

$b\bar{b}$ MESONS

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

$\eta_b(1S)$

$$I^G(J^{PC}) = 0^+(0^--)$$

Mass $m = 9398.7 \pm 2.0$ MeV ($S = 1.5$)
Full width $\Gamma = 10^{+5}_{-4}$ MeV

$\eta_b(1S)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
hadrons	seen		—
$3h^+3h^-$	not seen		4672
$2h^+2h^-$	not seen		4689
$4h^+4h^-$	not seen		4648
$\gamma\gamma$	not seen		4699
$\mu^+\mu^-$	$<9 \times 10^{-3}$	90%	4698
$\tau^+\tau^-$	$<8\%$	90%	4350

$\Upsilon(1S)$

$$I^G(J^{PC}) = 0^-(1^{--})$$

Mass $m = 9460.40 \pm 0.10$ MeV
Full width $\Gamma = 54.02 \pm 1.25$ keV

$\Upsilon(1S)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\tau^+\tau^-$	(2.60 $\pm$ 0.10) %		4384
e^+e^-	(2.39 $\pm$ 0.08) %		4730
$\mu^+\mu^-$	(2.48 $\pm$ 0.04) %		4729

Hadronic decays

ggg	(81.7 $\pm$ 0.7) %		—
γgg	(2.2 $\pm$ 0.6) %		—
$\eta'(958)$ anything	(2.94 $\pm$ 0.24) %		—
$J/\psi(1S)$ anything	(5.4 $\pm$ 0.4) $\times 10^{-4}$	$S=1.4$	4223
$J/\psi(1S)\eta_c$	< 2.2	$\times 10^{-6}$ CL=90%	3623
$J/\psi(1S)\chi_{c0}$	< 3.4	$\times 10^{-6}$ CL=90%	3429
$J/\psi(1S)\chi_{c1}$	(3.9 $\pm$ 1.2) $\times 10^{-6}$		3382
$J/\psi(1S)\chi_{c2}$	< 1.4	$\times 10^{-6}$ CL=90%	3359
$J/\psi(1S)\eta_c(2S)$	< 2.2	$\times 10^{-6}$ CL=90%	3317
$J/\psi(1S)X(3940)$	< 5.4	$\times 10^{-6}$ CL=90%	3148
$J/\psi(1S)X(4160)$	< 5.4	$\times 10^{-6}$ CL=90%	3020

