

CHARMED, STRANGE MESONS

($C = \pm 1, S = \pm 1$)

(including possibly non- $q\bar{q}$ states)

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

$D_s^\pm$

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

$$\text{Mass } m = 1968.35 \pm 0.07 \text{ MeV}$$

$$m_{D_s^\pm} - m_{D^\pm} = 98.69 \pm 0.05 \text{ MeV}$$

$$\text{Mean life } \tau = (501.2 \pm 2.2) \times 10^{-15} \text{ s} \quad (S = 1.3)$$

$$c\tau = 150.3 \text{ } \mu\text{m}$$

CP-violating decay-rate asymmetries

$$A_{CP}(\mu^\pm \nu) = (-0.2 \pm 2.5)\%$$

$$A_{CP}(\tau^\pm \nu) \text{ in } D_s^+ \rightarrow \tau^+ \nu_\tau, D_s^- \rightarrow \tau^- \bar{\nu}_\tau = (3 \pm 5)\%$$

$$A_{CP}(K^\pm K_S^0) = (0.07 \pm 0.24)\%$$

$$A_{CP}(K^\pm K_L^0) \text{ in } D_s^\pm \rightarrow K^\pm K_L^0 = (-1.1 \pm 2.7) \times 10^{-2}$$

$$A_{CP}(K^+ K^- \pi^\pm) = (0.35 \pm 0.34)\%$$

$$A_{CP}(\phi \pi^\pm) = (-0.38 \pm 0.27)\%$$

$$A_{CP}(K^\pm K_S^0 \pi^0) = (-0.9 \pm 1.9)\%$$

$$A_{CP}(2K_S^0 \pi^\pm) = (1.3 \pm 1.6)\%$$

$$A_{CP}(K^+ K^- \pi^\pm \pi^0) = (-0.6 \pm 0.9)\%$$

$$A_{CP}(K^\pm K_S^0 \pi^+ \pi^-) = (0.7 \pm 2.9)\% \quad (S = 1.3)$$

$$A_{CP}(K_S^0 K^\mp 2\pi^\pm) = (0.7 \pm 1.8)\% \quad (S = 1.3)$$

$$A_{CP}(\pi^+ \pi^- \pi^\pm) = (-0.9 \pm 1.1)\%$$

$$A_{CP}(\pi^\pm \eta) = (0.24 \pm 0.29)\%$$

$$A_{CP}(\pi^\pm \pi^+ \pi^- \eta) = (2.4 \pm 3.0)\%$$

$$A_{CP}(\pi^\pm \eta') = (-0.08 \pm 0.17)\% \quad (S = 1.2)$$

$$A_{CP}(\eta \pi^\pm \pi^0) = (0.9 \pm 1.5)\%$$

$$A_{CP}(\eta' \pi^\pm \pi^0) = (-1.5 \pm 2.5)\%$$

$$A_{CP}(K^\pm \pi^0) = (2 \pm 4)\% \quad (S = 1.2)$$

$$A_{CP}(\bar{K}^0 / K^0 \pi^\pm) = (0.4 \pm 0.5)\%$$

$$A_{CP}(K_S^0 \pi^\pm) = (0.20 \pm 0.18)\%$$

$$A_{CP}(K^\pm \pi^+ \pi^-) = (2.2 \pm 1.9)\%$$

$$A_{CP}(K_S^0 \pi^+ \pi^0) \text{ in } D_s^\pm \rightarrow K_S^0 \pi^\pm \pi^0 = (-2 \pm 5)\%$$

$$A_{CP}(K^\pm \pi^+ \pi^- \pi^0) \text{ in } D_s^\pm \rightarrow K^\pm \pi^+ \pi^- \pi^0 = (7 \pm 5) \times 10^{-2}$$

$$A_{CP}(K^\pm \eta) = (1.8 \pm 1.9)\%$$

$$A_{CP}(K^\pm \eta'(958)) = (6 \pm 19)\%$$

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

$$A_T(K_S^0 K^\pm \pi^+ \pi^-) = (-8 \pm 6) \times 10^{-3} [a]$$

 $D_s^+ \rightarrow \phi \ell^+ \nu_\ell$ form factors

$$r_2 = 0.83 \pm 0.08 \quad (S = 1.8)$$

$$r_v = 1.76 \pm 0.07 \quad (S = 1.1)$$

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

$$f_+(0) |V_{cs}| \text{ in } D_s^+ \rightarrow \eta e^+ \nu_e = 0.449 \pm 0.009$$

$$f_+(0) |V_{cs}| \text{ in } D_s^+ \rightarrow \eta \mu^+ \nu_\mu = 0.452 \pm 0.012$$

$$r_1 \equiv a_1/a_0 \text{ in } D_s^+ \rightarrow \eta \mu^+ \nu_\mu = -2.9 \pm 0.6$$

$$\langle A_{FB}^\eta \rangle \text{ in } D_s^+ \rightarrow \eta \mu^+ \nu_\mu = (-5.9 \pm 3.1) \times 10^{-2}$$

