BOTTOM, STRANGE MESONS ($B = \pm 1$, $S = \mp 1$)

$B_s^0 = s\overline{b}$, $\overline{B}_s^0 = \overline{s}\,b$, similarly for B_s^*'s

B_s^0

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

I, J, P need confirmation. Quantum numbers shown are quark-model predictions.

Mass $m_{B_s^0} = 5366.88 \pm 0.14$ MeV

$m_{B_s^0} - m_B = 87.38 \pm 0.16$ MeV

Mean life $\tau = (1.515 \pm 0.004) \times 10^{-12}$ s

$c\tau = 454.2\ \mu$m

$\Delta\Gamma_{B_s^0} = \Gamma_{B_{sL}^0} - \Gamma_{B_{sH}^0} = (0.085 \pm 0.004) \times 10^{12}\ \text{s}^{-1}$

B_s^0-$\overline{B}_s^0$ mixing parameters

$\Delta m_{B_s^0} = m_{B_{sH}^0} - m_{B_{sL}^0} = (17.749 \pm 0.020) \times 10^{12}\ \hbar\ \text{s}^{-1}$

$= (1.1683 \pm 0.0013) \times 10^{-8}$ MeV

$x_s = \Delta m_{B_s^0}/\Gamma_{B_s^0} = 26.89 \pm 0.07$

$\chi_s = 0.499312 \pm 0.000004$

CP violation parameters in B_s^0

$\text{Re}(\epsilon_{B_s^0}) / (1 + |\epsilon_{B_s^0}|^2) = (-0.15 \pm 0.70) \times 10^{-3}$

$C_{KK}(B_s^0 \to K^+K^-) = 0.14 \pm 0.11$

$S_{KK}(B_s^0 \to K^+K^-) = 0.30 \pm 0.13$

$\text{r}_B(B_s^0 \to D_s^\mp K^\pm) = 0.37^{+0.10}_{-0.09}$

$\delta_B(B_s^0 \to D_s^\pm K^\mp) = (358 \pm 14)^\circ$

CP Violation phase $\beta_s = (2.55 \pm 1.15) \times 10^{-2}$ rad

$|\lambda|\ (B_s^0 \to J/\psi(1S)\phi) = 1.012 \pm 0.017$

$|\lambda| = 0.999 \pm 0.017$

A, *CP* violation parameter $= -0.75 \pm 0.12$

C, *CP* violation parameter $= 0.19 \pm 0.06$

S, *CP* violation parameter $= 0.17 \pm 0.06$

$A_{CP}^L(B_s \to J/\psi\overline{K}^*(892)^0) = -0.05 \pm 0.06$

$A_{CP}^\parallel(B_s \to J/\psi\overline{K}^*(892)^0) = 0.17 \pm 0.15$

$A_{CP}^\perp(B_s \to J/\psi\overline{K}^*(892)^0) = -0.05 \pm 0.10$

$\boldsymbol{A_{CP}(B_s \to \pi^+K^-)} = 0.221 \pm 0.015$

$A_{CP}(B_s^0 \to [K^+K^-]_D\overline{K}^*(892)^0) = -0.04 \pm 0.07$

$A_{CP}(B_s^0 \to [\pi^+ K^-]_D K^*(892)^0) = -0.01 \pm 0.04$
$A_{CP}(B_s^0 \to [\pi^+ \pi^-]_D K^*(892)^0) = 0.06 \pm 0.13$
$S(B_s^0 \to \phi\gamma) = 0.43 \pm 0.32$
$C(B_s^0 \to \phi\gamma) = 0.11 \pm 0.31$
$A^{\Delta}(B_s \to \phi\gamma) = -0.7 \pm 0.4$
$\Delta a_\perp < 1.2 \times 10^{-12}$ GeV, CL = 95%
$\Delta a_\parallel = (-0.9 \pm 1.5) \times 10^{-14}$ GeV
$\Delta a_X = (1.0 \pm 2.2) \times 10^{-14}$ GeV
$\Delta a_Y = (-3.8 \pm 2.2) \times 10^{-14}$ GeV
$\mathrm{Re}(\xi) = -0.022 \pm 0.033$
$\mathrm{Im}(\xi) = 0.004 \pm 0.011$

These branching fractions all scale with $B(\overline{b} \to B_s^0)$.

