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BOTTOM MESONS
($B = \pm 1$)

$B^+ = u\overline{b}$, $B^0 = d\overline{b}$, $\overline{B}^0 = \overline{d}\, b$, $B^- = \overline{u}\, b$,   similarly for B^*'s

B-particle organization

Many measurements of B decays involve admixtures of B hadrons. Previously we arbitrarily included such admixtures in the $B^\pm$ section, but because of their importance we have created two new sections: "$B^\pm/B^0$ Admixture" for $\Upsilon(4S)$ results and "$B^\pm/B^0/B^0_s/b$-baryon Admixture" for results at higher energies. Most inclusive decay branching fractions and χ_b at high energy are found in the Admixture sections. B^0-$\overline{B}^0$ mixing data are found in the B^0 section, while B^0_s-$\overline{B}^0_s$ mixing data and B-$\overline{B}$ mixing data for a B^0/B^0_s admixture are found in the B^0_s section. CP-violation data are found in the $B^\pm$, B^0, and $B^\pm$ B^0 Admixture sections. b-baryons are found near the end of the Baryon section.

The organization of the B sections is now as follows, where bullets indicate particle sections and brackets indicate reviews.

- $B^\pm$
  mass, mean life, branching fractions CP violation
- B^0
  mass, mean life, branching fractions
  polarization in B^0 decay, B^0-$\overline{B}^0$ mixing, CP violation
- $B^\pm$ B^0 Admixtures
  branching fractions, CP violation
- $B^\pm/B^0/B^0_s/b$-baryon Admixtures
  mean life, production fractions, branching fractions
  χ_b at high energy, V_{cb} measurements
  - B^*
    mass
  - B^0_s
    mass, mean life, branching fractions
    polarization in B^0_s decay, B^0_s-$\overline{B}^0_s$ mixing
  - $B^\pm_c$
    mass, mean life, branching fractions

At end of Baryon Listings:

- Λ_b
  mass, mean life, branching fractions
- b-baryon Admixture
  mean life, branching fractions

$B^{\pm}$

$I(J^P) = \frac{1}{2}(0^-)$

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

Mass $m_{B^{\pm}} = 5279.0 \pm 0.5$ MeV
Mean life $\tau_{B^{\pm}} = (1.671 \pm 0.018) \times 10^{-12}$ s
$c\tau = 501$ μm

CP violation

$A_{CP}(B^+ \to J/\psi(1S) K^+) = -0.007 \pm 0.019$
$A_{CP}(B^+ \to J/\psi(1S) \pi^+) = -0.01 \pm 0.13$
$A_{CP}(B^+ \to \psi(2S) K^+) = -0.037 \pm 0.025$
$A_{CP}(B^+ \to \overline{D}^0 K^+) = 0.04 \pm 0.07$
$A_{CP}(B^+ \to D_{CP(+1)} K^+) = 0.06 \pm 0.19$
$A_{CP}(B^+ \to D_{CP(-1)} K^+) = -0.19 \pm 0.18$
$A_{CP}(B^+ \to \pi^+ \pi^0) = 0.05 \pm 0.15$
$A_{CP}(B^+ \to K^+ \pi^0) = -0.10 \pm 0.08$
$A_{CP}(B^+ \to K^0_S \pi^+) = 0.03 \pm 0.08$ (S = 1.1)
$A_{CP}(B^+ \to \pi^+ \pi^- \pi^+) = -0.39 \pm 0.35$
$A_{CP}(B^+ \to \rho^+ \rho^0) = -0.09 \pm 0.16$
$A_{CP}(B^+ \to K^+ \pi^- \pi^+) = 0.01 \pm 0.08$
$A_{CP}(B^+ \to K^+ K^- K^+) = 0.02 \pm 0.08$
$A_{CP}(B^+ \to K^+ \eta') = 0.009 \pm 0.035$
$A_{CP}(B^+ \to \omega \pi^+) = -0.21 \pm 0.19$
$A_{CP}(B^+ \to \omega K^+) = -0.21 \pm 0.28$
$A_{CP}(B^+ \to \phi K^+) = 0.03 \pm 0.07$
$A_{CP}(B^+ \to \phi K^*(892)^+) = 0.09 \pm 0.15$
$A_{CP}(B^+ \to \rho^0 K^*(892)^+) = 0.20 \pm 0.31$

B^- modes are charge conjugates of the modes below. Modes which do not identify the charge state of the B are listed in the $B^{\pm}/B^0$ ADMIXTURE section.

The branching fractions listed below assume 50% $B^0 \overline{B}^0$ and 50% $B^+ B^-$ production at the $\Upsilon(4S)$. We have attempted to bring older measurements up to date by rescaling their assumed $\Upsilon(4S)$ production ratio to 50:50 and their assumed D, D_s, D^*, and ψ branching ratios to current values whenever this would affect our averages and best limits significantly.

Indentation is used to indicate a subchannel of a previous reaction. All resonant subchannels have been corrected for resonance branching fractions to the final state so the sum of the subchannel branching fractions can exceed that of the final state.

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^+ DECAY MODES		Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
Semileptonic and leptonic modes				
$\ell^+ \nu_\ell$ anything	[a]	(10.2 ± 0.9) %		–
$\overline{D}^0 \ell^+ \nu_\ell$	[a]	(2.15 ± 0.22) %		2310
$\overline{D}^*(2007)^0 \ell^+ \nu_\ell$	[a]	(6.5 ± 0.5) %		2258
$\overline{D}_1(2420)^0 \ell^+ \nu_\ell$		$(5.6 \pm 1.6) \times 10^{-3}$		2084
$\overline{D}_2^*(2460)^0 \ell^+ \nu_\ell$		$< 8 \times 10^{-3}$	CL=90%	2067
$\pi^0 e^+ \nu_e$		$(9.0 \pm 2.8) \times 10^{-5}$		2638
$\eta \ell^+ \nu_\ell$		$(8 \pm 4) \times 10^{-5}$		2611
$\omega \ell^+ \nu_\ell$	[a]	$< 2.1 \times 10^{-4}$	CL=90%	2582
$\rho^0 \ell^+ \nu_\ell$	[a]	$(1.34^{+0.32}_{-0.35}) \times 10^{-4}$		2583
$p \overline{p} e^+ \nu_e$		$< 5.2 \times 10^{-3}$	CL=90%	2467
$e^+ \nu_e$		$< 1.5 \times 10^{-5}$	CL=90%	2640
$\mu^+ \nu_\mu$		$< 2.1 \times 10^{-5}$	CL=90%	2638
$\tau^+ \nu_\tau$		$< 5.7 \times 10^{-4}$	CL=90%	2340
$e^+ \nu_e \gamma$		$< 2.0 \times 10^{-4}$	CL=90%	2640
$\mu^+ \nu_\mu \gamma$		$< 5.2 \times 10^{-5}$	CL=90%	2638
D, D^*, or D_s modes				
$\overline{D}^0 \pi^+$		$(4.98 \pm 0.29) \times 10^{-3}$		2308
$\overline{D}^0 \rho^+$		(1.34 ± 0.18) %		2236
$\overline{D}^0 K^+$		$(3.7 \pm 0.6) \times 10^{-4}$	S=1.1	2280
$\overline{D}^0 K^*(892)^+$		$(6.1 \pm 2.3) \times 10^{-4}$		2213
$\overline{D}^0 K^+ \overline{K}^0$		$(5.5 \pm 1.6) \times 10^{-4}$		2189
$\overline{D}^0 K^+ \overline{K}^*(892)^0$		$(7.5 \pm 1.7) \times 10^{-4}$		2071
$\overline{D}^0 \pi^+ \pi^+ \pi^-$		(1.1 ± 0.4) %		2289
$\overline{D}^0 \pi^+ \pi^+ \pi^-$ nonresonant		$(5 \pm 4) \times 10^{-3}$		2289
$\overline{D}^0 \pi^+ \rho^0$		$(4.2 \pm 3.0) \times 10^{-3}$		2207
$\overline{D}^0 a_1(1260)^+$		$(5 \pm 4) \times 10^{-3}$		2123
$\overline{D}^0 \omega \pi^+$		$(4.1 \pm 0.9) \times 10^{-3}$		2206
$D^*(2010)^- \pi^+ \pi^+$		$(2.1 \pm 0.6) \times 10^{-3}$		2247
$D^- \pi^+ \pi^+$		$< 1.4 \times 10^{-3}$	CL=90%	2299
$\overline{D}^*(2007)^0 \pi^+$		$(4.6 \pm 0.4) \times 10^{-3}$		2256
$\overline{D}^*(2007)^0 \omega \pi^+$		$(4.5 \pm 1.2) \times 10^{-3}$		2149
$\overline{D}^*(2007)^0 \rho^+$		$(9.8 \pm 1.7) \times 10^{-3}$		2181
$\overline{D}^*(2007)^0 K^+$		$(3.6 \pm 1.0) \times 10^{-4}$		2227
$\overline{D}^*(2007)^0 K^*(892)^+$		$(7.2 \pm 3.4) \times 10^{-4}$		2156
$\overline{D}^*(2007)^0 K^+ \overline{K}^0$		$< 1.06 \times 10^{-3}$	CL=90%	2132
$\overline{D}^*(2007)^0 K^+ K^*(892)^0$		$(1.5 \pm 0.4) \times 10^{-3}$		2008