$$f_+(0) |V_{cs}| \text{ in } D_s^+ \rightarrow \eta' e^+ \nu_e = 0.527 \pm 0.024$$

$$r_1 \equiv a_1/a_0 \text{ in } D_s^+ \rightarrow \eta' \mu^+ \nu_\mu = -11 \pm 5$$

$$\langle A_{FB}^{\eta'} \rangle \text{ in } D_s^+ \rightarrow \eta' \mu^+ \nu_\mu = (-6 \pm 8) \times 10^{-2}$$

$$f_+(0) |V_{cs}| \text{ in } D_s^+ \rightarrow \eta' \mu^+ \nu_\mu = 0.50 \pm 0.04$$

$$f_+(0) |V_{cs}| \text{ in } D_s^+ \rightarrow f_0(980) e^+ \nu_e = 0.50 \pm 0.04$$

$$f_+(0) |V_{cd}| \text{ in } D_s^+ \rightarrow K^0 e^+ \nu_e = 0.145 \pm 0.010$$

$$r_v \equiv V(0)/A_1(0) \text{ in } D_s^+ \rightarrow K^*(892)^0 e^+ \nu_e = 1.7 \pm 0.4$$

$$r_2 \equiv A_2(0)/A_1(0) \text{ in } D_s^+ \rightarrow K^*(892)^0 e^+ \nu_e = 0.77 \pm 0.29$$

$$f_{D_s^+} |V_{cs}| \text{ in } D_s^+ \rightarrow \mu^+ \nu_\mu = 242.7 \pm 3.0 \text{ MeV}$$

$$f_{D_s^+} |V_{cs}| \text{ in } D_s^+ \rightarrow \tau^+ \nu_\tau = 247.5 \pm 2.3 \text{ MeV}$$

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] (6.33 $\pm$ 0.15) %		—
π^+ anything	(119.3 $\pm$ 1.4) %		—
π^- anything	(43.2 $\pm$ 0.9) %		—
π^0 anything	(123 $\pm$ 7) %		—
K^- anything	(18.7 $\pm$ 0.5) %		—
K^+ anything	(28.9 $\pm$ 0.7) %		—
K_S^0 anything	(19.0 $\pm$ 1.1) %		—
η anything	[c] (29.9 $\pm$ 2.8) %		—
ω anything	(6.1 $\pm$ 1.4) %		—
η' anything	[d] (10.3 $\pm$ 1.4) %	S=1.1	—
$f_0(980)$ anything, $f_0 \rightarrow \pi^+ \pi^-$	< 1.3 %	CL=90%	—
ϕ anything	(15.7 $\pm$ 1.0) %		—

$K^+ K^-$ anything	(15.8 $\pm$ 0.7) %	—
$K_S^0 K^+$ anything	(5.8 $\pm$ 0.5) %	—
$K_S^0 K^-$ anything	(1.9 $\pm$ 0.4) %	—
$2K_S^0$ anything	(1.70 $\pm$ 0.32) %	—
$2K^+$ anything	< 2.6 $\times 10^{-3}$ CL=90%	—
$2K^-$ anything	< 6 $\times 10^{-4}$ CL=90%	—
$2\pi^+ \pi^- +$ anything	(32.8 $\pm$ 0.7) %	—

Leptonic and semileptonic modes

$e^+ \nu_e$	< 8.3 $\times 10^{-5}$ CL=90%	984
$\mu^+ \nu_\mu$	(5.37 $\pm$ 0.11) $\times 10^{-3}$	981
$\tau^+ \nu_\tau$	(5.39 $\pm$ 0.09) %	182
$\gamma e^+ \nu_e$	< 1.3 $\times 10^{-4}$ CL=90%	984
$K^+ K^- e^+ \nu_e$	—	851
$K_S^0 K_S^0 e^+ \nu_e$	< 3.8 $\times 10^{-4}$ CL=90%	849
$\phi e^+ \nu_e$	[e] (2.34 $\pm$ 0.12) % S=1.2	720
$K_1(1270)^0 e^+ \nu_e$	< 4.1 $\times 10^{-4}$ CL=90%	585
$b_1(1235)^0 e^+ \nu_e, b_1^0 \rightarrow \omega \pi^0$	< 6.4 $\times 10^{-4}$ CL=90%	—
$\phi \mu^+ \nu_\mu$	(2.24 $\pm$ 0.11) %	715
$\eta e^+ \nu_e$	[e] (2.27 $\pm$ 0.06) %	908
$\eta'(958) e^+ \nu_e$	[e] (8.1 $\pm$ 0.4) $\times 10^{-3}$	751
$\eta \mu^+ \nu_\mu$	(2.24 $\pm$ 0.07) %	905
$\eta'(958) \mu^+ \nu_\mu$	(8.0 $\pm$ 0.6) $\times 10^{-3}$	747
$\omega e^+ \nu_e$	[f] < 2.0 $\times 10^{-3}$ CL=90%	829
$K^0 e^+ \nu_e$	(2.88 $\pm$ 0.26) $\times 10^{-3}$ S=1.2	921
$K^*(892)^0 e^+ \nu_e$	[e] (2.05 $\pm$ 0.20) $\times 10^{-3}$	782
$f_0(500) e^+ \nu_e, f_0 \rightarrow \pi^0 \pi^0$	< 7.3 $\times 10^{-4}$ CL=90%	—
$f_0(500) e^+ \nu_e, f_0 \rightarrow \pi^+ \pi^-$	< 3.3 $\times 10^{-4}$ CL=90%	—
$f_0(980) e^+ \nu_e, f_0 \rightarrow \pi^0 \pi^0$	(7.9 $\pm$ 1.5) $\times 10^{-4}$	—
$f_0(980) e^+ \nu_e, f_0 \rightarrow \pi^+ \pi^-$	(1.64 $\pm$ 0.13) $\times 10^{-3}$	—
$f_0(980) \mu^+ \nu_\mu, f_0 \rightarrow K^+ K^-$	< 5.45 $\times 10^{-4}$ CL=90%	—
$a_0(980)^0 e^+ \nu_e, a_0^0 \rightarrow \pi^0 \eta$	< 1.2 $\times 10^{-4}$ CL=90%	—
$\pi^0 e^+ \nu_e$	< 6.4 $\times 10^{-5}$ CL=90%	980