$X(4350)$ anything, $X \rightarrow J/\psi(1S)\phi$	< 8.1	$\times 10^{-6}$	CL=90%	—
$T_{c\bar{c}1}(3900)^\pm$ anything, $T_{c\bar{c}1} \rightarrow J/\psi(1S)\pi^\pm$	< 1.3	$\times 10^{-5}$	CL=90%	—
$T_{c\bar{c}1}(4200)^\pm$ anything, $Z_c \rightarrow J/\psi(1S)\pi^\pm$	< 6.0	$\times 10^{-5}$	CL=90%	—
$T_{c\bar{c}1}(4430)^\pm$ anything, $T_{c\bar{c}1} \rightarrow J/\psi(1S)\pi^\pm$	< 4.9	$\times 10^{-5}$	CL=90%	—
$X_{cs}^\pm$ anything, $X \rightarrow J/\psi K^\pm$	< 5.7	$\times 10^{-6}$	CL=90%	—
$\psi(4230)$ anything, $\psi \rightarrow J/\psi(1S)\pi^+\pi^-$	< 3.8	$\times 10^{-5}$	CL=90%	—
$\psi(4230)$ anything, $\psi \rightarrow J/\psi(1S)K^+K^-$	< 7.5	$\times 10^{-6}$	CL=90%	—
$\chi_{c1}(4140)$ anything, $\chi_{c1} \rightarrow J/\psi(1S)\phi$	< 5.2	$\times 10^{-6}$	CL=90%	—
χ_{c0} anything	< 4	$\times 10^{-3}$	CL=90%	—
χ_{c1} anything	$(1.90 \pm 0.35) \times 10^{-4}$			—
$\chi_{c1}(1P)X_{tetra}$	< 3.78	$\times 10^{-5}$	CL=90%	—
χ_{c2} anything	$(2.8 \pm 0.8) \times 10^{-4}$			—
$\psi(2S)$ anything	$(1.23 \pm 0.20) \times 10^{-4}$			—
$\psi(2S)\eta_c$	< 3.6	$\times 10^{-6}$	CL=90%	3345
$\psi(2S)\chi_{c0}$	< 6.5	$\times 10^{-6}$	CL=90%	3124
$\psi(2S)\chi_{c1}$	< 4.5	$\times 10^{-6}$	CL=90%	3070
$\psi(2S)\chi_{c2}$	< 2.1	$\times 10^{-6}$	CL=90%	3043
$\psi(2S)\eta_c(2S)$	< 3.2	$\times 10^{-6}$	CL=90%	2994
$\psi(2S)X(3940)$	< 2.9	$\times 10^{-6}$	CL=90%	2797
$\psi(2S)X(4160)$	< 2.9	$\times 10^{-6}$	CL=90%	2645
$\psi(4230)$ anything, $\psi \rightarrow \psi(2S)\pi^+\pi^-$	< 7.9	$\times 10^{-5}$	CL=90%	—
$\psi(4360)$ anything, $\psi \rightarrow \psi(2S)\pi^+\pi^-$	< 5.2	$\times 10^{-5}$	CL=90%	—
$\psi(4660)$ anything, $\psi \rightarrow \psi(2S)\pi^+\pi^-$	< 2.2	$\times 10^{-5}$	CL=90%	—
$T_{c\bar{c}}(4050)^\pm$ anything, $X \rightarrow \psi(2S)\pi^\pm$	< 8.8	$\times 10^{-5}$	CL=90%	—
$T_{c\bar{c}1}(4430)^\pm$ anything, $T_{c\bar{c}1} \rightarrow \psi(2S)\pi^\pm$	< 6.7	$\times 10^{-5}$	CL=90%	—
$\chi_{c1}(3872)$ anything	< 2.2	$\times 10^{-4}$	CL=90%	—
$T_{c\bar{c}1}(4200)^+ T_{c\bar{c}1}(4200)^-$	< 2.23	$\times 10^{-5}$	CL=90%	—
$T_{c\bar{c}1}(3900)^\pm T_{c\bar{c}1}(4200)^\mp$	< 8.1	$\times 10^{-6}$	CL=90%	—
$T_{c\bar{c}1}(3900)^+ T_{c\bar{c}1}(3900)^-$	< 1.8	$\times 10^{-6}$	CL=90%	—
$T_{c\bar{c}}(4050)^+ T_{c\bar{c}}(4050)^-$	< 1.58	$\times 10^{-5}$	CL=90%	—
$T_{c\bar{c}}(4250)^+ T_{c\bar{c}}(4250)^-$	< 2.66	$\times 10^{-5}$	CL=90%	—