$\overline{D}^*(2007)^0\pi^+\pi^+\pi^-$	$(9.4 \pm 2.6) \times 10^{-3}$		2236
$\quad\overline{D}^*(2007)^0 a_1(1260)^+$	(1.9 ± 0.5) %		2062
$\overline{D}^*(2007)^0\pi^-\pi^+\pi^+\pi^0$	(1.8 ± 0.4) %		2219
$D^*(2010)^+\pi^0$	$< 1.7 \times 10^{-4}$	CL=90%	2255
$\overline{D}^*(2010)^+ K^0$	$< 9.5 \times 10^{-5}$	CL=90%	2225
$D^*(2010)^-\pi^+\pi^+\pi^0$	(1.5 ± 0.7) %		2235
$D^*(2010)^-\pi^+\pi^+\pi^+\pi^-$	< 1 %	CL=90%	2217
$\overline{D}_1^*(2420)^0\pi^+$	$(1.5 \pm 0.6) \times 10^{-3}$	S=1.3	2081
$\overline{D}_1^*(2420)^0\rho^+$	$< 1.4 \times 10^{-3}$	CL=90%	1995
$\overline{D}_2^*(2460)^0\pi^+$	$< 1.3 \times 10^{-3}$	CL=90%	2064
$\overline{D}_2^*(2460)^0\rho^+$	$< 4.7 \times 10^{-3}$	CL=90%	1977
$\overline{D}^0 D_s^+$	(1.3 ± 0.4) %		1815
$\overline{D}^0 D_{sJ}(2317)^+$	seen		1605
$\overline{D}^0 D_{sJ}(2457)^+$	seen		–
$\overline{D}^0 D_{sJ}(2536)^+$	not seen		1447
$\overline{D}^*(2007)^0 D_{sJ}(2536)^+$	not seen		1338
$\overline{D}^0 D_{sJ}(2573)^+$	not seen		1417
$\overline{D}^*(2007)^0 D_{sJ}(2573)^+$	not seen		1306
$\overline{D}^0 D_s^{*+}$	$(9 \pm 4) \times 10^{-3}$		1734
$\overline{D}^*(2007)^0 D_s^+$	(1.2 ± 0.5) %		1737
$\overline{D}^*(2007)^0 D_s^{*+}$	(2.7 ± 1.0) %		1651
$D_s^{(*)+}\overline{D}^{**0}$	(2.7 ± 1.2) %		–
$\overline{D}^*(2007)^0 D^*(2010)^+$	< 1.1 %	CL=90%	1713
$\overline{D}^0 D^*(2010)^+ + \overline{D}^*(2007)^0 D^+$	< 1.3 %	CL=90%	1792
$\overline{D}^0 D^+$	$< 6.7 \times 10^{-3}$	CL=90%	1866
$\overline{D}^0 D^+ K^0$	$< 2.8 \times 10^{-3}$	CL=90%	1571
$\overline{D}^*(2007)^0 D^+ K^0$	$< 6.1 \times 10^{-3}$	CL=90%	1475
$\overline{D}^0\overline{D}^*(2010)^+ K^0$	$(5.2 \pm 1.2) \times 10^{-3}$		1476
$\overline{D}^*(2007)^0 D^*(2010)^+ K^0$	$(7.8 \pm 2.6) \times 10^{-3}$		1362
$\overline{D}^0 D^0 K^+$	$(1.9 \pm 0.4) \times 10^{-3}$		1577
$\overline{D}^*(2010)^0 D^0 K^+$	$< 3.8 \times 10^{-3}$	CL=90%	–
$\overline{D}^0 D^*(2007)^0 K^+$	$(4.7 \pm 1.0) \times 10^{-3}$		1481
$\overline{D}^*(2007)^0 D^*(2007)^0 K^+$	$(5.3 \pm 1.6) \times 10^{-3}$		1368
$D^- D^+ K^+$	$< 4 \times 10^{-4}$	CL=90%	1571
$D^- D^*(2010)^+ K^+$	$< 7 \times 10^{-4}$	CL=90%	1475
$D^*(2010)^- D^+ K^+$	$(1.5 \pm 0.4) \times 10^{-3}$		1475
$D^*(2010)^- D^*(2010)^+ K^+$	$< 1.8 \times 10^{-3}$	CL=90%	1363
$(\overline{D}+\overline{D}^*)(D+D^*)K$	(3.5 ± 0.6) %		–
$D_s^+\pi^0$	$< 2.0 \times 10^{-4}$	CL=90%	2270
$D_s^{*+}\pi^0$	$< 3.3 \times 10^{-4}$	CL=90%	2215
$D_s^+\eta$	$< 5 \times 10^{-4}$	CL=90%	2235
$D_s^{*+}\eta$	$< 8 \times 10^{-4}$	CL=90%	2178

$D_s^+ \rho^0$	$<$ 4	$\times 10^{-4}$	CL=90%	2197
$D_s^{*+} \rho^0$	$<$ 5	$\times 10^{-4}$	CL=90%	2138
$D_s^+ \omega$	$<$ 5	$\times 10^{-4}$	CL=90%	2195
$D_s^{*+} \omega$	$<$ 7	$\times 10^{-4}$	CL=90%	2136
$D_s^+ a_1(1260)^0$	$<$ 2.2	$\times 10^{-3}$	CL=90%	2079
$D_s^{*+} a_1(1260)^0$	$<$ 1.6	$\times 10^{-3}$	CL=90%	2014
$D_s^+ \phi$	$<$ 3.2	$\times 10^{-4}$	CL=90%	2141
$D_s^{*+} \phi$	$<$ 4	$\times 10^{-4}$	CL=90%	2079
$D_s^+ \overline{K}^0$	$<$ 1.1	$\times 10^{-3}$	CL=90%	2241
$D_s^{*+} \overline{K}^0$	$<$ 1.1	$\times 10^{-3}$	CL=90%	2184
$D_s^+ \overline{K}^*(892)^0$	$<$ 5	$\times 10^{-4}$	CL=90%	2172
$D_s^{*+} \overline{K}^*(892)^0$	$<$ 4	$\times 10^{-4}$	CL=90%	2112
$D_s^- \pi^+ K^+$	$<$ 8	$\times 10^{-4}$	CL=90%	2222
$D_s^{*-} \pi^+ K^+$	$<$ 1.2	$\times 10^{-3}$	CL=90%	2164
$D_s^- \pi^+ K^*(892)^+$	$<$ 6	$\times 10^{-3}$	CL=90%	2138
$D_s^{*-} \pi^+ K^*(892)^+$	$<$ 8	$\times 10^{-3}$	CL=90%	2076

Charmonium modes

$\eta_c K^+$	(9.0 $\pm$2.7)	$\times 10^{-4}$		1754
$J/\psi(1S) K^+$	(1.00$\pm$0.04)	$\times 10^{-3}$		1683
$J/\psi(1S) K^+ \pi^+ \pi^-$	(7.7 $\pm$2.0)	$\times 10^{-4}$		1612
$X(3872) K^+$	seen			–
$J/\psi(1S) K^*(892)^+$	(1.35$\pm$0.10)	$\times 10^{-3}$		1571
$J/\psi(1S) K(1270)^+$	(1.8 $\pm$0.5)	$\times 10^{-3}$		1390
$J/\psi(1S) K(1400)^+$	$<$ 5	$\times 10^{-4}$	CL=90%	1308
$J/\psi(1S) \phi K^+$	(5.2 $\pm$1.7)	$\times 10^{-5}$	S=1.2	1227
$J/\psi(1S) \pi^+$	(4.0 $\pm$0.5)	$\times 10^{-5}$		1727
$J/\psi(1S) \rho^+$	$<$ 7.7	$\times 10^{-4}$	CL=90%	1611
$J/\psi(1S) a_1(1260)^+$	$<$ 1.2	$\times 10^{-3}$	CL=90%	1414
$J/\psi(1S) p \overline{\Lambda}$	(1.2 $^{+0.9}_{-0.6}$)	$\times 10^{-5}$		567
$\psi(2S) K^+$	(6.8 $\pm$0.4)	$\times 10^{-4}$		1284
$\psi(2S) K^*(892)^+$	(9.2 $\pm$2.2)	$\times 10^{-4}$		1115
$\psi(2S) K^+ \pi^+ \pi^-$	(1.9 $\pm$1.2)	$\times 10^{-3}$		1178
$\chi_{c0}(1P) K^+$	(6.0 $^{+2.4}_{-2.1}$)	$\times 10^{-4}$		1478
$\chi_{c1}(1P) K^+$	(6.8 $\pm$1.2)	$\times 10^{-4}$		1411
$\chi_{c1}(1P) K^*(892)^+$	$<$ 2.1	$\times 10^{-3}$	CL=90%	1265

K or K^* modes

$K^0 \pi^+$	(1.88$\pm$0.21)	$\times 10^{-5}$		2614
$K^+ \pi^0$	(1.29$\pm$0.12)	$\times 10^{-5}$		2615
$\eta' K^+$	(7.8 $\pm$0.5)	$\times 10^{-5}$		2528
$\eta' K^*(892)^+$	$<$ 3.5	$\times 10^{-5}$	CL=90%	2472

ηK^+	$<$ 6.9	$\times 10^{-6}$	CL=90%	2588
$\eta K^*(892)^+$	(2.6 $^{+1.0}_{-0.9}$)	$\times 10^{-5}$		2534
ωK^+	(9.2 $^{+2.8}_{-2.5}$)	$\times 10^{-6}$		2557
$\omega K^*(892)^+$	$<$ 8.7	$\times 10^{-5}$	CL=90%	2503
$K^*(892)^0 \pi^+$	(1.9 $^{+0.6}_{-0.8}$)	$\times 10^{-5}$		2562
$K^*(892)^+ \pi^0$	$<$ 3.1	$\times 10^{-5}$	CL=90%	2562
$K^+ \pi^- \pi^+$	(5.7 $\pm$0.4)	$\times 10^{-5}$		2609
$K^+ \pi^- \pi^+$ nonresonant	$<$ 2.8	$\times 10^{-5}$	CL=90%	2609
$K^+ \rho^0$	$<$ 1.2	$\times 10^{-5}$	CL=90%	2558
$K_2^*(1430)^0 \pi^+$	$<$ 6.8	$\times 10^{-4}$	CL=90%	2445
$K^- \pi^+ \pi^+$	$<$ 1.8	$\times 10^{-6}$	CL=90%	2609
$K^- \pi^+ \pi^+$ nonresonant	$<$ 5.6	$\times 10^{-5}$	CL=90%	2609
$K_1(1400)^0 \pi^+$	$<$ 2.6	$\times 10^{-3}$	CL=90%	2451
$K^0 \pi^+ \pi^0$	$<$ 6.6	$\times 10^{-5}$	CL=90%	2609
$K^0 \rho^+$	$<$ 4.8	$\times 10^{-5}$	CL=90%	2558
$K^*(892)^+ \pi^+ \pi^-$	$<$ 1.1	$\times 10^{-3}$	CL=90%	2556
$K^*(892)^+ \rho^0$	(1.1 $\pm$0.4)	$\times 10^{-5}$		2504
$K^*(892)^+ K^*(892)^0$	$<$ 7.1	$\times 10^{-5}$	CL=90%	2484
$K_1(1400)^+ \rho^0$	$<$ 7.8	$\times 10^{-4}$	CL=90%	2387
$K_2^*(1430)^+ \rho^0$	$<$ 1.5	$\times 10^{-3}$	CL=90%	2381
$K^+ \overline{K}^0$	$<$ 2.0	$\times 10^{-6}$	CL=90%	2593
$\overline{K}^0 K^+ \pi^0$	$<$ 2.4	$\times 10^{-5}$	CL=90%	2578
$K^+ K_S^0 K_S^0$	(1.34$\pm$0.24)	$\times 10^{-5}$		2521
$K_S^0 K_S^0 \pi^+$	$<$ 3.2	$\times 10^{-6}$	CL=90%	2577
$K^+ K^- \pi^+$	$<$ 6.3	$\times 10^{-6}$	CL=90%	2578
$K^+ K^- \pi^+$ nonresonant	$<$ 7.5	$\times 10^{-5}$	CL=90%	2578
$K^+ K^+ \pi^-$	$<$ 1.3	$\times 10^{-6}$	CL=90%	2578
$K^+ K^+ \pi^-$ nonresonant	$<$ 8.79	$\times 10^{-5}$	CL=90%	2578
$K^+ K^*(892)^0$	$<$ 5.3	$\times 10^{-6}$	CL=90%	2540
$K^+ K^- K^+$	(3.08$\pm$0.21)	$\times 10^{-5}$		2522
$K^+ \phi$	(9.3 $\pm$1.0)	$\times 10^{-6}$	S=1.3	2516
$K^+ K^- K^+$ nonresonant	$<$ 3.8	$\times 10^{-5}$	CL=90%	2522
$K^*(892)^+ K^+ K^-$	$<$ 1.6	$\times 10^{-3}$	CL=90%	2466
$K^*(892)^+ \phi$	(9.6 $\pm$3.0)	$\times 10^{-6}$	S=1.9	2460
$K_1(1400)^+ \phi$	$<$ 1.1	$\times 10^{-3}$	CL=90%	2339
$K_2^*(1430)^+ \phi$	$<$ 3.4	$\times 10^{-3}$	CL=90%	2332
$K^+ \phi \phi$	(2.6 $^{+1.1}_{-0.9}$)	$\times 10^{-6}$		2306
$K^*(892)^+ \gamma$	(3.8 $\pm$0.5)	$\times 10^{-5}$		2564
$K_1(1270)^+ \gamma$	$<$ 9.9	$\times 10^{-5}$	CL=90%	2486
$\phi K^+ \gamma$	(3.4 $\pm$1.0)	$\times 10^{-6}$		2516
$K^+ \pi^- \pi^+ \gamma$	(2.4 $^{+0.6}_{-0.5}$)	$\times 10^{-5}$		2609