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

$K^+ K_S^0$	(1.500 $\pm$ 0.014) %	850
$K^+ K_L^0$	(1.49 $\pm$ 0.06) %	850
$K^+ \bar{K}^0$	(2.95 $\pm$ 0.14) %	850
$K^+ K^- \pi^+$	[g] (5.45 $\pm$ 0.08) % S=1.3	805
$\phi \pi^+$	[e,h] (4.5 $\pm$ 0.4) %	712
$\phi \pi^+, \phi \rightarrow K^+ K^-$	[h] (2.25 $\pm$ 0.05) %	712
$K^+ \bar{K}^*(892)^0$	(12.7 $^{+4.0}_{-3.1}$) %	685
$K^+ \bar{K}^*(892)^0, \bar{K}^{*0} \rightarrow K^- \pi^+$	(2.61 $\pm$ 0.05) %	416

$K^+ \bar{K}^*(892)^0, \bar{K}^{*0} \rightarrow K_S^0 \pi^0$	(4.8 ±0.4) × 10 ⁻³	—
$f_0(980) \pi^+, f_0 \rightarrow K^+ K^-$	(1.12 ±0.19) %	732
$f_0(1370) \pi^+, f_0 \rightarrow K^+ K^-$	(7.2 ±3.0) × 10 ⁻⁴	—
$f_0(1710) \pi^+, f_0 \rightarrow K^+ K^-$	(6.8 ±2.8) × 10 ⁻⁴	198
$a_0(980)^+ \pi^0, a_0^+ \rightarrow K^+ K_S^0$	(1.1 ±0.4) × 10 ⁻³	—
$a_0(1710)^+ \pi^0, a_0^+ \rightarrow K^+ K_S^0$	(3.5 ±0.6) × 10 ⁻³	—
$K^+ \bar{K}_0^*(1430)^0, \bar{K}_0^{*0} \rightarrow K^- \pi^+$	(1.79 ±0.26) × 10 ⁻³	218
$K^+ \bar{K}^*(1410)^0, \bar{K}_0^{*0} \rightarrow K_S^0 \pi^0$	(8.8 ±2.8) × 10 ⁻⁴	—
$K^+ K_S^0 \pi^0$	(1.471 ±0.028) %	805
$K^*(892)^+ K_S^0, K^{*+} \rightarrow K^+ \pi^0$	(2.04 ±0.32) × 10 ⁻³	—
$2K_S^0 \pi^+$	(7.32 ±0.14) × 10 ⁻³	802
$f_0(980) \pi^+, f_0 \rightarrow K_S^0 K_S^0$	< 1.8 × 10 ⁻⁴ CL=90%	—
$f_0(1710) \pi^+, f_0 \rightarrow K_S^0 K_S^0$	(3.39 ±0.31) × 10 ⁻³	—
$K^*(892)^+ K_S^0, K^{*+} \rightarrow K_S^0 \pi^+$	(3.19 ±0.29) × 10 ⁻³	683
$K^0 \bar{K}^0 \pi^+$	—	802
$K^*(892)^+ \bar{K}^0$	[e] (5.4 ±1.2) %	683
$K^+ K^- \pi^+ \pi^0$	(5.53 ±0.15) % S=1.3	748
$\phi \rho^+$	[e] (5.59 ±0.34) %	401
$\bar{K}_1(1270)^0 K^+, \bar{K}_1(1270)^0 \rightarrow K^- \rho^+$	(5.7 ±0.6) × 10 ⁻³	—
$\bar{K}_1(1270)^0 K^+, \bar{K}_1(1270)^0 \rightarrow K^*(892) \pi$	(1.31 ±0.25) %	—
$\bar{K}_1(1400)^0 K^+, \bar{K}_1(1400)^0 \rightarrow K^*(892) \pi$	(2.0 ±0.4) %	—
$a_0(980)^0 \rho^+, a_0^0 \rightarrow K^+ K^-$	(1.9 ±0.4) × 10 ⁻³	—
$f_1(1420)^0 \pi^+, f_1(1420)^0 \rightarrow K^*(892)^\mp K^\pm$	(3.9 ±0.7) × 10 ⁻³	—
$f_1(1420)^0 \pi^+, f_1^0 \rightarrow a_0(980)^0 \pi^0, a_0^0 \rightarrow K^+ K^-$	(4.0 ±1.4) × 10 ⁻⁴	—
$\eta(1475) \pi^+, \eta \rightarrow a_0(980)^0 \pi^0, a_0^0 \rightarrow K^+ K^-$	(7.0 ±2.8) × 10 ⁻⁴	—
$K_S^0 K^- 2\pi^+$	(1.569 ±0.028) %	744
$K^+ K^- K_S^0 \pi^+$	(1.27 ±0.15) × 10 ⁻⁴	527
$K^*(892)^+ \bar{K}^*(892)^0$	[e] (5.64 ±0.35) %	417