$T_{c\bar{c}}(4050)^{\pm} T_{c\bar{c}}(4250)^{\mp}$	< 4.42	$\times 10^{-5}$	CL=90%	—
$T_{c\bar{c}1}(4430)^{+} T_{c\bar{c}1}(4430)^{-}$	< 2.03	$\times 10^{-5}$	CL=90%	—
$T_{c\bar{c}}(4055)^{\pm} T_{c\bar{c}}(4055)^{\mp}$	< 2.33	$\times 10^{-5}$	CL=90%	—
$T_{c\bar{c}}(4055)^{\pm} T_{c\bar{c}1}(4430)^{\mp}$	< 4.55	$\times 10^{-5}$	CL=90%	—
$\rho\pi$	< 3.68	$\times 10^{-6}$	CL=90%	4697
$\omega\pi^0$	< 3.90	$\times 10^{-6}$	CL=90%	4697
$\pi^{+}\pi^{-}$	< 5	$\times 10^{-4}$	CL=90%	4728
$K^{+}K^{-}$	< 5	$\times 10^{-4}$	CL=90%	4704
$p\bar{p}$	< 5	$\times 10^{-4}$	CL=90%	4636
$\pi^{+}\pi^{-}\pi^0$	$(2.1 \pm 0.8) \times 10^{-6}$			4725
$\phi K^{+}K^{-}$	$(2.4 \pm 0.5) \times 10^{-6}$			4623
$\omega\pi^{+}\pi^{-}$	$(4.5 \pm 1.0) \times 10^{-6}$			4694
$K^{*}(892)^0 K^{-}\pi^{+} + \text{c.c.}$	$(4.4 \pm 0.8) \times 10^{-6}$			4667
$\phi f'_2(1525)$	< 1.63	$\times 10^{-6}$	CL=90%	4551
$\omega f_2(1270)$	< 1.79	$\times 10^{-6}$	CL=90%	4611
$\rho(770) a_2(1320)$	< 2.24	$\times 10^{-6}$	CL=90%	4605
$K^{*}(892)^0 \bar{K}_2^{*}(1430)^0 + \text{c.c.}$	$(3.0 \pm 0.8) \times 10^{-6}$			4579
$K_1(1270)^{\pm} K^{\mp}$	< 2.41	$\times 10^{-6}$	CL=90%	4634
$K_1(1400)^{\pm} K^{\mp}$	$(1.0 \pm 0.4) \times 10^{-6}$			4613
$b_1(1235)^{\pm} \pi^{\mp}$	< 1.25	$\times 10^{-6}$	CL=90%	4649
$\pi^{+}\pi^{-}\pi^0\pi^0$	$(1.28 \pm 0.30) \times 10^{-5}$			4720
$K_S^0 K^{+}\pi^{-} + \text{c.c.}$	$(1.6 \pm 0.4) \times 10^{-6}$			4696
$K^{*}(892)^0 \bar{K}^0 + \text{c.c.}$	$(2.9 \pm 0.9) \times 10^{-6}$			4675
$K^{*}(892)^{-} K^{+} + \text{c.c.}$	< 1.11	$\times 10^{-6}$	CL=90%	4675
$f_1(1285) \text{ anything}$	$(4.6 \pm 3.1) \times 10^{-3}$			—
$D^{*}(2010)^{\pm} \text{ anything}$	$(2.52 \pm 0.20) \%$			—
$f_1(1285) X_{tetra}$	< 6.24	$\times 10^{-5}$	CL=90%	—
$^2H \text{ anything}$	$(2.85 \pm 0.25) \times 10^{-5}$			—
Sum of 100 exclusive modes	$(1.200 \pm 0.017) \%$			—

Radiative decays

$\gamma\pi^{+}\pi^{-}$	$(6.3 \pm 1.8) \times 10^{-5}$			4728
$\gamma\pi^0\pi^0$	$(1.7 \pm 0.7) \times 10^{-5}$			4728
$\gamma\pi\pi$ (S-wave)	$(4.6 \pm 0.7) \times 10^{-5}$			4728
$\gamma\pi^0\eta$	< 2.4	$\times 10^{-6}$	CL=90%	4713
$\gamma K^{+}K^{-}$	[a] $(1.14 \pm 0.13) \times 10^{-5}$			4704
$\gamma p\bar{p}$	[b] < 6	$\times 10^{-6}$	CL=90%	4636
$\gamma 2h^{+}2h^{-}$	$(7.0 \pm 1.5) \times 10^{-4}$			4720
$\gamma 3h^{+}3h^{-}$	$(5.4 \pm 2.0) \times 10^{-4}$			4703
$\gamma 4h^{+}4h^{-}$	$(7.4 \pm 3.5) \times 10^{-4}$			4679
$\gamma\pi^{+}\pi^{-} K^{+}K^{-}$	$(2.9 \pm 0.9) \times 10^{-4}$			4686
$\gamma 2\pi^{+}2\pi^{-}$	$(2.5 \pm 0.9) \times 10^{-4}$			4720
$\gamma 3\pi^{+}3\pi^{-}$	$(2.5 \pm 1.2) \times 10^{-4}$			4703
$\gamma 2\pi^{+}2\pi^{-} K^{+}K^{-}$	$(2.4 \pm 1.2) \times 10^{-4}$			4659