$K^*(892)^0 \pi^+ \gamma$	$(2.0 {}^{+0.7}_{-0.6}) \times 10^{-5}$			2562
$K^+ \rho^0 \gamma$	< 2.0	$\times 10^{-5}$	CL=90%	2558
$K^+ \pi^- \pi^+ \gamma$ nonresonant	< 9.2	$\times 10^{-6}$	CL=90%	2609
$K_1(1400)^+ \gamma$	< 5.0	$\times 10^{-5}$	CL=90%	2453
$K_2^*(1430)^+ \gamma$	< 1.4	$\times 10^{-3}$	CL=90%	2447
$K^*(1680)^+ \gamma$	< 1.9	$\times 10^{-3}$	CL=90%	2360
$K_3^*(1780)^+ \gamma$	< 5.5	$\times 10^{-3}$	CL=90%	2341
$K_4^*(2045)^+ \gamma$	< 9.9	$\times 10^{-3}$	CL=90%	2243

Light unflavored meson modes

$\rho^+ \gamma$	< 2.1	$\times 10^{-6}$	CL=90%	2583
$\pi^+ \pi^0$	$(5.6 {}^{+0.9}_{-1.1}) \times 10^{-6}$			2636
$\pi^+ \pi^+ \pi^-$	$(1.1 \pm 0.4) \times 10^{-5}$			2630
$\rho^0 \pi^+$	$(8.6 \pm 2.0) \times 10^{-6}$			2581
$\pi^+ f_0(980)$	< 1.4	$\times 10^{-4}$	CL=90%	2547
$\pi^+ f_2(1270)$	< 2.4	$\times 10^{-4}$	CL=90%	2483
$\pi^+ \pi^- \pi^+$ nonresonant	< 4.1	$\times 10^{-5}$	CL=90%	2630
$\pi^+ \pi^0 \pi^0$	< 8.9	$\times 10^{-4}$	CL=90%	2631
$\rho^+ \pi^0$	< 4.3	$\times 10^{-5}$	CL=90%	2581
$\pi^+ \pi^- \pi^+ \pi^0$	< 4.0	$\times 10^{-3}$	CL=90%	2621
$\rho^+ \rho^0$	$(2.6 \pm 0.6) \times 10^{-5}$			2523
$a_1(1260)^+ \pi^0$	< 1.7	$\times 10^{-3}$	CL=90%	2494
$a_1(1260)^0 \pi^+$	< 9.0	$\times 10^{-4}$	CL=90%	2494
$\omega \pi^+$	$(6.4 {}^{+1.8}_{-1.6}) \times 10^{-6}$		S=1.3	2580
$\omega \rho^+$	< 6.1	$\times 10^{-5}$	CL=90%	2522
$\eta \pi^+$	< 5.7	$\times 10^{-6}$	CL=90%	2609
$\eta' \pi^+$	< 7.0	$\times 10^{-6}$	CL=90%	2551
$\eta' \rho^+$	< 3.3	$\times 10^{-5}$	CL=90%	2492
$\eta \rho^+$	< 1.5	$\times 10^{-5}$	CL=90%	2553
$\phi \pi^+$	< 4.1	$\times 10^{-7}$	CL=90%	2539
$\phi \rho^+$	< 1.6	$\times 10^{-5}$		2480
$\pi^+ \pi^+ \pi^+ \pi^- \pi^-$	< 8.6	$\times 10^{-4}$	CL=90%	2608
$\rho^0 a_1(1260)^+$	< 6.2	$\times 10^{-4}$	CL=90%	2433
$\rho^0 a_2(1320)^+$	< 7.2	$\times 10^{-4}$	CL=90%	2410
$\pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^0$	< 6.3	$\times 10^{-3}$	CL=90%	2592
$a_1(1260)^+ a_1(1260)^0$	< 1.3	%	CL=90%	2335

Charged particle ($h^\pm$) modes

$h^\pm = K^\pm$ or $\pi^\pm$

$h^+ \pi^0$	$(1.6 {}^{+0.7}_{-0.6}) \times 10^{-5}$			2636
ωh^+	$(1.38 {}^{+0.27}_{-0.24}) \times 10^{-5}$			2580
$h^+ X^0$ (Familon)	< 4.9	$\times 10^{-5}$	CL=90%	–

Baryon modes

$p\overline{p}\pi^+$	< 3.7	$\times 10^{-6}$	CL=90%	2439
$p\overline{p}\pi^+$ nonresonant	< 5.3	$\times 10^{-5}$	CL=90%	2439
$p\overline{p}\pi^+\pi^+\pi^-$	< 5.2	$\times 10^{-4}$	CL=90%	2369
$p\overline{p}K^+$	$(4.3\ ^{+1.2}_{-1.0})$	$\times 10^{-6}$		2348
$p\overline{p}K^+$ nonresonant	< 8.9	$\times 10^{-5}$	CL=90%	2348
$p\overline{\Lambda}$	< 1.5	$\times 10^{-6}$	CL=90%	2430
$p\overline{\Lambda}\pi^+\pi^-$	< 2.0	$\times 10^{-4}$	CL=90%	2367
$\overline{\Delta}^0 p$	< 3.8	$\times 10^{-4}$	CL=90%	2402
$\Delta^{++}\overline{p}$	< 1.5	$\times 10^{-4}$	CL=90%	2402
$D^+ p\overline{p}$	< 1.5	$\times 10^{-5}$	CL=90%	1860
$D^*(2010)^+ p\overline{p}$	< 1.5	$\times 10^{-5}$	CL=90%	1786
$\overline{\Lambda}_c^- p\pi^+$	(2.1 ± 0.7)	$\times 10^{-4}$		1981
$\overline{\Lambda}_c^- p\pi^+\pi^0$	(1.8 ± 0.6)	$\times 10^{-3}$		1936
$\overline{\Lambda}_c^- p\pi^+\pi^+\pi^-$	(2.3 ± 0.7)	$\times 10^{-3}$		1881
$\overline{\Lambda}_c^- p\pi^+\pi^+\pi^-\pi^0$	< 1.34	%	CL=90%	1823
$\overline{\Sigma}_c(2455)^0 p$	< 8	$\times 10^{-5}$	CL=90%	1939
$\overline{\Sigma}_c(2520)^0 p$	< 4.6	$\times 10^{-5}$	CL=90%	1905
$\overline{\Sigma}_c(2455)^0 p\pi^0$	(4.4 ± 1.8)	$\times 10^{-4}$		1897
$\overline{\Sigma}_c(2455)^0 p\pi^-\pi^+$	(4.4 ± 1.7)	$\times 10^{-4}$		1845
$\overline{\Sigma}_c(2455)^{--} p\pi^+\pi^+$	(2.8 ± 1.2)	$\times 10^{-4}$		1845
$\overline{\Lambda}_c(2593)^- / \overline{\Lambda}_c(2625)^- p\pi^+$	< 1.9	$\times 10^{-4}$	CL=90%	–

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

$\pi^+ e^+ e^-$	*B1*		< 3.9	$\times 10^{-3}$	CL=90%	2638
$\pi^+ \mu^+ \mu^-$	*B1*		< 9.1	$\times 10^{-3}$	CL=90%	2633
$K^+ e^+ e^-$	*B1*		$(6.3\ ^{+1.9}_{-1.7})$	$\times 10^{-7}$		2616
$K^+ \mu^+ \mu^-$	*B1*		$(4.5\ ^{+1.4}_{-1.2})$	$\times 10^{-7}$		2612
$K^+ \ell^+ \ell^-$	*B1*	[a]	(5.3 ± 1.1)	$\times 10^{-7}$		2616
$K^+ \overline{\nu}\nu$	*B1*		< 2.4	$\times 10^{-4}$	CL=90%	2616
$K^*(892)^+ e^+ e^-$	*B1*		< 4.6	$\times 10^{-6}$	CL=90%	2564
$K^*(892)^+ \mu^+ \mu^-$	*B1*		< 2.2	$\times 10^{-6}$	CL=90%	2560
$K^*(892)^+ \ell^+ \ell$	*B1*	[a]	< 2.2	$\times 10^{-6}$	CL=90%	2564
$\pi^+ e^+ \mu^-$	*LF*		< 6.4	$\times 10^{-3}$	CL=90%	2637
$\pi^+ e^- \mu^+$	*LF*		< 6.4	$\times 10^{-3}$	CL=90%	2637
$K^+ e^+ \mu^-$	*LF*		< 8	$\times 10^{-7}$	CL=90%	2615
$K^+ e^- \mu^+$	*LF*		< 6.4	$\times 10^{-3}$	CL=90%	2615
$K^*(892)^+ e^\pm \mu^\mp$	*LF*		< 7.9	$\times 10^{-6}$	CL=90%	2563
$\pi^- e^+ e^+$	*L*		< 1.6	$\times 10^{-6}$	CL=90%	2638
$\pi^- \mu^+ \mu^+$	*L*		< 1.4	$\times 10^{-6}$	CL=90%	2633

$\pi^- e^+ \mu^+$	L	$<$ 1.3	$\times 10^{-6}$	CL=90%	2637
$\rho^- e^+ e^+$	L	$<$ 2.6	$\times 10^{-6}$	CL=90%	2583
$\rho^- \mu^+ \mu^+$	L	$<$ 5.0	$\times 10^{-6}$	CL=90%	2578
$\rho^- e^+ \mu^+$	LF	$<$ 3.3	$\times 10^{-6}$	CL=90%	2581
$K^- e^+ e^+$	L	$<$ 1.0	$\times 10^{-6}$	CL=90%	2616
$K^- \mu^+ \mu^+$	L	$<$ 1.8	$\times 10^{-6}$	CL=90%	2612
$K^- e^+ \mu^+$	L	$<$ 2.0	$\times 10^{-6}$	CL=90%	2615
$K^*(892)^- e^+ e^+$	L	$<$ 2.8	$\times 10^{-6}$	CL=90%	2564
$K^*(892)^- \mu^+ \mu^+$	L	$<$ 8.3	$\times 10^{-6}$	CL=90%	2560
$K^*(892)^- e^+ \mu^+$	LF	$<$ 4.4	$\times 10^{-6}$	CL=90%	2563