$\eta(1475) K_S^0, \eta \rightarrow$	$(3.5 \pm 1.0) \times 10^{-4}$	—
$K^{*0}(892) \pi^+, K^{*0} \rightarrow$		
$K^- \pi^+$		
$\eta(1475) \pi^+, \eta \rightarrow$	$(3.5 \pm 1.0) \times 10^{-4}$	—
$\bar{K}^{*0}(892) K^-, \bar{K}^{*0} \rightarrow$		
$K_S^0 \pi^+$		
$\eta(1475) \pi^+, \eta \rightarrow$	$(1.7 \pm 0.9) \times 10^{-3}$	—
$a_0(980)^- \pi^+, a_0^- \rightarrow$		
$K_S^0 K^-$		
$f_1(1285) \pi^+, f_1 \rightarrow$	$(3.5 \pm 0.8) \times 10^{-4}$	—
$a_0(980)^- \pi^+, a_0^- \rightarrow$		
$K_S^0 K^-$		
$K^+ K_S^0 \pi^+ \pi^-$	$(9.34 \pm 0.22) \times 10^{-3}$	744
$K^+ K^- 2\pi^+ \pi^-$	$(6.6 \pm 0.6) \times 10^{-3}$	673
$\phi 2\pi^+ \pi^-$	[e] $(1.21 \pm 0.16) \%$	640
$\phi \rho^0 \pi^+, \phi \rightarrow K^+ K^-$	$(4.9 \pm 0.7) \times 10^{-3}$	181
$\phi a_1(1260)^+, \phi \rightarrow$	$(7.5 \pm 1.2) \times 10^{-3}$	†
$K^+ K^-, a_1^+ \rightarrow$		
$\rho^0 \pi^+$		
$\phi 2\pi^+ \pi^- \text{ non-}\rho, \phi \rightarrow$	$(1.4 \pm 0.5) \times 10^{-3}$	—
$K^+ K^-$		
$K^+ K^- \rho^0 \pi^+ \text{ non-}\phi$	$< 2.0 \times 10^{-4} \text{ CL=90\%}$	249
$K^+ K^- 2\pi^+ \pi^- \text{ nonresonant}$	$(1.0 \pm 0.4) \times 10^{-3}$	673
$2K_S^0 2\pi^+ \pi^-$	$(8.0 \pm 3.3) \times 10^{-4}$	669
Hadronic modes without K's		
$\pi^+ \pi^0$	$< 1.2 \times 10^{-4} \text{ CL=90\%}$	975
$2\pi^+ \pi^-$	$(1.090 \pm 0.014) \%$	959
$\rho^0 \pi^+$	$(1.14 \pm 0.16) \times 10^{-4}$	825
$\omega \pi^+, \omega \rightarrow \pi^+ \pi^-$	$(3.9 \pm 0.4) \times 10^{-5}$	—
$\pi^+ (\pi^+ \pi^-)_{S\text{-wave}}$	[i] $(9.23 \pm 0.13) \times 10^{-3}$	959
$f_2(1270) \pi^+, f_2 \rightarrow \pi^+ \pi^-$	$(1.42 \pm 0.10) \times 10^{-3}$	559
$f_2'(1525)^0 \pi^+, f_2' \rightarrow \pi^+ \pi^-$	$(5.8 \pm 2.0) \times 10^{-6}$	—
$\rho(1450)^0 \pi^+, \rho^0 \rightarrow \pi^+ \pi^-$	$(1.8 \pm 0.6) \times 10^{-4}$	421
$\rho(1700)^0 \pi^+, \rho^0 \rightarrow \pi^+ \pi^-$	$(4 \pm 4) \times 10^{-5}$	—
$\pi^+ 2\pi^0$	$(5.2 \pm 0.5) \times 10^{-3}$	S=1.1 961
$f_0(980) \pi^+, f_0 \rightarrow \pi^0 \pi^0$	$(2.9 \pm 0.6) \times 10^{-3}$	—
$f_0(1370) \pi^+, f_0 \rightarrow \pi^0 \pi^0$	$(1.3 \pm 0.6) \times 10^{-3}$	—
$f_2(1270) \pi^+, f_2 \rightarrow \pi^0 \pi^0$	$(5.0 \pm 3.5) \times 10^{-4}$	—
$2\pi^+ \pi^- \pi^0$	—	935
$\omega \pi^+$	[e] $(1.93 \pm 0.30) \times 10^{-3}$	822
$\eta \pi^+$	[e] $(1.686 \pm 0.027) \%$	902
$(2\pi^+ \pi^- \pi^0)_{\text{non-}\eta}$	$(2.04 \pm 0.09) \%$	—