The branching fraction $B(B_s^0 \to D_s^- \ell^+ \nu_\ell \text{anything})$ is not a pure measurement since the measured product branching fraction $B(\overline{b} \to B_s^0) \times B(B_s^0 \to D_s^- \ell^+ \nu_\ell \text{anything})$ was used to determine $B(\overline{b} \to B_s^0)$, as described in the note on "B^0-$\overline{B}^0$ Mixing"

For inclusive branching fractions, *e.g.*, $B \to D^{\pm}$ anything, the values usually are multiplicities, not branching fractions. They can be greater than one.

B_s^0 DECAY MODES		Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
D_s^- anything		(93 ±25) %		–
$\ell\nu_\ell X$		(9.6 ± 0.8) %		–
$e^+\nu X^-$		(9.1 ± 0.8) %		–
$\mu^+\nu X^-$		(10.2 ± 1.0) %		–
$D_s^-\ell^+\nu_\ell$ anything	[a]	(8.1 ± 1.3) %		–
$D_s^{*-}\ell^+\nu_\ell$ anything		(5.4 ± 1.1) %		–
$D_{s1}(2536)^-\mu^+\nu_\mu$, $D_{s1}^- \to D^{*-}K_S^0$		(2.7 ± 0.7) $\times 10^{-3}$		–
$D_{s1}(2536)^- X\mu^+\nu$, $D_{s1}^- \to \overline{D}^0 K^+$		(4.4 ± 1.3) $\times 10^{-3}$		–
$D_{s2}(2573)^- X\mu^+\nu$, $D_{s2}^- \to \overline{D}^0 K^+$		(2.7 ± 1.0) $\times 10^{-3}$		–
$D_s^-\pi^+$		(3.00± 0.23) $\times 10^{-3}$		2320
$D_s^-\rho^+$		(6.9 ± 1.4) $\times 10^{-3}$		2249
$D_s^-\pi^+\pi^+\pi^-$		(6.1 ± 1.0) $\times 10^{-3}$		2301
$D_{s1}(2536)^-\pi^+$, $D_{s1}^- \to D_s^-\pi^+\pi^-$		(2.5 ± 0.8) $\times 10^{-5}$		–
$D_s^{\mp}K^{\pm}$		(2.27± 0.19) $\times 10^{-4}$		2293