B^0

$I(J^P) = \frac{1}{2}(0^-)$

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

Mass $m_{B^0} = 5279.4 \pm 0.5$ MeV

$m_{B^0} - m_{B^\pm} = 0.33 \pm 0.28$ MeV (S = 1.1)

Mean life $\tau_{B^0} = (1.536 \pm 0.014) \times 10^{-12}$ s

$c\tau = 460$ μm

$\tau_{B^+}/\tau_{B^0} = 1.086 \pm 0.017$ (direct measurements)

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

$\chi_d = 0.186 \pm 0.004$

$\Delta m_{B^0} = m_{B^0_H} - m_{B^0_L} = (0.502 \pm 0.007) \times 10^{12}\ \hbar\ \mathrm{s}^{-1}$

$= (3.304 \pm 0.046) \times 10^{-10}$ MeV

$x_d = \Delta m_{B^0}/\Gamma_{B^0} = 0.771 \pm 0.012$

CP violation parameters

$\mathrm{Re}(\epsilon_{B^0})/(1+|\epsilon_{B^0}|^2) = (0.5 \pm 3.1) \times 10^{-3}$
$A_{T/CP} = 0.005 \pm 0.018$
$A_{CP}\ (B^0 \to K^+\pi^-) = -0.09 \pm 0.04$
$A_{CP}(B^0 \to \rho^+\pi^-) = -0.18 \pm 0.09$
$A_{CP}(B^0 \to \rho^+K^-) = 0.28 \pm 0.19$
$A_{CP}(B^0 \to K^*(892)^+\pi^-) = 0.26 \pm 0.35$
$A_{CP}(B^0 \to K^*(892)^0\phi) = 0.05 \pm 0.10$
$A_{CP}(B^0 \to D^*(2010)^+D^-) = -0.03 \pm 0.12$
$C_{\pi\pi}\ (B^0 \to \pi^+\pi^-) = -0.51 \pm 0.23$ (S = 1.2)
$S_{\pi\pi}\ (B^0 \to \pi^+\pi^-) = -0.5 \pm 0.6$ (S = 2.3)
$C_{\rho\pi}\ (B^0 \to \rho^+\pi^-) = 0.36 \pm 0.18$
$S_{\rho\pi}\ (B^0 \to \rho^+\pi^-) = 0.19 \pm 0.24$
$C_{\eta'(958)K}\ (B^0 \to \eta'(958)K^0_S) = 0.04 \pm 0.13$
$S_{\eta'(958)K}\ (B^0 \to \eta'(958)K^0_S) = 0.27 \pm 0.21$
$C_{\phi K^0_S}\ (B^0 \to \phi K^0_S) = 0.15 \pm 0.30$
$S_{\phi K^0_S}\ (B^0 \to \phi K^0_S) = -1.0 \pm 0.5$
$C_{K^+K^-K^0_S}\ (B^0 \to K^+K^-K^0_S) = 0.17 \pm 0.16$
$S_{K^+K^-K^0_S}\ (B^0 \to K^+K^-K^0_S) = -0.51 \pm 0.26$
$C_{D^*(2010)^-D^+}\ (B^0 \to D^*(2010)^-D^+) = -0.2 \pm 0.4$
$S_{D^*(2010)^-D^+}\ (B^0 \to D^*(2010)^-D^+) = -0.2 \pm 0.7$
$C_{D^*(2010)^+D^-}\ (B^0 \to D^*(2010)^+D^-) = -0.5 \pm 0.4$
$S_{D^*(2010)^+D^-}\ (B^0 \to D^*(2010)^+D^-) = -0.8 \pm 0.8$
$C_{J/\psi(1S)\pi^0}\ (B^0 \to J/\psi(1S)\pi^0) = 0.4 \pm 0.4$
$S_{J/\psi(1S)\pi^0}\ (B^0 \to J/\psi(1S)\pi^0) = 0.1 \pm 0.5$
$\Delta C_{\rho\pi}\ (B^0 \to \rho^+\pi^-) = 0.28 \pm 0.19$
$\Delta S_{\rho\pi}\ (B^0 \to \rho^+\pi^-) = 0.15 \pm 0.25$
$|\lambda|\ (B^0 \to c\overline{c}K^0) = 0.949 \pm 0.045$
$|\lambda|\ (B^0 \to D^{*+}D^{*-}) = 0.75 \pm 0.19$
$\mathrm{Im}(\lambda)\ (B^0 \to D^{*+}D^{*-}) = 0.05 \pm 0.31$
$\sin(2\beta) = 0.731 \pm 0.056$

$\overline{B}^0$ modes are charge conjugates of the modes below. Reactions indicate the weak decay vertex and do not include mixing. Modes which do not identify the charge state of the B are listed in the $B^\pm/B^0$ ADMIXTURE section.

The branching fractions listed below assume 50% $B^0\overline{B}^0$ and 50% B^+B^- production at the $\Upsilon(4S)$. We have attempted to bring older measurements up to date by rescaling their assumed $\Upsilon(4S)$ production ratio to 50:50

and their assumed D, D_s, D^*, and ψ branching ratios to current values whenever this would affect our averages and best limits significantly.

Indentation is used to indicate a subchannel of a previous reaction. All resonant subchannels have been corrected for resonance branching fractions to the final state so the sum of the subchannel branching fractions can exceed that of the final state.

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^0 DECAY MODES		Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\ell^+ \nu_\ell$ anything	[a]	(10.5 ± 0.8) %		–
$D^- \ell^+ \nu_\ell$	[a]	(2.14 ± 0.20) %		2309
$D^*(2010)^- \ell^+ \nu_\ell$	[a]	(5.44 ± 0.23) %		2257
$\rho^- \ell^+ \nu_\ell$	[a]	$(2.6 \pm 0.7) \times 10^{-4}$		2583
$\pi^- \ell^+ \nu_\ell$	[a]	$(1.33 \pm 0.22) \times 10^{-4}$		2638
Inclusive modes				
K^+ anything		(78 ± 8) %		–
D, D^*, or D_s modes				
$D^- \pi^+$		$(2.76 \pm 0.25) \times 10^{-3}$		2306
$D^- \rho^+$		$(7.7 \pm 1.3) \times 10^{-3}$		2235
$D^- K^*(892)^+$		$(3.7 \pm 1.8) \times 10^{-4}$		2211
$D^- \omega \pi^+$		$(2.8 \pm 0.6) \times 10^{-3}$		2204
$D^- K^+$		$(2.0 \pm 0.6) \times 10^{-4}$		2279
$D^- K^+ \overline{K}^0$		$< 3.1 \times 10^{-4}$	CL=90%	2188
$D^- K^+ \overline{K}^*(892)^0$		$(8.8 \pm 1.9) \times 10^{-4}$		2070
$\overline{D}^0 \pi^+ \pi^-$		$(8.0 \pm 1.6) \times 10^{-4}$		2301
$D^*(2010)^- \pi^+$		$(2.76 \pm 0.21) \times 10^{-3}$		2255
$D^- \pi^+ \pi^+ \pi^-$		$(8.0 \pm 2.5) \times 10^{-3}$		2287
$(D^- \pi^+ \pi^+ \pi^-)$ nonresonant		$(3.9 \pm 1.9) \times 10^{-3}$		2287
$D^- \pi^+ \rho^0$		$(1.1 \pm 1.0) \times 10^{-3}$		2206
$D^- a_1(1260)^+$		$(6.0 \pm 3.3) \times 10^{-3}$		2121
$D^*(2010)^- \pi^+ \pi^0$		(1.5 ± 0.5) %		2247
$D^*(2010)^- \rho^+$		$(6.8 \pm 0.9) \times 10^{-3}$		2180
$D^*(2010)^- K^+$		$(2.0 \pm 0.5) \times 10^{-4}$		2226
$D^*(2010)^- K^*(892)^+$		$(3.8 \pm 1.5) \times 10^{-4}$		2155
$D^*(2010)^- K^+ \overline{K}^0$		$< 4.7 \times 10^{-4}$	CL=90%	2131
$D^*(2010)^- K^+ \overline{K}^*(892)^0$		$(1.29 \pm 0.33) \times 10^{-3}$		2007
$D^*(2010)^- \pi^+ \pi^+ \pi^-$		$(7.6 \pm 1.8) \times 10^{-3}$	S=1.4	2235
$(D^*(2010)^- \pi^+ \pi^+ \pi^-)$ nonresonant		$(0.0 \pm 2.5) \times 10^{-3}$		2235
$D^*(2010)^- \pi^+ \rho^0$		$(5.7 \pm 3.2) \times 10^{-3}$		2150

$D^*(2010)^- a_1(1260)^+$	(1.30 ± 0.27) %		2061
$D^*(2010)^- \pi^+ \pi^+ \pi^- \pi^0$	(1.76 ± 0.27) %		2218
$D^*(2010)^+ \pi^+ \pi^- \pi^- \pi^0$	$(1.8\ \pm0.7\ )$ %		2218
$D^*(2010)^- p \overline{p} \pi^+$	$(6.5\ \pm1.6\ )\times10^{-4}$		1707
$D^*(2010)^- p \overline{n}$	$(1.5\ \pm0.4\ )\times10^{-3}$		1785
$\overline{D}^*(2010)^- \omega \pi^+$	$(2.9\ \pm0.5\ )\times10^{-3}$		2148
$\overline{D}{}_2^*(2460)^- \pi^+$	$<\ 2.2\ \times10^{-3}$	CL=90%	2064
$\overline{D}{}_2^*(2460)^- \rho^+$	$<\ 4.9\ \times10^{-3}$	CL=90%	1977
$D^- D^+$	$<\ 9.4\ \times10^{-4}$	CL=90%	1864
$D^- D_s^+$	$(8.0\ \pm3.0\ )\times10^{-3}$		1812
$D^*(2010)^- D_s^+$	(1.07 ± 0.29) %		1735
$D^- D_s^{*+}$	$(1.0\ \pm0.5\ )$ %		1732
$D^*(2010)^- D_s^{*+}$	$(1.9\ \pm0.5\ )$ %		1649
$D^- D_{sJ}(2317)^+$	seen		1602
$D^- D_{sJ}(2457)^+$	seen		–
$D^- D_{sJ}(2536)^+$	not seen		1444
$D^*(2010)^- D_{sJ}(2536)^+$	not seen		1336
$D^- D_{sJ}(2573)^+$	not seen		1414
$D^*(2010)^- D_{sJ}(2573)^+$	not seen		1303
$D_s^+ \pi^-$	$(2.7\ \pm1.0\ )\times10^{-5}$		2270
$D_s^{*+} \pi^-$	$<\ 4.1\ \times10^{-5}$	CL=90%	2215
$D_s^+ \rho^-$	$<\ 7\ \times10^{-4}$	CL=90%	2197
$D_s^{*+} \rho^-$	$<\ 8\ \times10^{-4}$	CL=90%	2138
$D_s^+ a_1(1260)^-$	$<\ 2.6\ \times10^{-3}$	CL=90%	2080
$D_s^{*+} a_1(1260)^-$	$<\ 2.2\ \times10^{-3}$	CL=90%	2015
$D_s^- K^+$	$(3.8\ \pm1.3\ )\times10^{-5}$		2242
$D_s^{*-} K^+$	$<\ 2.5\ \times10^{-5}$	CL=90%	2185
$D_s^- K^*(892)^+$	$<\ 9.9\ \times10^{-4}$	CL=90%	2172
$D_s^{*-} K^*(892)^+$	$<\ 1.1\ \times10^{-3}$	CL=90%	2112
$D_s^- \pi^+ K^0$	$<\ 5\ \times10^{-3}$	CL=90%	2222
$D_s^{*-} \pi^+ K^0$	$<\ 3.1\ \times10^{-3}$	CL=90%	2164
$D_s^- \pi^+ K^*(892)^0$	$<\ 4\ \times10^{-3}$	CL=90%	2138
$D_s^{*-} \pi^+ K^*(892)^0$	$<\ 2.0\ \times10^{-3}$	CL=90%	2076
$\overline{D}{}^0 K^0$	$(5.0\ \pm1.4\ )\times10^{-5}$		2280
$\overline{D}{}^0 K^*(892)^0$	$(4.8\ \pm1.2\ )\times10^{-5}$		2213
$\overline{D}{}^0 \pi^0$	$(2.91\pm0.28)\times10^{-4}$		2308
$\overline{D}{}^0 \rho^0$	$(2.9\ \pm1.1\ )\times10^{-4}$		2237
$\overline{D}{}^0 \eta$	$(2.2\ \pm0.5\ )\times10^{-4}$	S=1.6	2274
$\overline{D}{}^0 \eta'$	$(1.7\ \pm0.4\ )\times10^{-4}$		2198
$\overline{D}{}^0 \omega$	$(2.5\ \pm0.6\ )\times10^{-4}$	S=1.5	2235
$D^0 K^*(892)^0$	$<\ 1.8\ \times10^{-5}$	CL=90%	2213
$\overline{D}{}^{*0} \gamma$	$<\ 5.0\ \times10^{-5}$	CL=90%	2258