$f_0(1370)\rho^+, f_0\rho^+ \rightarrow$ $2\pi^+\pi^-\pi^0$	$(5.1 \pm 0.9) \times 10^{-3}$	—
$f_0(980)^0\rho^+, f_0^0\rho^+ \rightarrow$ $2\pi^+\pi^-\pi^0$	$(2.6 \pm 0.5) \times 10^{-3}$	—
$f_2(1270)^0\rho^+,$ $f_2(1270)^0\rho^+ \rightarrow$ $2\pi^+\pi^-\pi^0$	$(1.9 \pm 0.4) \times 10^{-3}$	—
$(\rho^+\rho^0)_{S-wave} \rightarrow$ $2\pi^+\pi^-\pi^0$	$(7.1 \pm 2.8) \times 10^{-4}$	—
$(\rho(1450)^+\rho^0)_{S-wave} \rightarrow$ $2\pi^+\pi^-\pi^0$	$(9.4 \pm 3.1) \times 10^{-4}$	—
$(\rho^+\rho(1450)^0)_{P-wave} \rightarrow$ $2\pi^+\pi^-\pi^0$	$(1.75 \pm 0.29) \times 10^{-3}$	—
$\phi\pi^+, \phi \rightarrow \rho\pi$	$(5.08 \pm 0.35) \times 10^{-3}$	—
$\omega\pi^+, \omega \rightarrow \rho\pi$	$(1.41 \pm 0.19) \times 10^{-3}$	—
$a_1(1260)^+\pi^0, a_1^+ \rightarrow$ $(\rho^0\pi^+)_{S-wave}$	$(2.6 \pm 0.4) \times 10^{-3}$	—
$a_1(1260)^0\pi^+, a_1^0 \rightarrow$ $(\rho\pi)_{S-wave}$	$(1.3 \pm 0.5) \times 10^{-3}$	—
$\pi(1300)^0\pi^+, \pi^0 \rightarrow$ $(\rho\pi)_{P-wave}$	$(2.4 \pm 0.7) \times 10^{-3}$	—
$3\pi^+2\pi^-$	$(8.0 \pm 0.8) \times 10^{-3}$	899
$2\pi^+\pi^-2\pi^0$	—	902
$\eta\rho^+$	[e] $(8.9 \pm 0.8) \%$	724
$\eta\pi^+\pi^0$	$(9.10 \pm 0.17) \%$	885
$\eta(\pi^+\pi^0)_{P-wave}$	$(4.9 \pm 3.0) \times 10^{-3}$	885
$a_0(980)^{+0}\pi^{0+},$ $a_0(980)^{+0} \rightarrow \eta\pi^{+0}$	$(2.1 \pm 0.4) \%$	—
$\omega\pi^+\pi^0$	[e] $(2.8 \pm 0.7) \%$	802
$2\pi^+\pi^-\eta$	$(3.08 \pm 0.08) \%$	855
$a_1(1260)^+\eta, a_1^+ \rightarrow$ $\rho(770)^0\pi^+, \rho^0 \rightarrow$ $\pi^+\pi^-$	$(1.71 \pm 0.14) \%$	—
$a_1(1260)^+\eta, a_1^+ \rightarrow$ $f_0(500)\pi^+, f_0 \rightarrow \pi^+\pi^-$	$(2.5 \pm 0.9) \times 10^{-3}$	—
$a_0(980)^+\rho(770)^0, a_0^+ \rightarrow$ $\eta\pi^+$	$(2.1 \pm 0.9) \times 10^{-3}$	—
$\eta(1405)\pi^+, \eta \rightarrow$ $a_0(980)^-\pi^+, a_0^- \rightarrow$ $\eta\pi^-$	$(2.2 \pm 0.7) \times 10^{-4}$	—
$\eta(1405)\pi^+, \eta \rightarrow$ $a_0(980)^+\pi^-, a_0^+ \rightarrow$ $\eta\pi^+$	$(2.2 \pm 0.7) \times 10^{-4}$	—