$D_s^- K^+ \pi^+ \pi^-$	$(3.2 \pm 0.6) \times 10^{-4}$		2249
$D_s^+ D_s^-$	$(4.4 \pm 0.5) \times 10^{-3}$		1824
$D_s^- D^+$	$(2.8 \pm 0.5) \times 10^{-4}$		1875
$D^+ D^-$	$(2.2 \pm 0.6) \times 10^{-4}$		1925
$D^0 \overline{D}^0$	$(1.9 \pm 0.5) \times 10^{-4}$		1930
$D_s^{*-} \pi^+$	$(2.0 \pm 0.5) \times 10^{-3}$		2265
$D_s^{*\mp} K^\pm$	$(1.33 \pm 0.35) \times 10^{-4}$		–
$D_s^{*-} \rho^+$	$(9.6 \pm 2.1) \times 10^{-3}$		2191
$D_s^{*+} D_s^- + D_s^{*-} D_s^+$	$(1.39 \pm 0.17) \%$		1742
$D_s^{*+} D_s^{*-}$	$(1.44 \pm 0.21) \%$	S=1.1	1655
$D_s^{(*)+} D_s^{(*)-}$	$(4.5 \pm 1.4) \%$		–
$\overline{D}^{*0} \overline{K}^0$	$(2.8 \pm 1.1) \times 10^{-4}$		2278
$\overline{D}^0 \overline{K}^0$	$(4.3 \pm 0.9) \times 10^{-4}$		2330
$\overline{D}^0 K^- \pi^+$	$(1.04 \pm 0.13) \times 10^{-3}$		2312
$\overline{D}^0 \overline{K}^*(892)^0$	$(4.4 \pm 0.6) \times 10^{-4}$		2264
$\overline{D}^0 \overline{K}^*(1410)$	$(3.9 \pm 3.5) \times 10^{-4}$		2117
$\overline{D}^0 \overline{K}_0^*(1430)$	$(3.0 \pm 0.7) \times 10^{-4}$		2113
$\overline{D}^0 \overline{K}_2^*(1430)$	$(1.1 \pm 0.4) \times 10^{-4}$		2112
$\overline{D}^0 \overline{K}^*(1680)$	$< 7.8 \times 10^{-5}$	CL=90%	1997
$\overline{D}^0 \overline{K}_0^*(1950)$	$< 1.1 \times 10^{-4}$	CL=90%	1890
$\overline{D}^0 \overline{K}_3^*(1780)$	$< 2.6 \times 10^{-5}$	CL=90%	1971
$\overline{D}^0 \overline{K}_4^*(2045)$	$< 3.1 \times 10^{-5}$	CL=90%	1835
$\overline{D}^0 K^- \pi^+$ (non-resonant)	$(2.1 \pm 0.8) \times 10^{-4}$		2312
$D_{s2}^*(2573)^- \pi^+$, $D_{s2}^* \to \overline{D}^0 K^-$	$(2.6 \pm 0.4) \times 10^{-4}$		–
$D_{s1}^*(2700)^- \pi^+$, $D_{s1}^* \to \overline{D}^0 K^-$	$(1.6 \pm 0.8) \times 10^{-5}$		–
$D_{s1}^*(2860)^- \pi^+$, $D_{s1}^* \to \overline{D}^0 K^-$	$(5 \pm 4) \times 10^{-5}$		–
$D_{s3}^*(2860)^- \pi^+$, $D_{s3}^* \to \overline{D}^0 K^-$	$(2.2 \pm 0.6) \times 10^{-5}$		–
$\overline{D}^0 K^+ K^-$	$(5.5 \pm 0.8) \times 10^{-5}$		2243
$\overline{D}^0 f_0(980)$	$< 3.1 \times 10^{-6}$	CL=90%	2242
$\overline{D}^0 \phi$	$(3.0 \pm 0.5) \times 10^{-5}$		2235
$\overline{D}^{*0} \phi$	$(3.7 \pm 0.6) \times 10^{-5}$		2178
$D^{*\mp} \pi^\pm$	$< 6.1 \times 10^{-6}$	CL=90%	–
$\eta_c \phi$	$(5.0 \pm 0.9) \times 10^{-4}$		1663
$\eta_c \pi^+ \pi^-$	$(1.8 \pm 0.7) \times 10^{-4}$		1840
$J/\psi(1S) \phi$	$(1.08 \pm 0.08) \times 10^{-3}$		1588
$J/\psi(1S) \phi \phi$	$(1.24^{+\ 0.17}_{-\ 0.19}) \times 10^{-5}$		764
$J/\psi(1S) \pi^0$	$< 1.2 \times 10^{-3}$	CL=90%	1787
$J/\psi(1S) \eta$	$(4.0 \pm 0.7) \times 10^{-4}$	S=1.4	1733