$\overline{D}^*(2007)^0 \pi^0$	$(2.7 \pm 0.5) \times 10^{-4}$		2256
$\overline{D}^*(2007)^0 \rho^0$	$< 5.1 \times 10^{-4}$	CL=90%	2181
$\overline{D}^*(2007)^0 \eta$	$(2.6 \pm 0.6) \times 10^{-4}$		2220
$\overline{D}^*(2007)^0 \eta'$	$< 2.6 \times 10^{-4}$	CL=90%	2141
$\overline{D}^*(2007)^0 \pi^+ \pi^-$	$(6.2 \pm 2.2) \times 10^{-4}$		2248
$\overline{D}^*(2007)^0 K^0$	$< 6.6 \times 10^{-5}$	CL=90%	2227
$\overline{D}^*(2007)^0 K^*(892)^0$	$< 6.9 \times 10^{-5}$	CL=90%	2157
$D^*(2007)^0 K^*(892)^0$	$< 4.0 \times 10^{-5}$	CL=90%	2157
$D^*(2007)^0 \pi^+ \pi^+ \pi^- \pi^-$	$(3.0 \pm 0.9) \times 10^{-3}$		2219
$D^*(2010)^+ D^*(2010)^-$	$(8.7 \pm 1.8) \times 10^{-4}$		1711
$\overline{D}^*(2007)^0 \omega$	$(4.2 \pm 1.1) \times 10^{-4}$		2180
$D^*(2010)^+ D^-$	$< 6.3 \times 10^{-4}$	CL=90%	1790
$D^*(2010)^- D^+ + D^*(2010)^+ D^-$	$(9.3 \pm 1.5) \times 10^{-4}$		1790
$D^*(2007)^0 \overline{D}^*(2007)^0$	< 2.7 %	CL=90%	1715
$D^- D^0 K^+$	$(1.7 \pm 0.4) \times 10^{-3}$		1574
$D^- D^*(2007)^0 K^+$	$(4.6 \pm 1.0) \times 10^{-3}$		1478
$D^*(2010)^- D^0 K^+$	$(3.1 {}^{+0.6}_{-0.5}) \times 10^{-3}$		1479
$D^*(2010)^- D^*(2007)^0 K^+$	(1.18 ± 0.20) %		1366
$D^- D^+ K^0$	$< 1.7 \times 10^{-3}$	CL=90%	1568
$D^*(2010)^- D^+ K^0 + D^- D^*(2010)^+ K^0$	$(6.5 \pm 1.6) \times 10^{-3}$		1473
$D^*(2010)^- D^*(2010)^+ K^0$	$(8.8 \pm 1.9) \times 10^{-3}$		1360
$\overline{D}^0 D^0 K^0$	$< 1.4 \times 10^{-3}$	CL=90%	1575
$\overline{D}^0 D^*(2007)^0 K^0 + \overline{D}^*(2007)^0 D^0 K^0$	$< 3.7 \times 10^{-3}$	CL=90%	1478
$\overline{D}^*(2007)^0 D^*(2007)^0 K^0$	$< 6.6 \times 10^{-3}$	CL=90%	1365
$(\overline{D} + \overline{D}^*)(D + D^*) K$	(4.3 ± 0.7) %		–

Charmonium modes

$\eta_c K^0$	$(1.2 \pm 0.4) \times 10^{-3}$		1753
$\eta_c K^*(892)^0$	$(1.6 \pm 0.7) \times 10^{-3}$		1648
$J/\psi(1S) K^0$	$(8.5 \pm 0.5) \times 10^{-4}$		1683
$J/\psi(1S) K^+ \pi^-$	$(1.2 \pm 0.6) \times 10^{-3}$		1652
$J/\psi(1S) K^*(892)^0$	$(1.31 \pm 0.07) \times 10^{-3}$		1571
$J/\psi(1S) \phi K^0$	$(9.4 \pm 2.6) \times 10^{-5}$		1224
$J/\psi(1S) K(1270)^0$	$(1.3 \pm 0.5) \times 10^{-3}$		1390
$J/\psi(1S) \pi^0$	$(2.2 \pm 0.4) \times 10^{-5}$		1728
$J/\psi(1S) \eta$	$< 2.7 \times 10^{-5}$	CL=90%	1672
$J/\psi(1S) \pi^+ \pi^-$	$(4.6 \pm 0.9) \times 10^{-5}$		1716
$J/\psi(1S) \rho^0$	$(1.6 \pm 0.7) \times 10^{-5}$		1611
$J/\psi(1S) \omega$	$< 2.7 \times 10^{-4}$	CL=90%	1609
$J/\psi(1S) \phi$	$< 9.2 \times 10^{-6}$	CL=90%	1519

$J/\psi(1S)\eta'(958)$	$< 6.3 \times 10^{-5}$		CL=90%	1546
$J/\psi(1S)K^0\pi^+\pi^-$	$(1.0 \pm 0.4) \times 10^{-3}$			1611
$J/\psi(1S)K^0\rho^0$	$(5.4 \pm 3.0) \times 10^{-4}$			1390
$J/\psi(1S)K^*(892)^+\pi^-$	$(8 \pm 4) \times 10^{-4}$			1514
$J/\psi(1S)K^*(892)^0\pi^+\pi^-$	$(6.6 \pm 2.2) \times 10^{-4}$			1447
$J/\psi(1S)p\overline{p}$	$< 1.9 \times 10^{-6}$		CL=90%	862
$\psi(2S)K^0$	$(6.2 \pm 0.7) \times 10^{-4}$			1283
$\psi(2S)K^+\pi^-$	$< 1 \times 10^{-3}$		CL=90%	1238
$\psi(2S)K^*(892)^0$	$(8.0 \pm 1.3) \times 10^{-4}$			1116
$\chi_{c0}(1P)K^0$	$< 5.0 \times 10^{-4}$		CL=90%	1477
$\chi_{c1}(1P)K^0$	$(4.0 {}^{+1.2}_{-1.0}) \times 10^{-4}$			1411
$\chi_{c1}(1P)K^*(892)^0$	$(4.1 \pm 1.5) \times 10^{-4}$			1265

K or K^* modes

$K^+\pi^-$	$(1.85 \pm 0.11) \times 10^{-5}$		S=1.2	2615
$K^0\pi^0$	$(9.5 {}^{+2.1}_{-1.9}) \times 10^{-6}$			2614
$\eta' K^0$	$(6.3 \pm 0.7) \times 10^{-5}$		S=1.1	2528
$\eta' K^*(892)^0$	$< 2.4 \times 10^{-5}$		CL=90%	2472
$\eta K^*(892)^0$	$(1.4 {}^{+0.6}_{-0.5}) \times 10^{-5}$			2534
ηK^0	$< 9.3 \times 10^{-6}$		CL=90%	2587
ωK^0	$< 1.3 \times 10^{-5}$		CL=90%	2557
$K^0_S X^0$ (Familon)	$< 5.3 \times 10^{-5}$		CL=90%	–
$\omega K^*(892)^0$	$< 2.3 \times 10^{-5}$		CL=90%	2503
$K^0\overline{K}^0$	$< 3.3 \times 10^{-6}$		CL=90%	2592
$K^0_S K^0_S K^0_S$	$(4.2 {}^{+1.8}_{-1.5}) \times 10^{-6}$			2521
$K^+\pi^-\pi^0$	$< 4.0 \times 10^{-5}$		CL=90%	2609
$K^+\rho^-$	$(7.3 \pm 1.8) \times 10^{-6}$			2559
$K^0\pi^+\pi^-$	$(4.7 \pm 0.7) \times 10^{-5}$			2609
$K^0\rho^0$	$< 3.9 \times 10^{-5}$		CL=90%	2558
$K^0 f_0(980)$	$< 3.6 \times 10^{-4}$		CL=90%	2524
$K^*(892)^+\pi^-$	$(1.6 {}^{+0.6}_{-0.5}) \times 10^{-5}$			2562
$K^*(892)^0\pi^0$	$< 3.6 \times 10^{-6}$		CL=90%	2563
$K^*_2(1430)^+\pi^-$	$< 1.8 \times 10^{-5}$		CL=90%	2445
$K^0K^-\pi^+$	$< 2.1 \times 10^{-5}$		CL=90%	2578
$K^+K^-\pi^0$	$< 1.9 \times 10^{-5}$		CL=90%	2579
$K^0K^+K^-$	$(2.8 \pm 0.5) \times 10^{-5}$			2522
$K^0\phi$	$(8.6 {}^{+1.3}_{-1.1}) \times 10^{-6}$			2516
$K^-\pi^+\pi^+\pi^-$	$< 2.3 \times 10^{-4}$	[b]	CL=90%	2600
$K^*(892)^0\pi^+\pi^-$	$< 1.4 \times 10^{-3}$		CL=90%	2557
$K^*(892)^0\rho^0$	$< 3.4 \times 10^{-5}$		CL=90%	2504