$f_1(1420)\pi^+, f_1 \rightarrow$	$(5.9 \pm 1.8) \times 10^{-4}$	—
$a_0(980)^-\pi^+, a_0^- \rightarrow$		
$\eta\pi^-$		
$f_1(1420)\pi^+, f_1 \rightarrow$	$(5.2 \pm 1.8) \times 10^{-4}$	—
$a_0(980)^+\pi^-, a_0^+ \rightarrow$		
$\eta\pi^+$		
$3\pi^+2\pi^-\pi^0$	$(4.9 \pm 3.2) \%$	856
$\omega 2\pi^+\pi^-$	[e] $(1.6 \pm 0.5) \%$	766
$\eta'(958)\pi^+$	[d,e] $(3.95 \pm 0.08) \%$	743
$3\pi^+2\pi^-\pi^0$	—	803
$\omega\eta\pi^+$	[e] $(5.4 \pm 1.3) \times 10^{-3}$	654
$\eta'(958)\rho^+$	[d,e] $(5.8 \pm 1.5) \%$	465
$\eta'(958)\pi^+\pi^0$	$(6.14 \pm 0.18) \%$	720
$\eta'(958)\pi^+\pi^0$ nonresonant	$< 5.1 \%$ CL=90%	720

Modes with one or three K's

$K^+\pi^0$	$(7.5 \pm 0.5) \times 10^{-4}$	917
$K_S^0\pi^+$	$(1.22 \pm 0.04) \times 10^{-3}$	916
$K^+\eta$	[e] $(1.76 \pm 0.08) \times 10^{-3}$	835
$K^+\omega$	[e] $(9.9 \pm 1.5) \times 10^{-4}$	741
$K^+\eta'(958)$	[e] $(2.68 \pm 0.24) \times 10^{-3}$	646
$K^+\pi^+\pi^-$	$(6.23 \pm 0.10) \times 10^{-3}$	900
$K^+\rho^0$	$(2.18 \pm 0.25) \times 10^{-3}$	745
$K^+\rho(1450)^0, \rho^0 \rightarrow \pi^+\pi^-$	$(7.3 \pm 1.7) \times 10^{-4}$	—
$K^+f_0(500), f_0 \rightarrow \pi^+\pi^-$	$(4.5 \pm 3.0) \times 10^{-4}$	—
$K^+f_0(980), f_0 \rightarrow \pi^+\pi^-$	$(2.8 \pm 1.1) \times 10^{-4}$	—
$K^+f_0(1370), f_0 \rightarrow \pi^+\pi^-$	$(1.2 \pm 0.6) \times 10^{-3}$	—
$K^*(892)^0\pi^+, K^{*0} \rightarrow$	$(1.68 \pm 0.26) \times 10^{-3}$	775
$K^+\pi^-$		
$K^*(1410)^0\pi^+, K^{*0} \rightarrow$	$(6 \pm 4) \times 10^{-4}$	—
$K^+\pi^-$		
$K^*(1430)^0\pi^+, K^{*0} \rightarrow$	$(9.4 \pm 3.2) \times 10^{-4}$	—
$K^+\pi^-$		
$K^+\pi^+\pi^-$ nonresonant	$(9.9 \pm 3.2) \times 10^{-4}$	900
$K_S^0\pi^+\pi^0$	$(5.09 \pm 0.22) \times 10^{-3}$	899
$K_S^0\rho(770)^+, \rho^+ \rightarrow \pi^+\pi^0$	$(2.6 \pm 0.4) \times 10^{-3}$	—
$K_S^0\rho(1450)^+, \rho^+ \rightarrow \pi^+\pi^0$	$(1.04 \pm 0.32) \times 10^{-3}$	—
$K^*(892)^0\pi^+, K^{*0} \rightarrow$	$(4.3 \pm 1.2) \times 10^{-4}$	—
$K_S^0\pi^0$		
$K^*(892)^+\pi^0, K^{*+} \rightarrow$	$(2.3 \pm 0.7) \times 10^{-4}$	—
$K_S^0\pi^+$		
$K^*(1410)^0\pi^+, K^{*0} \rightarrow$	$(1.7 \pm 0.9) \times 10^{-4}$	—
$K_S^0\pi^0$		
$K_S^02\pi^+\pi^-$	$(2.8 \pm 1.0) \times 10^{-3}$	870