$J/\psi(1S)K^0_S$	$(\ 1.88\pm\ 0.15)\times10^{-5}$		1743
$J/\psi(1S)\overline{K}^*(892)^0$	$(\ 4.1\ \pm\ 0.4\ )\times10^{-5}$		1637
$J/\psi(1S)\eta'$	$(\ 3.3\ \pm\ 0.4\ )\times10^{-4}$		1612
$J/\psi(1S)\pi^+\pi^-$	$(\ 2.09\pm\ 0.23)\times10^{-4}$	S=1.3	1775
$J/\psi(1S)f_0(500),\ \ f_0\to\ \pi^+\pi^-$	$<\ 4\ \times10^{-6}$	CL=90%	–
$J/\psi(1S)\rho,\ \ \rho\to\ \pi^+\pi^-$	$<\ 4\ \times10^{-6}$	CL=90%	–
$J/\psi(1S)f_0(980),\ \ f_0\to\ \pi^+\pi^-$	$(\ 1.28\pm\ 0.18)\times10^{-4}$	S=1.7	–
$J/\psi(1S)f_2(1270),\ \ f_2\to\ \pi^+\pi^-$	$(\ 1.1\ \pm\ 0.4\ )\times10^{-6}$		–
$J/\psi(1S)f_2(1270)_0,\ \ f_2\to\ \pi^+\pi^-$	$(\ 7.5\ \pm\ 1.8\ )\times10^{-7}$		–
$J/\psi(1S)f_2(1270)_\parallel,\ \ f_2\to\ \pi^+\pi^-$	$(\ 1.09\pm\ 0.34)\times10^{-6}$		–
$J/\psi(1S)f_2(1270)_\perp,\ \ f_2\to\ \pi^+\pi^-$	$(\ 1.3\ \pm\ 0.8\ )\times10^{-6}$		–
$J/\psi(1S)f_0(1370),\ \ f_0\to\ \pi^+\pi^-$	$(\ 4.5\ ^{+\ 0.7}_{-\ 4.0}\ )\times10^{-5}$		–
$J/\psi(1S)f_0(1500),\ \ f_0\to\ \pi^+\pi^-$	$(\ 2.11^{+\ 0.40}_{-\ 0.29})\times10^{-5}$		–
$J/\psi(1S)f_2'(1525)_0,\ \ f_2'\to\ \pi^+\pi^-$	$(\ 1.07\pm\ 0.24)\times10^{-6}$		–
$J/\psi(1S)f_2'(1525)_\parallel,\ \ f_2'\to\ \pi^+\pi^-$	$(\ 1.3\ ^{+\ 2.7}_{-\ 0.9}\ )\times10^{-7}$		–
$J/\psi(1S)f_2'(1525)_\perp,\ \ f_2'\to\ \pi^+\pi^-$	$(\ 5\ \ \pm\ 4\ \ )\times10^{-7}$		–
$J/\psi(1S)f_0(1790),\ \ f_0\to\ \pi^+\pi^-$	$(\ 5.0\ ^{+11.0}_{-\ 1.1}\ )\times10^{-6}$		–
$J/\psi(1S)\pi^+\pi^-$(nonresonant)	$(\ 1.8\ ^{+\ 1.1}_{-\ 0.4}\ )\times10^{-5}$		1775
$J/\psi(1S)\overline{K}^0\pi^+\pi^-$	$<\ 4.4\ \times10^{-5}$	CL=90%	1675
$J/\psi(1S)K^+K^-$	$(\ 7.9\ \pm\ 0.7\ )\times10^{-4}$		1601
$J/\psi(1S)K^0K^-\pi^+$ + c.c.	$(\ 9.2\ \pm\ 1.3\ )\times10^{-4}$		1538
$J/\psi(1S)\overline{K}^0K^+K^-$	$<\ 1.2\ \times10^{-5}$	CL=90%	1333
$J/\psi(1S)f_2'(1525)$	$(\ 2.6\ \pm\ 0.6\ )\times10^{-4}$		1310
$J/\psi(1S)p\overline{p}$	$(\ 3.6\ \pm\ 0.4\ )\times10^{-6}$		982
$J/\psi(1S)\gamma$	$<\ 7.3\ \times10^{-6}$	CL=90%	1790
$J/\psi(1S)\pi^+\pi^-\pi^+\pi^-$	$(\ 7.8\ \pm\ 1.0\ )\times10^{-5}$		1731
$J/\psi(1S)f_1(1285)$	$(\ 7.2\ \pm\ 1.4\ )\times10^{-5}$		1460
$\psi(2S)\eta$	$(\ 3.3\ \pm\ 0.9\ )\times10^{-4}$		1338
$\psi(2S)\eta'$	$(\ 1.29\pm\ 0.35)\times10^{-4}$		1158
$\psi(2S)\pi^+\pi^-$	$(\ 7.1\ \pm\ 1.3\ )\times10^{-5}$		1397
$\psi(2S)\phi$	$(\ 5.4\ \pm\ 0.6\ )\times10^{-4}$		1120
$\psi(2S)K^-\pi^+$	$(\ 3.1\ \pm\ 0.4\ )\times10^{-5}$		1310