$K^*(892)^0 f_0(980)$		< 1.7	$\times 10^{-4}$	CL=90%	2468
$K_1(1400)^+ \pi^-$		< 1.1	$\times 10^{-3}$	CL=90%	2451
$K^- a_1(1260)^+$	[b]	< 2.3	$\times 10^{-4}$	CL=90%	2471
$K^*(892)^0 K^+ K^-$		< 6.1	$\times 10^{-4}$	CL=90%	2466
$K^*(892)^0 \phi$		(1.07±0.11)	$\times 10^{-5}$		2460
$\overline{K}^*(892)^0 K^*(892)^0$		< 2.2	$\times 10^{-5}$	CL=90%	2485
$K^*(892)^0 K^*(892)^0$		< 3.7	$\times 10^{-5}$	CL=90%	2485
$K^*(892)^+ K^*(892)^-$		< 1.41	$\times 10^{-4}$	CL=90%	2485
$K_1(1400)^0 \rho^0$		< 3.0	$\times 10^{-3}$	CL=90%	2388
$K_1(1400)^0 \phi$		< 5.0	$\times 10^{-3}$	CL=90%	2339
$K_2^*(1430)^0 \rho^0$		< 1.1	$\times 10^{-3}$	CL=90%	2381
$K_2^*(1430)^0 \phi$		< 1.4	$\times 10^{-3}$	CL=90%	2333
$K^*(892)^0 \gamma$		(4.3 ±0.4)	$\times 10^{-5}$		2564
$K^0 \phi \gamma$		< 8.3	$\times 10^{-6}$	CL=90%	2516
$K^+ \pi^- \gamma$		(4.6 ±1.4)	$\times 10^{-6}$		2615
$K^*(1410) \gamma$		< 1.3	$\times 10^{-4}$	CL=90%	2450
$K^+ \pi^- \gamma$ nonresonant		< 2.6	$\times 10^{-6}$	CL=90%	2615
$K_1(1270)^0 \gamma$		< 7.0	$\times 10^{-3}$	CL=90%	2486
$K_1(1400)^0 \gamma$		< 4.3	$\times 10^{-3}$	CL=90%	2453
$K_2^*(1430)^0 \gamma$		(1.3 ±0.5)	$\times 10^{-5}$		2447
$K^*(1680)^0 \gamma$		< 2.0	$\times 10^{-3}$	CL=90%	2360
$K_3^*(1780)^0 \gamma$		< 1.0	%	CL=90%	2341
$K_4^*(2045)^0 \gamma$		< 4.3	$\times 10^{-3}$	CL=90%	2244

Light unflavored meson modes

$\rho^0 \gamma$	< 1.2	$\times 10^{-6}$	CL=90%	2583
$\omega \gamma$	< 1.0	$\times 10^{-6}$	CL=90%	2582
$\phi \gamma$	< 3.3	$\times 10^{-6}$	CL=90%	2541
$\pi^+ \pi^-$	(4.8 ±0.5)	$\times 10^{-6}$		2636
$\pi^0 \pi^0$	(1.9 ±0.5)	$\times 10^{-6}$		2636
$\eta \pi^0$	< 2.9	$\times 10^{-6}$	CL=90%	2610
$\eta \eta$	< 1.8	$\times 10^{-5}$	CL=90%	2582
$\eta' \pi^0$	< 5.7	$\times 10^{-6}$	CL=90%	2551
$\eta' \eta'$	< 4.7	$\times 10^{-5}$	CL=90%	2460
$\eta' \eta$	< 2.7	$\times 10^{-5}$	CL=90%	2522
$\eta' \rho^0$	< 1.2	$\times 10^{-5}$	CL=90%	2492
$\eta \rho^0$	< 1.0	$\times 10^{-5}$	CL=90%	2553
$\omega \eta$	< 1.2	$\times 10^{-5}$	CL=90%	2552
$\omega \eta'$	< 6.0	$\times 10^{-5}$	CL=90%	2491
$\omega \rho^0$	< 1.1	$\times 10^{-5}$	CL=90%	2522
$\omega \omega$	< 1.9	$\times 10^{-5}$	CL=90%	2521
$\phi \pi^0$	< 5	$\times 10^{-6}$	CL=90%	2539
$\phi \eta$	< 9	$\times 10^{-6}$	CL=90%	2511
$\phi \eta'$	< 3.1	$\times 10^{-5}$	CL=90%	2447

$\phi\rho^0$		$<$ 1.3	$\times 10^{-5}$	CL=90%	2480
$\phi\omega$		$<$ 2.1	$\times 10^{-5}$	CL=90%	2479
$\phi\phi$		$<$ 1.2	$\times 10^{-5}$	CL=90%	2435
$\pi^+\pi^-\pi^0$		$<$ 7.2	$\times 10^{-4}$	CL=90%	2631
$\quad\rho^0\pi^0$		$<$ 5.3	$\times 10^{-6}$	CL=90%	2581
$\quad\rho^\mp\pi^\pm$	[c]	(2.28$\pm$0.25)	$\times 10^{-5}$		2581
$\pi^+\pi^-\pi^+\pi^-$		$<$ 2.3	$\times 10^{-4}$	CL=90%	2621
$\quad\rho^0\rho^0$		$<$ 2.1	$\times 10^{-6}$	CL=90%	2523
$\quad a_1(1260)^\mp\pi^\pm$	[c]	$<$ 4.9	$\times 10^{-4}$	CL=90%	2494
$\quad a_2(1320)^\mp\pi^\pm$	[c]	$<$ 3.0	$\times 10^{-4}$	CL=90%	2473
$\pi^+\pi^-\pi^0\pi^0$		$<$ 3.1	$\times 10^{-3}$	CL=90%	2622
$\quad\rho^+\rho^-$		$<$ 2.2	$\times 10^{-3}$	CL=90%	2523
$\quad a_1(1260)^0\pi^0$		$<$ 1.1	$\times 10^{-3}$	CL=90%	2494
$\quad\omega\pi^0$		$<$ 3	$\times 10^{-6}$	CL=90%	2580
$\pi^+\pi^+\pi^-\pi^-\pi^0$		$<$ 9.0	$\times 10^{-3}$	CL=90%	2609
$\quad a_1(1260)^+\rho^-$		$<$ 3.4	$\times 10^{-3}$	CL=90%	2433
$\quad a_1(1260)^0\rho^0$		$<$ 2.4	$\times 10^{-3}$	CL=90%	2433
$\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-$		$<$ 3.0	$\times 10^{-3}$	CL=90%	2592
$\quad a_1(1260)^+a_1(1260)^-$		$<$ 2.8	$\times 10^{-3}$	CL=90%	2336
$\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-\pi^0$		$<$ 1.1	%	CL=90%	2572

Baryon modes

$p\overline{p}$	$<$ 1.2	$\times 10^{-6}$	CL=90%	2467
$p\overline{p}\pi^+\pi^-$	$<$ 2.5	$\times 10^{-4}$	CL=90%	2406
$p\overline{p}K^0$	$<$ 7.2	$\times 10^{-6}$	CL=90%	2347
$p\overline{\Lambda}\pi^-$	($4.0\ ^{+1.1}_{-1.0}$)	$\times 10^{-6}$		2401
$p\overline{\Lambda}K^-$	$<$ 8.2	$\times 10^{-7}$	CL=90%	2308
$p\overline{\Sigma}^0\pi^-$	$<$ 3.8	$\times 10^{-6}$	CL=90%	2383
$\overline{\Lambda}\Lambda$	$<$ 1.0	$\times 10^{-6}$	CL=90%	2392
$\Delta^0\overline{\Delta}^0$	$<$ 1.5	$\times 10^{-3}$	CL=90%	2335
$\Delta^{++}\overline{\Delta}^{--}$	$<$ 1.1	$\times 10^{-4}$	CL=90%	2335
$\overline{D}^0 p\overline{p}$	(1.18$\pm$0.22)	$\times 10^{-4}$		1862
$\overline{D}^*(2007)^0 p\overline{p}$	(1.2 $\pm$0.4)	$\times 10^{-4}$		1788
$\overline{\Sigma}_c^{--}\Delta^{++}$	$<$ 1.0	$\times 10^{-3}$	CL=90%	1840
$\overline{\Lambda}_c^- p\pi^+\pi^-$	(1.3 $\pm$0.4)	$\times 10^{-3}$		1934
$\overline{\Lambda}_c^- p$	(2.2 $\pm$0.8)	$\times 10^{-5}$		2021
$\overline{\Lambda}_c^- p\pi^0$	$<$ 5.9	$\times 10^{-4}$	CL=90%	1982
$\overline{\Lambda}_c^- p\pi^+\pi^-\pi^0$	$<$ 5.07	$\times 10^{-3}$	CL=90%	1883
$\overline{\Lambda}_c^- p\pi^+\pi^-\pi^+\pi^-$	$<$ 2.74	$\times 10^{-3}$	CL=90%	1821
$\overline{\Sigma}_c(2520)^{--}p\pi^+$	(1.6 $\pm$0.7)	$\times 10^{-4}$		1861
$\overline{\Sigma}_c(2520)^0 p\pi^-$	$<$ 1.21	$\times 10^{-4}$	CL=90%	1861

$\overline{\Sigma}_c(2455)^0 p \pi^-$			$(10 \pm 8) \times 10^{-5}$	S=1.7	1896
$\overline{\Sigma}_c(2455)^{--} p \pi^+$			$(2.8 \pm 0.9) \times 10^{-4}$		1896
$\overline{\Lambda}_c(2593)^- / \overline{\Lambda}_c(2625)^- p$			$< 1.1 \times 10^{-4}$	CL=90%	–

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

$\gamma\gamma$	$B1$		$< 1.7 \times 10^{-6}$	CL=90%	2640
$e^+ e^-$	$B1$		$< 1.9 \times 10^{-7}$	CL=90%	2640
$\mu^+ \mu^-$	$B1$		$< 1.6 \times 10^{-7}$	CL=90%	2638
$K^0 e^+ e^-$	$B1$		$< 5.4 \times 10^{-7}$	CL=90%	2616
$K^0 \mu^+ \mu^-$	$B1$		$(5.6 ^{+2.9}_{-2.4}) \times 10^{-7}$		2612
$K^0 \ell^+ \ell^-$	$B1$	[a]	$< 6.8 \times 10^{-7}$	CL=90%	2616
$K^*(892)^0 e^+ e^-$	$B1$		$< 2.4 \times 10^{-6}$	CL=90%	2564
$K^*(892)^0 \mu^+ \mu^-$	$B1$		$(1.3 \pm 0.4) \times 10^{-6}$		2560
$K^*(892)^0 \nu \overline{\nu}$	$B1$		$< 1.0 \times 10^{-3}$	CL=90%	2564
$K^*(892)^0 \ell^+ \ell^-$	$B1$	[a]	$(1.17 \pm 0.30) \times 10^{-6}$		2564
$e^\pm \mu^\mp$	LF	[c]	$< 1.7 \times 10^{-7}$	CL=90%	2639
$K^0 e^\pm \mu^\mp$	LF		$< 4.0 \times 10^{-6}$	CL=90%	2615
$K^*(892)^0 e^\pm \mu^\mp$	LF		$< 3.4 \times 10^{-6}$	CL=90%	2563
$e^\pm \tau^\mp$	LF	[c]	$< 5.3 \times 10^{-4}$	CL=90%	2341
$\mu^\pm \tau^\mp$	LF	[c]	$< 8.3 \times 10^{-4}$	CL=90%	2339

$B^\pm/B^0$ ADMIXTURE

CP violation

$A_{CP}(B \to K^*(892)\gamma) = -0.01 \pm 0.07$

$A_{CP}(B \to s\gamma) = -0.08 \pm 0.11$

The branching fraction measurements are for an admixture of B mesons at the $\Upsilon(4S)$. The values quoted assume that $B(\Upsilon(4S) \to B\overline{B}) = 100\%$.