$K^+ \pi^+ \pi^- \pi^0$	$(9.7 \pm 0.6) \times 10^{-3}$	873
$K^*(892)^0 \rho^+, K^{*0} \rightarrow$	$(3.9 \pm 0.4) \times 10^{-3}$	—
$K^+ \pi^-$		
$K^*(892)^+ \rho^0, K^{*+} \rightarrow$	$(4.2 \pm 1.2) \times 10^{-4}$	—
$K^+ \pi^0$		
$K_1(1270)^0 \pi^+, K_1^0 \rightarrow$	$(3.9 \pm 1.3) \times 10^{-4}$	†
$K^+ \rho^-$		
$K_1(1400)^0 \pi^+, K_1^0 \rightarrow$	$(5.4 \pm 0.9) \times 10^{-4}$	—
$K^*(890)^+ \pi^-, K^{*+} \rightarrow$		
$K^+ \pi^0$		
$K_1(1400)^0 \pi^+, K_1^0 \rightarrow$	$(5.9 \pm 1.0) \times 10^{-4}$	—
$K^*(890)^0 \pi^0, K^{*0} \rightarrow$		
$K^+ \pi^-$		
$K^+ a_1(1260)^0, a_1 \rightarrow \rho^+ \pi^-$	$(1.8 \pm 1.1) \times 10^{-4}$	—
$K^+ a_1(1260)^0, a_1 \rightarrow \rho^- \pi^+$	$(1.8 \pm 1.1) \times 10^{-4}$	—
$K^+ \pi^+ \pi^- \pi^0$ nonresonant	$(9.2 \pm 2.4) \times 10^{-4}$	873
$(K^+ \pi^0)_{P\text{-wave}} \rho^0$	$(1.01 \pm 0.21) \times 10^{-3}$	688
$K^+ \omega \pi^0$	$[e] < 8.2 \times 10^{-3} \text{CL}=90\%$	684
$K^+ \omega \pi^+ \pi^-$	$[e] < 5.4 \times 10^{-3} \text{CL}=90\%$	603
$K^+ \omega \eta$	$[e] < 7.9 \times 10^{-3} \text{CL}=90\%$	366
$2K^+ K^-$	$(2.18 \pm 0.20) \times 10^{-4}$	628
$\phi K^+, \phi \rightarrow K^+ K^-$	$(8.9 \pm 2.0) \times 10^{-5}$	—

Radiative decays

$\rho(770)^+ \gamma$	$< 6.1 \times 10^{-4} \text{CL}=90\%$	—
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Doubly Cabibbo-suppressed modes

$2K^+ \pi^-$	$(1.293 \pm 0.027) \times 10^{-4} \quad S=1.1$	805
$K^+ K^*(892)^0, K^{*0} \rightarrow$	$(6.1 \pm 3.4) \times 10^{-5}$	—
$K^+ \pi^-$		
$2K^+ \pi^- \pi^0$	$< 1.7 \times 10^{-4} \text{CL}=90\%$	748

Baryon-antibaryon mode

$p \bar{n}$	$(1.22 \pm 0.11) \times 10^{-3}$	295
$p \bar{p} e^+ \nu_e$	$< 2.0 \times 10^{-4} \text{CL}=90\%$	296

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

$\pi^+ e^+ e^-$	$[j] < 5.5 \times 10^{-6} \text{CL}=90\%$	979
$\pi^+ \phi, \phi \rightarrow e^+ e^-$	$[k] (1.17 \pm 0.22) \times 10^{-5}$	—
$\pi^+ \pi^0 e^+ e^-$	$< 7.0 \times 10^{-5} \text{CL}=90\%$	974
$\rho^+ \phi, \phi \rightarrow e^+ e^-$	$(2.4 \pm 0.7) \times 10^{-5}$	—
$\pi^+ \mu^+ \mu^-$	$[j] < 1.8 \times 10^{-7} \text{CL}=90\%$	968
$K^+ e^+ e^-$	$C1 < 3.7 \times 10^{-6} \text{CL}=90\%$	922
$K^+ \pi^0 e^+ e^-$	$< 7.1 \times 10^{-5} \text{CL}=90\%$	917
$K_S^0 \pi^+ e^+ e^-$	$< 8.1 \times 10^{-5} \text{CL}=90\%$	916

$K^+ \mu^+ \mu^-$	CI	< 1.4	$\times 10^{-7} \text{CL}=90\%$	909
$K^*(892)^+ \mu^+ \mu^-$	CI	< 1.4	$\times 10^{-3} \text{CL}=90\%$	765
$\pi^+ e^+ \mu^-$	LF	< 1.1	$\times 10^{-6} \text{CL}=90\%$	976
$\pi^+ e^- \mu^+$	LF	< 9.4	$\times 10^{-7} \text{CL}=90\%$	976
$K^+ e^+ \mu^-$	LF	< 7.9	$\times 10^{-7} \text{CL}=90\%$	919
$K^+ e^- \mu^+$	LF	< 5.6	$\times 10^{-7} \text{CL}=90\%$	919
$\pi^- 2e^+$	L	< 1.4	$\times 10^{-6} \text{CL}=90\%$	979
$\pi^- 2\mu^+$	L	< 8.6	$\times 10^{-8} \text{CL}=90\%$	968
$\pi^- e^+ \mu^+$	L	< 6.3	$\times 10^{-7} \text{CL}=90\%$	976
$K^- 2e^+$	L	< 7.7	$\times 10^{-7} \text{CL}=90\%$	922
$K^- 2\mu^+$	L	< 2.6	$\times 10^{-8} \text{CL}=90\%$	909
$K^- e^+ \mu^+$	L	< 2.6	$\times 10^{-7} \text{CL}=90\%$	919
$K^*(892)^- 2\mu^+$	L	< 1.4	$\times 10^{-3} \text{CL}=90\%$	765

