< 1.4 \%$	CL=90%	720

**Modes with one or three K's**

$K^0\pi^+$		$< 8 \times 10^{-3}$	CL=90%	916
$K^+\pi^+\pi^-$		$(1.0 \pm 0.4) \%$		900
$K^+\rho^0$		$< 2.9 \times 10^{-3}$	CL=90%	744
$K^*(892)^0\pi^+$	[c]	$(6.5 \pm 2.8) \times 10^{-3}$		775
$K^+K^+K^-$		$(4.0 \pm 1.7) \times 10^{-4}$		627
$\phi K^+$	[c]	$< 5 \times 10^{-4}$	CL=90%	607

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

$\pi^+e^+e^-$		[f]	$< 2.7 \times 10^{-4}$	CL=90%	979
$\pi^+\mu^+\mu^-$		[f]	$< 2.6 \times 10^{-5}$	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	[g]	$< 6.1 \times 10^{-4}$	CL=90%	976
$K^+e^\pm\mu^\mp$	LF	[g]	$< 6.3 \times 10^{-4}$	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



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

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

Mass  $m = 2112.1 \pm 0.7$  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 ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$D_s^+ \gamma$	(94.2±2.5) %	139
$D_s^+ \pi^0$	( 5.8±2.5) %	48

### $D_{sJ}^*(2317)^\pm$

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

$J, P$  need confirmation.

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

$$\text{Mass } m = 2317.4 \pm 0.9 \text{ MeV} \quad (S = 1.1)$$

$$m_{D_{sJ}^*(2317)^\pm} - m_{D_s^\pm} = 349.2 \pm 0.7 \text{ MeV}$$

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

### $D_{sJ}(2460)^\pm$

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

$$\text{Mass } m = 2459.3 \pm 1.3 \text{ MeV} \quad (S = 1.3)$$

$$m_{D_{sJ}(2460)^\pm} - m_{D_s^{*\pm}} = 347.2 \pm 1.2 \text{ MeV} \quad (S = 1.3)$$

$$m_{D_{sJ}(2460)^\pm} - m_{D_s^\pm} = 491.0 \pm 1.2 \text{ MeV} \quad (S = 1.3)$$

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

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

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

$J, P$  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 ( $\Gamma_i/\Gamma$ )	$p$ (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  $m = 2572.4 \pm 1.5$  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 ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$D^0 K^+$	seen	435
$D^*(2007)^0 K^+$	not seen	244

### 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 value includes only  $K^+ K^-$  decays of the intermediate resonance, because branching fractions of this resonance are not known.
- [e] This value includes only  $\pi^+ \pi^-$  decays of the intermediate resonance, because branching fractions of this resonance are not known.
- [f] This mode is not a useful test for a  $\Delta C=1$  weak neutral current because both quarks must change flavor in this decay.
- [g] The value is for the sum of the charge states or particle/antiparticle states indicated.