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.

$\overline{B}$ modes are charge conjugates of the modes below. Reactions indicate the weak decay vertex and do not include mixing.

B DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)

Semileptonic and leptonic modes

$B \to e^+ \nu_e$ anything	[d]	(10.73 ± 0.28) %		–
$B \to \overline{p} e^+ \nu_e$ anything		$< 5.9 \times 10^{-4}$	CL=90%	–
$B \to \ell^+ \nu_\ell$ anything	[a,d]	(10.73 ± 0.28) %		–
$B \to D^- \ell^+ \nu_\ell$ anything	[a]	(2.8 ± 0.9) %		–
$B \to \overline{D}^0 \ell^+ \nu_\ell$ anything	[a]	(7.2 ± 1.5) %		–
$B \to \overline{D}^{**} \ell^+ \nu_\ell$	[a,e]	(2.7 ± 0.7) %		–
$B \to \overline{D}_1(2420) \ell^+ \nu_\ell$ anything		$(7.4 \pm 1.6) \times 10^{-3}$		–
$B \to D \pi \ell^+ \nu_\ell$ anything + $D^* \pi \ell^+ \nu_\ell$ anything		(2.6 ± 0.5) %	S=1.5	–
$B \to D \pi \ell^+ \nu_\ell$ anything		(1.5 ± 0.6) %		–
$B \to D^* \pi \ell^+ \nu_\ell$ anything		(1.9 ± 0.4) %		–
$B \to \overline{D}_2^*(2460) \ell^+ \nu_\ell$ anything		$< 6.5 \times 10^{-3}$	CL=95%	–
$B \to D^{*-} \pi^+ \ell^+ \nu_\ell$ anything		(1.00 ± 0.34) %		–
$B \to D_s^- \ell^+ \nu_\ell$ anything	[a]	$< 9 \times 10^{-3}$	CL=90%	–
$B \to D_s^- \ell^+ \nu_\ell K^+$ anything	[a]	$< 6 \times 10^{-3}$	CL=90%	–
$B \to D_s^- \ell^+ \nu_\ell K^0$ anything	[a]	$< 9 \times 10^{-3}$	CL=90%	–
$B \to K^+ \ell^+ \nu_\ell$ anything	[a]	(6.2 ± 0.6) %		–
$B \to K^- \ell^+ \nu_\ell$ anything	[a]	$(10 \pm 4) \times 10^{-3}$		–
$B \to K^0 / \overline{K}^0 \ell^+ \nu_\ell$ anything	[a]	(4.5 ± 0.5) %		–

D, D^*, or D_s modes

$B \to D^\pm$ anything		(23.5 ± 1.9) %		–
$B \to D^0 / \overline{D}^0$ anything		(64.0 ± 3.0) %	S=1.1	–
$B \to D^*(2010)^\pm$ anything		(22.5 ± 1.5) %		–
$B \to D^*(2007)^0$ anything		(26.0 ± 2.7) %		–
$B \to D_s^\pm$ anything	[c]	(10.5 ± 2.6) %		–
$B \to D_s^{*\pm}$ anything		(7.9 ± 2.2) %		–
$B \to D_s^{*\pm} \overline{D}^{(*)}$		(4.2 ± 1.2) %		–
$B \to \overline{D} D_{sJ}(2317)$		seen		1605
$B \to \overline{D} D_{sJ}(2457)$		seen		–
$B \to D^{(*)} \overline{D}^{(*)} K^0 + D^{(*)} \overline{D}^{(*)} K^\pm$	[c,f]	$(7.1 {}^{+2.7}_{-1.7})$ %		–
$b \to c \overline{c} s$		(22 ± 4) %		–

$B \to D_s^{(*)} \overline{D}^{(*)}$	[c,f]	(4.9 ± 1.2) %			–
$B \to D^* D^*(2010)^{\pm}$	[c]	< 5.9	$\times 10^{-3}$	CL=90%	1711
$B \to D D^*(2010)^{\pm} + D^* D^{\pm}$	[c]	< 5.5	$\times 10^{-3}$	CL=90%	–
$B \to D D^{\pm}$	[c]	< 3.1	$\times 10^{-3}$	CL=90%	1866
$B \to D_s^{(*)\pm} \overline{D}^{(*)} X(n\pi^{\pm})$	[c,f]	($9 \ {}^{+5}_{-4}$) %			–
$B \to D^*(2010)\gamma$		< 1.1	$\times 10^{-3}$	CL=90%	2257
$B \to D_s^+\pi^-$, $D_s^{*+}\pi^-$, $D_s^+\rho^-$, $D_s^{*+}\rho^-$, $D_s^+\pi^0$, $D_s^{*+}\pi^0$, $D_s^+\eta$, $D_s^{*+}\eta$, $D_s^+\rho^0$, $D_s^{*+}\rho^0$, $D_s^+\omega$, $D_s^{*+}\omega$	[c]	< 5	$\times 10^{-4}$	CL=90%	–
$B \to D_{s1}(2536)^+$ anything		< 9.5	$\times 10^{-3}$	CL=90%	–

Charmonium modes

$B \to J/\psi(1S)$ anything		(1.094 ± 0.032) %		S=1.1	–
$B \to J/\psi(1S)$(direct) anything		(7.8 ± 0.4)	$\times 10^{-3}$	S=1.1	–
$B \to \psi(2S)$ anything		(3.07 ± 0.21)	$\times 10^{-3}$		–
$B \to \chi_{c1}(1P)$ anything		(3.86 ± 0.27)	$\times 10^{-3}$		–
$B \to \chi_{c1}(1P)$(direct) anything		(3.34 ± 0.28)	$\times 10^{-3}$		–
$B \to \chi_{c2}(1P)$ anything		(1.3 ± 0.4)	$\times 10^{-3}$	S=1.9	–
$B \to \chi_{c2}(1P)$(direct) anything		(1.65 ± 0.31)	$\times 10^{-3}$		–
$B \to \eta_c(1S)$ anything		< 9	$\times 10^{-3}$	CL=90%	–

K or K^* modes

$B \to K^{\pm}$ anything	[c]	(78.9 ± 2.5) %			–
$B \to K^+$ anything		(66 ± 5) %			–
$B \to K^-$ anything		(13 ± 4) %			–
$B \to K^0/\overline{K}^0$ anything	[c]	(64 ± 4) %			–
$B \to K^*(892)^{\pm}$ anything		(18 ± 6) %			–
$B \to K^*(892)^0/\overline{K}^*(892)^0$ anything	[c]	(14.6 ± 2.6) %			–
$B \to K^*(892)\gamma$		(4.2 ± 0.6)	$\times 10^{-5}$		2564
$B \to K_1(1400)\gamma$		< 1.27	$\times 10^{-4}$	CL=90%	2453
$B \to K_2^*(1430)\gamma$		($1.7 \ {}^{+0.6}_{-0.5}$)	$\times 10^{-5}$		2447
$B \to K_2(1770)\gamma$		< 1.2	$\times 10^{-3}$	CL=90%	2342
$B \to K_3^*(1780)\gamma$		< 3.0	$\times 10^{-3}$	CL=90%	2341
$B \to K_4^*(2045)\gamma$		< 1.0	$\times 10^{-3}$	CL=90%	2244

$B \to K\eta'(958)$		$(8.3 \pm 1.1) \times 10^{-5}$			2528
$B \to K^*(892)\eta'(958)$		$< 2.2 \times 10^{-5}$		CL=90%	2472
$B \to K\eta$		$< 5.2 \times 10^{-6}$		CL=90%	2588
$B \to K^*(892)\eta$		$(1.8 \pm 0.5) \times 10^{-5}$			2534
$B \to K\phi\phi$		$(2.3 \pm 0.9) \times 10^{-6}$			2306
$B \to \overline{b} \to \overline{s}\gamma$		$(3.3 \pm 0.4) \times 10^{-4}$			–
$B \to \overline{b} \to \overline{s}$gluon		< 6.8 %		CL=90%	–
$B \to \eta$ anything		$< 4.4 \times 10^{-4}$		CL=90%	–
$B \to \eta'$ anything		$(4.6 \pm 1.3) \times 10^{-4}$			–

Light unflavored meson modes

$B \to \rho\gamma$		$< 1.9 \times 10^{-6}$		CL=90%	2583
$B \to \pi^{\pm}$ anything	[c,g]	(358 ± 7) %			–
$B \to \pi^0$ anything		(235 ± 11) %			–
$B \to \eta$ anything		(17.6 ± 1.6) %			–
$B \to \rho^0$ anything		(21 ± 5) %			–
$B \to \omega$ anything		< 81 %		CL=90%	–
$B \to \phi$ anything		(3.5 ± 0.7) %		S=1.8	–
$B \to \phi K^*(892)$		$< 2.2 \times 10^{-5}$		CL=90%	2460

Baryon modes

$B \to \Lambda_c^+ / \overline{\Lambda}_c^-$ anything		(6.4 ± 1.1) %			–
$B \to \overline{\Lambda}_c^- e^+$ anything		$< 3.2 \times 10^{-3}$		CL=90%	–
$B \to \overline{\Lambda}_c^- p$ anything		(3.6 ± 0.7) %			–
$B \to \overline{\Lambda}_c^- p e^+ \nu_e$		$< 1.5 \times 10^{-3}$		CL=90%	2021
$B \to \overline{\Sigma}_c^{--}$ anything		$(4.2 \pm 2.4) \times 10^{-3}$			–
$B \to \overline{\Sigma}_c^{-}$ anything		$< 9.6 \times 10^{-3}$		CL=90%	–
$B \to \overline{\Sigma}_c^{0}$ anything		$(4.6 \pm 2.4) \times 10^{-3}$			–
$B \to \overline{\Sigma}_c^{0} N (N = p$ or $n)$		$< 1.5 \times 10^{-3}$		CL=90%	1939
$B \to \Xi_c^0$ anything $\times$ B($\Xi_c^0 \to \Xi^- \pi^+$)		$(1.4 \pm 0.5) \times 10^{-4}$			–
$B \to \Xi_c^+$ anything $\times$ B($\Xi_c^+ \to \Xi^- \pi^+ \pi^+$)		$(4.5 {}^{+1.3}_{-1.2}) \times 10^{-4}$			–
$B \to p/\overline{p}$ anything	[c]	(8.0 ± 0.4) %			–
$B \to p/\overline{p}$(direct) anything	[c]	(5.5 ± 0.5) %			–
$B \to \Lambda/\overline{\Lambda}$ anything	[c]	(4.0 ± 0.5) %			–
$B \to \Xi^-/\overline{\Xi}^+$ anything	[c]	$(2.7 \pm 0.6) \times 10^{-3}$			–
$B \to$ baryons anything		(6.8 ± 0.6) %			–
$B \to p\overline{p}$ anything		(2.47 ± 0.23) %			–
$B \to \Lambda\overline{p}/\overline{\Lambda}p$ anything	[c]	(2.5 ± 0.4) %			–
$B \to \Lambda\overline{\Lambda}$ anything		$< 5 \times 10^{-3}$		CL=90%	–