$\psi(2S)\overline{K}^*(892)^0$	$(\ 3.3\ \pm\ 0.5\ )\times10^{-5}$		1196
$\chi_{c1}\phi$	$(\ 2.04\pm\ 0.30)\times10^{-4}$		1274
$\pi^+\pi^-$	$(\ 7.0\ \pm\ 1.0\ )\times10^{-7}$		2680
$\pi^0\pi^0$	$<\ 2.1\ \times10^{-4}$	CL=90%	2680
$\eta\pi^0$	$<\ 1.0\ \times10^{-3}$	CL=90%	2654
$\eta\eta$	$<\ 1.5\ \times10^{-3}$	CL=90%	2627
$\rho^0\rho^0$	$<\ 3.20\ \times10^{-4}$	CL=90%	2569
$\eta'\eta'$	$(\ 3.3\ \pm\ 0.7\ )\times10^{-5}$		2507
$\eta'\phi$	$<\ 8.2\ \times10^{-7}$	CL=90%	2495
$\phi f_0(980),\ f_0(980)\to\ \pi^+\pi^-$	$(\ 1.12\pm\ 0.21)\times10^{-6}$		–
$\phi f_2(1270),\ f_2(1270)\to\ \pi^+\pi^-$	$(\ 6.1\ ^{+\ 1.8}_{-\ 1.5}\ )\times10^{-7}$		–
$\phi\rho^0$	$(\ 2.7\ \pm\ 0.8\ )\times10^{-7}$		2526
$\phi\pi^+\pi^-$	$(\ 3.5\ \pm\ 0.5\ )\times10^{-6}$		2579
$\phi\phi$	$(\ 1.87\pm\ 0.15)\times10^{-5}$		2482
$\phi\phi\phi$	$(\ 2.2\ \pm\ 0.7\ )\times10^{-6}$		2165
π^+K^-	$(\ 5.8\ \pm\ 0.7\ )\times10^{-6}$		2659
K^+K^-	$(\ 2.66\pm\ 0.22)\times10^{-5}$		2638
$K^0\overline{K}^0$	$(\ 2.0\ \pm\ 0.6\ )\times10^{-5}$		2637
$K^0\pi^+\pi^-$	$(\ 9.5\ \pm\ 2.1\ )\times10^{-6}$		2653
$K^0K^\pm\pi^\mp$	$(\ 8.4\ \pm\ 0.9\ )\times10^{-5}$		2622
$K^*(892)^-\pi^+$	$(\ 2.9\ \pm\ 1.1\ )\times10^{-6}$		2607
$K^*(892)^\pm K^\mp$	$(\ 1.9\ \pm\ 0.5\ )\times10^{-5}$		2585
$K_0^*(1430)^\pm K^\mp$	$(\ 3.1\ \pm\ 2.5\ )\times10^{-5}$		–
$K_2^*(1430)^\pm K^\mp$	$(\ 1.0\ \pm\ 1.7\ )\times10^{-5}$		–
$K^*(892)^0\overline{K}^0+$ c.c.	$(\ 2.0\ \pm\ 0.6\ )\times10^{-5}$		2585
$K_0^*(1430)\overline{K}^0+$ c.c.	$(\ 3.3\ \pm\ 1.0\ )\times10^{-5}$		2468
$K_2^*(1430)^0\overline{K}^0+$ c.c.	$(\ 1.7\ \pm\ 2.2\ )\times10^{-5}$		2467
$K_S^0\overline{K}^*(892)^0+$ c.c.	$(\ 1.6\ \pm\ 0.4\ )\times10^{-5}$		2585
$K^0K^+K^-$	$(\ 1.3\ \pm\ 0.6\ )\times10^{-6}$		2568
$\overline{K}^*(892)^0\rho^0$	$<\ 7.67\ \times10^{-4}$	CL=90%	2550
$\overline{K}^*(892)^0K^*(892)^0$	$(\ 1.11\pm\ 0.27)\times10^{-5}$		2531
$\phi K^*(892)^0$	$(\ 1.14\pm\ 0.30)\times10^{-6}$		2507
$p\overline{p}$	$<\ 1.5\ \times10^{-8}$	CL=90%	2514
$p\overline{p}K^+K^-$	$(\ 4.5\ \pm\ 0.5\ )\times10^{-6}$		2231
$p\overline{p}K^+\pi^-$	$(\ 1.39\pm\ 0.26)\times10^{-6}$		2355
$p\overline{p}\pi^+\pi^-$	$(\ 4.3\ \pm\ 2.0\ )\times10^{-7}$		2454
$p\overline{\Lambda}K^-+$ c.c.	$(\ 5.5\ \pm\ 1.0\ )\times10^{-6}$		2358
$\Lambda_c^-\Lambda\pi^+$	$(\ 3.6\ \pm\ 1.6\ )\times10^{-4}$		1979
$\Lambda_c^-\Lambda_c^+$	$<\ 8.0\ \times10^{-5}$	CL=95%	1405