$D_s^{*\pm}$

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

Mass $m = 2112.2 \pm 0.4 \text{ MeV}$
 $m_{D_s^{*\pm}} - m_{D_s^\pm} = 143.8 \pm 0.4 \text{ MeV}$
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)	$p \text{ (MeV/c)}$
$D_s^+ \gamma$	$(93.6 \pm 0.4) \%$	139
$D_s^+ \pi^0$	$(5.77 \pm 0.35) \%$	48
$D_s^+ e^+ e^-$	$(6.7 \pm 1.6) \times 10^{-3}$	139
$e^+ \nu_e$	$(2.1^{+1.2}_{-0.9}) \times 10^{-5}$	1056

$D_{s0}^*(2317)^\pm$

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

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

See the review on "Heavy Non- $q\bar{q}$ Mesons."
Mass $m = 2317.8 \pm 0.5 \text{ MeV}$
 $m_{D_{s0}^*(2317)^\pm} - m_{D_s^\pm} = 349.4 \pm 0.5 \text{ MeV}$
Full width $\Gamma < 3.8 \text{ MeV}$, 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%	—
$D_s^+ \pi^+ \pi^-$	$< 4 \times 10^{-3}$	90%	194
$D_s^+ \pi^0 \pi^0$	not seen		205

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

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

See the review on "Heavy Non- $q\bar{q}$ Mesons."

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 ($S = 1.2$)

$m_{D_{s1}(2460)^\pm} - m_{D_s^\pm} = 491.1 \pm 0.6$ 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)
$D_s^{*+} \pi^0$	$(48 \pm 11)\%$		297
$D_s^+ \gamma$	$(18 \pm 4)\%$		442
$D_s^+ \pi^+ \pi^-$	$(4.3 \pm 1.3)\%$	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

$m_{D_{s1}(2536)^\pm} - m_{D_s^*(2111)} = 422.9 \pm 0.4$ MeV

$m_{D_{s1}(2536)^\pm} - m_{D^*(2010)^\pm} = 524.85 \pm 0.04$ MeV

$m_{D_{s1}(2536)^\pm} - m_{D^*(2007)^0} = 528.26 \pm 0.05$ MeV ($S = 1.1$)

Full width $\Gamma = 0.92 \pm 0.05$ MeV

Branching fractions are given relative to the one **DEFINED AS 1**.
 $D_{s1}(2536)^-$ modes are charge conjugates of the modes below.

$D_{s1}(2536)^+$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$D^*(2010)^+ K^0$	(31 $\pm$ 7) %		149
$(D^*(2010)^+ K^0)_{S-wave}$	(22 $\pm$ 5) %		149
$K_S^0 D^*(2010)^+$	(17 $\pm$ 4) %		149
$D^+ \pi^- K^+$	$(10.0 \pm 2.5) \times 10^{-3}$		176
$D^*(2007)^0 K^+$	(36 $\pm$ 6) %		167
$D^+ K^0$	< 12 %	90%	381
$D^0 K^+$	< 4 %	90%	391
$D_s^{*+} \gamma$	possibly seen		388
$D_s^+ \pi^+ \pi^-$	seen		437

$D_{s2}^*(2573)$

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

Mass $m = 2569.1 \pm 0.8$ MeV ($S = 2.4$)

$m_{D_{s2}^*(2573)} - m_{D^0} = 704 \pm 3.2$ MeV

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)
$D^0 K^+$	(37 $\pm$ 6) %	431
$D^*(2007)^0 K^+$	not seen	238
$D^+ K_S^0$	seen	422
$D^{*+} K_S^0$	seen	225

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

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

Mass $m = 2714 \pm 5$ MeV ($S = 1.5$)

Full width $\Gamma = 122 \pm 10$ MeV

$D_{s1}^*(2700)^\pm$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$D^0 K^+$	seen	579
$D^+ K_S^0$	seen	573
$D^{*0} K^+$	seen	438
$D^{*+} K_S^0$	seen	431

$D_{s3}^*(2860)^\pm$

$$I(J^P) = 0(3^-)$$

Mass $m = 2860 \pm 7$ MeVFull width $\Gamma = 53 \pm 10$ MeV

$D_{s3}^*(2860)^\pm$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$D^0 K^+$	seen	710
$D^+ K_S^0$	seen	704
$D^{*0} K^+$	seen	589
$D^{*+} K_S^0$	seen	584

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 $u\bar{u}$ or $d\bar{d}$ content in the D_s^+ . Neither Cabibbo-favored nor Cabibbo-suppressed decays can contribute, and ω - ϕ 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 $D_s^+ \rightarrow \phi \pi^+$ branching fraction obtained from mass projections (and used to get some of the other branching fractions) from the $D_s^+ \rightarrow \phi \pi^+$, $\phi \rightarrow K^+ K^-$ branching fraction obtained from the Dalitz-plot analysis of $D_s^+ \rightarrow K^+ K^- \pi^+$. That is, the ratio of these two branching fractions is not exactly the $\phi \rightarrow K^+ K^-$ 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 $\Delta C=1$ weak neutral current because both quarks must change flavor in this decay.

[*k*] This is *not* a test for the $\Delta C=1$ weak neutral current, but leads to the $\pi^+ \ell^+ \ell^-$ final state.