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

$B \to s e^+ e^-$	$B1$		$(5.0 \pm 2.6) \times 10^{-6}$		–
$B \to s \mu^+ \mu^-$	$B1$		$(7.9 {}^{+3.0}_{-2.6}) \times 10^{-6}$		–
$B \to s \ell^+ \ell^-$	$B1$	[a]	$(6.1 {}^{+2.0}_{-1.8}) \times 10^{-6}$		–
$B \to K e^+ e^-$	$B1$		$(4.8 {}^{+1.5}_{-1.3}) \times 10^{-7}$		2617
$B \to K^*(892) e^+ e^-$	$B1$		$(1.5 \pm 0.5) \times 10^{-6}$		2564
$B \to K \mu^+ \mu^-$	$B1$		$(4.8 \pm 1.2) \times 10^{-7}$		2612
$B \to K^*(892) \mu^+ \mu^-$	$B1$		$(1.17 {}^{+0.37}_{-0.33}) \times 10^{-6}$		2560
$B \to K \ell^+ \ell^-$	$B1$		$(5.4 \pm 0.8) \times 10^{-7}$		2617
$B \to K^*(892) \ell^+ \ell^-$	$B1$		$(1.05 \pm 0.20) \times 10^{-6}$		2564
$B \to e^\pm \mu^\mp s$	LF	[c]	$< 2.2 \times 10^{-5}$	CL=90%	–
$B \to \pi e^\pm \mu^\mp$	LF		$< 1.6 \times 10^{-6}$	CL=90%	2637
$B \to \rho e^\pm \mu^\mp$	LF		$< 3.2 \times 10^{-6}$	CL=90%	2582
$B \to K e^\pm \mu^\mp$	LF		$< 1.6 \times 10^{-6}$	CL=90%	2616
$B \to K^*(892) e^\pm \mu^\mp$	LF		$< 6.2 \times 10^{-6}$	CL=90%	2563

$B^\pm/B^0/B^0_s/b$-baryon ADMIXTURE

These measurements are for an admixture of bottom particles at high energy (LEP, Tevatron, $Sp\overline{p}S$).

Mean life $\tau = (1.564 \pm 0.014) \times 10^{-12}$ s

Mean life $\tau = (1.72 \pm 0.10) \times 10^{-12}$ s Charged b-hadron admixture

Mean life $\tau = (1.58 \pm 0.14) \times 10^{-12}$ s Neutral b-hadron admixture

$\tau_{\text{charged } b-\text{hadron}}/\tau_{\text{neutral } b-\text{hadron}} = 1.09 \pm 0.13$

$\left|\Delta\tau_b\right|/\tau_{b,\overline{b}} = -0.001 \pm 0.014$

The branching fraction measurements are for an admixture of B mesons and baryons at energies above the $\Upsilon(4S)$. Only the highest energy results (LEP, Tevatron, $Sp\overline{p}S$) are used in the branching fraction averages. In the following, we assume that the production fractions are the same at the LEP and at the Tevatron.

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.

The modes below are listed for a $\overline{b}$ initial state. b modes are their charge conjugates. Reactions indicate the weak decay vertex and do not include mixing.

$\overline{b}$ DECAY MODES		Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)

PRODUCTION FRACTIONS

The production fractions for weakly decaying b-hadrons at high energy have been calculated from the best values of mean lives, mixing parameters, and branching fractions in this edition by the Heavy Flavor Averaging Group (HFAG) as described in the note "B^0-$\overline{B}^0$ Mixing" in the B^0 Particle Listings. Values assume

$$B(\overline{b} \to B^+) = B(\overline{b} \to B^0)$$
$$B(\overline{b} \to B^+) + B(\overline{b} \to B^0) + B(\overline{b} \to B^0_s) + B(b \to b\text{-baryon}) = 100\ \%.$$

The notation for production fractions varies in the literature (f_d, d_{B^0}, $f(b \to \overline{B}^0)$, $\mathrm{Br}(b \to \overline{B}^0)$). We use our own branching fraction notation here, $B(\overline{b} \to B^0)$.

B^+		(39.7 ± 1.0) %		–
B^0		(39.7 ± 1.0) %		–
B^0_s		(10.7 ± 1.1) %		–
b-baryon		(9.9 ± 1.7) %		–
B_c		—		–

DECAY MODES

Semileptonic and leptonic modes

ν anything		(23.1 ± 1.5) %		–
$\ell^+ \nu_\ell$ anything	[a]	(10.68 ± 0.22) %		–
$e^+ \nu_e$ anything		(10.86 ± 0.35) %		–
$\mu^+ \nu_\mu$ anything		($10.95^{+0.29}_{-0.25}$) %		–
$D^- \ell^+ \nu_\ell$ anything	[a]	(2.3 ± 0.4) %	S=1.7	–
$D^- \pi^+ \ell^+ \nu_\ell$ anything		(4.9 ± 1.9) $\times 10^{-3}$		–
$D^- \pi^- \ell^+ \nu_\ell$ anything		(2.6 ± 1.6) $\times 10^{-3}$		–
$\overline{D}^0 \ell^+ \nu_\ell$ anything	[a]	(6.90 ± 0.35) %		–
$\overline{D}^0 \pi^- \ell^+ \nu_\ell$ anything		(1.07 ± 0.27) %		–
$\overline{D}^0 \pi^+ \ell^+ \nu_\ell$ anything		(2.3 ± 1.6) $\times 10^{-3}$		–
$D^{*-} \ell^+ \nu_\ell$ anything	[a]	(2.75 ± 0.19) %		–
$D^{*-} \pi^+ \ell^+ \nu_\ell$ anything		(4.8 ± 1.0) $\times 10^{-3}$		–
$D^{*-} \pi^- \ell^+ \nu_\ell$ anything		(6 ± 7) $\times 10^{-4}$		–
$D^-_j \ell^+ \nu_\ell$ anything	[a,h]	seen		–
$D^*_2(2460)^- \ell^+ \nu_\ell$ anything		seen		–

charmless $\ell \overline{\nu}_\ell$	[a]	$(1.7 \pm 0.5) \times 10^{-3}$		–
$\tau^+ \nu_\tau$ anything		(2.48 ± 0.26) %		–
$D^{*-} \tau \nu_\tau$ anything		$(9 \pm 4) \times 10^{-3}$		–
$\overline{c} \to \ell^- \overline{\nu}_\ell$ anything	[a]	(8.0 ± 0.4) %		–
$c \to \ell^+ \nu$ anything		$(1.6 {+0.4 \atop -0.5})$ %		–

Charmed meson and baryon modes

$\overline{D}^0$ anything		(61.0 ± 3.2) %		–
$D^0 D_s^\pm$ anything	[c]	$(9.1 {+3.9 \atop -2.8})$ %		–
$D^\mp D_s^\pm$ anything	[c]	$(4.0 {+2.3 \atop -1.8})$ %		–
$\overline{D}^0 D^0$ anything	[c]	$(5.1 {+2.0 \atop -1.8})$ %		–
$D^0 D^\pm$ anything	[c]	$(2.7 {+1.8 \atop -1.6})$ %		–
$D^\pm D^\mp$ anything	[c]	$< 9 \times 10^{-3}$	CL=90%	–
D^- anything		(23.1 ± 2.2) %		–
$D^*(2010)^+$ anything		(17.3 ± 2.0) %		–
$D_1(2420)^0$ anything		(5.0 ± 1.5) %		–
$D^*(2010)^\mp D_s^\pm$ anything	[c]	$(3.3 {+1.6 \atop -1.3})$ %		–
$D^0 D^*(2010)^\pm$ anything	[c]	$(3.0 {+1.1 \atop -0.9})$ %		–
$D^*(2010)^\pm D^\mp$ anything	[c]	$(2.5 {+1.2 \atop -1.0})$ %		–
$D^*(2010)^\pm D^*(2010)^\mp$ anything	[c]	(1.2 ± 0.4) %		–
$D_2^*(2460)^0$ anything		(4.7 ± 2.7) %		–
D_s^- anything		(18 ± 5) %		–
D_s^+ anything		(10.1 ± 3.1) %		–
Λ_c^+ anything		(9.7 ± 2.9) %		–
$\overline{c}/c$ anything	[g]	(116.6 ± 3.3) %		–

Charmonium modes

$J/\psi(1S)$ anything		(1.16 ± 0.10) %		–
$\psi(2S)$ anything		$(4.8 \pm 2.4) \times 10^{-3}$		–
$\chi_{c1}(1P)$ anything		(1.5 ± 0.5) %		–

K or K^* modes

$\overline{s} \gamma$		$(3.1 \pm 1.1) \times 10^{-4}$		–
$\overline{s} \overline{\nu} \nu$		$< 6.4 \times 10^{-4}$	CL=90%	–
$K^\pm$ anything		(74 ± 6) %		–
K_S^0 anything		(29.0 ± 2.9) %		–

Pion modes

$\pi^\pm$ anything		(397 ± 21) %		–
π^0 anything	[g]	(278 ± 60) %		–
ϕ anything		(2.82 ± 0.23) %		–

	Baryon modes		
$p/\overline{p}$anything		(13.1 ± 1.1) %	–
	Other modes		
charged anything	[g]	(497 ± 7) %	–
hadron^+ hadron^-		$(1.7 {}^{+1.0}_{-0.7}) \times 10^{-5}$	–
charmless		$(7 \pm 21) \times 10^{-3}$	–
	Baryon modes		
$\Lambda/\overline{\Lambda}$anything		(5.9 ± 0.6) %	–
b-baryon anything		(10.2 ± 2.8) %	–
	$\Delta B = 1$ weak neutral current ($B1$) modes		
$\mu^+ \mu^-$ anything	$B1$	$< 3.2 \times 10^{-4}$ CL=90%	–

B^*

$I(J^P) = \frac{1}{2}(1^-)$

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

Mass $m_{B^*} = 5325.0 \pm 0.6$ MeV

$m_{B^*} - m_B = 45.78 \pm 0.35$ MeV

B^* DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$B\gamma$	dominant	45

NOTES

[a] An ℓ indicates an e or a μ mode, not a sum over these modes.

[b] B^0 and B^0_s contributions not separated. Limit is on weighted average of the two decay rates.

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

[d] These values are model dependent. See 'Note on Semileptonic Decays' in the B^+ Particle Listings.

[e] D^{**} stands for the sum of the $D(1\,^1P_1)$, $D(1\,^3P_0)$, $D(1\,^3P_1)$, $D(1\,^3P_2)$, $D(2\,^1S_0)$, and $D(2\,^1S_1)$ resonances.

[f] $D^{(*)}\overline{D}^{(*)}$ stands for the sum of $D^*\overline{D}^*$, $D^*\overline{D}$, $D\overline{D}^*$, and $D\overline{D}$.

[g] Inclusive branching fractions have a multiplicity definition and can be greater than 100%.

[h] D_j represents an unresolved mixture of pseudoscalar and tensor D^{**} (P-wave) states.