Lepton Family number (*LF*) violating modes or $\Delta B = 1$ weak neutral current (*B1*) modes

$\gamma\gamma$	*B1*	$<$ 3.1	$\times 10^{-6}$	CL=90%	2683
$\phi\gamma$	*B1*	(3.4 $\pm$ 0.4)	$\times 10^{-5}$		2587
$\mu^+\mu^-$	*B1*	(3.0 $\pm$ 0.4)	$\times 10^{-9}$		2681
e^+e^-	*B1*	$<$ 2.8	$\times 10^{-7}$	CL=90%	2683
$\tau^+\tau^-$	*B1*	$<$ 6.8	$\times 10^{-3}$	CL=95%	2011
$\mu^+\mu^-\mu^+\mu^-$	*B1*	$<$ 2.5	$\times 10^{-9}$	CL=95%	2673
$SP,\ S\to\ \mu^+\mu^-,\ P\to\ \mu^+\mu^-$	*B1*	[*b*] $<$ 2.2	$\times 10^{-9}$	CL=95%	–
$\phi(1020)\mu^+\mu^-$	*B1*	(8.2 $\pm$ 1.2)	$\times 10^{-7}$		2582
$\overline{K}^*(892)^0\mu^+\mu^-$		(2.9 $\pm$ 1.1)	$\times 10^{-8}$		2605
$\pi^+\pi^-\mu^+\mu^-$	*B1*	(8.4 $\pm$ 1.7)	$\times 10^{-8}$		2670
$\phi\nu\overline{\nu}$	*B1*	$<$ 5.4	$\times 10^{-3}$	CL=90%	2587
$e^\pm\mu^\mp$	*LF*	[*c*] $<$ 5.4	$\times 10^{-9}$	CL=90%	2682
$\mu^\pm\tau^\mp$		$<$ 4.2	$\times 10^{-5}$	CL=95%	2388

B_s^*

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

I, *J*, *P* need confirmation. Quantum numbers shown are quark-model predictions.

Mass $m = 5415.4^{+1.8}_{-1.5}$ MeV (S = 2.9)

$m_{B_s^*} - m_{B_s} = 48.6^{+1.8}_{-1.5}$ MeV (S = 2.9)

B_s^* DECAY MODES	Fraction (Γ_i/Γ)	*p* (MeV/*c*)
$B_s\gamma$	seen	48

$B_{s1}(5830)^0$

$I(J^P) = 0(1^+)$
I, *J*, *P* need confirmation.

Mass $m = 5828.70 \pm 0.20$ MeV

$m_{B_{s1}^0} - m_{B^{*+}} = 504.00 \pm 0.17$ MeV

Full width $\Gamma = 0.5 \pm 0.4$ MeV

$B_{s1}(5830)^0$ DECAY MODES	Fraction (Γ_i/Γ)	*p* (MeV/*c*)
$B^{*+}K^-$	seen	97

$B^*_{s2}(5840)^0$

$I(J^P) = 0(2^+)$
I, J, P need confirmation.

Mass $m = 5839.86 \pm 0.12$ MeV
$m_{B^{*0}_{s2}} - m_{B^+} = 560.52 \pm 0.14$ MeV
Full width $\Gamma = 1.49 \pm 0.27$ MeV

$B^*_{s2}(5840)^0$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$B^+ K^-$	**DEFINED AS 1**	252
$B^{*+} K^-$	0.093±0.018	141
$B^0 K^0_S$	0.43 ±0.11	245
$B^{*0} K^0_S$	0.04 ±0.04	–

NOTES

[*a*] Not a pure measurement. See note at head of B^0_s Decay Modes.

[*b*] Here S and P are the hypothetical scalar and pseudoscalar particles with masses of 2.5 GeV/c^2 and 214.3 MeV/c^2, respectively.

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