$\gamma\pi^+\pi^-p\bar{p}$	$(1.5 \pm 0.6) \times 10^{-4}$	4604
$\gamma 2\pi^+ 2\pi^- p\bar{p}$	$(4 \pm 6) \times 10^{-5}$	4563
$\gamma 2K^+ 2K^-$	$(2.0 \pm 2.0) \times 10^{-5}$	4601
$\gamma\eta'(958)$	$< 1.9 \times 10^{-6}$ CL=90%	4682
$\gamma\eta$	$< 1.0 \times 10^{-6}$ CL=90%	4714
$\gamma f_0(980)$	$< 3 \times 10^{-5}$ CL=90%	4678
$\gamma f'_2(1525)$	$(2.9 \pm 0.6) \times 10^{-5}$	4609
$\gamma f_2(1270)$	$(1.01 \pm 0.06) \times 10^{-4}$	4644
$\gamma\eta(1405)$	$< 8.2 \times 10^{-5}$ CL=90%	4625
$\gamma f_0(1500)$	$< 1.5 \times 10^{-5}$ CL=90%	4608
$\gamma f_0(1500) \rightarrow \gamma K^+ K^-$	$(1.0 \pm 0.4) \times 10^{-5}$	—
$\gamma f_0(1710)$	$< 2.6 \times 10^{-4}$ CL=90%	4571
$\gamma f_0(1710) \rightarrow \gamma K^+ K^-$	$(1.01 \pm 0.32) \times 10^{-5}$	—
$\gamma f_0(1710) \rightarrow \gamma\pi^+\pi^-$	$(5.3 \pm 2.0) \times 10^{-6}$	—
$\gamma f_0(1710) \rightarrow \gamma\pi^0\pi^0$	$< 1.4 \times 10^{-6}$ CL=90%	—
$\gamma f_0(1710) \rightarrow \gamma\eta\eta$	$< 1.8 \times 10^{-6}$ CL=90%	—
$\gamma f_4(2050)$	$< 5.3 \times 10^{-5}$ CL=90%	4515
$\gamma f_0(2200) \rightarrow \gamma K^+ K^-$	$< 2 \times 10^{-4}$ CL=90%	4475
$\gamma f_J(2220) \rightarrow \gamma K^+ K^-$	$< 8 \times 10^{-7}$ CL=90%	4469
$\gamma f_J(2220) \rightarrow \gamma\pi^+\pi^-$	$< 6 \times 10^{-7}$ CL=90%	—
$\gamma f_J(2220) \rightarrow \gamma p\bar{p}$	$< 1.1 \times 10^{-6}$ CL=90%	—
$\gamma\eta(2225) \rightarrow \gamma\phi\phi$	$< 3 \times 10^{-3}$ CL=90%	4469
$\gamma\eta_c(1S)$	$< 2.9 \times 10^{-5}$ CL=90%	4260
$\gamma\eta_c(2S)$	$< 4 \times 10^{-4}$ CL=90%	4031
$\gamma\chi_{c0}$	$< 6.6 \times 10^{-5}$ CL=90%	4114
$\gamma\chi_{c1}$	$(4.7^{+2.4}_{-1.9}) \times 10^{-5}$	4079
$\gamma\chi_{c2}$	$< 7.6 \times 10^{-6}$ CL=90%	4062
$\gamma\chi_{c1}(3872)$	$< 4 \times 10^{-5}$ CL=90%	3938
$\gamma\chi_{c1}(3872), \chi_{c1} \rightarrow \pi^+\pi^-\pi^0 J/\psi$	$< 2.8 \times 10^{-6}$ CL=90%	—
$\gamma\chi_{c0}(3915) \rightarrow \omega J/\psi$	$< 3.0 \times 10^{-6}$ CL=90%	—
$\gamma\chi_{c1}(4140) \rightarrow \phi J/\psi$	$< 2.2 \times 10^{-6}$ CL=90%	—
$\gamma X\bar{X} (m_X < 3.1 \text{ GeV})$	[c] $< 1 \times 10^{-3}$ CL=90%	—
$\gamma X\bar{X} (m_X < 4.5 \text{ GeV})$	[d] $< 2.4 \times 10^{-4}$ CL=90%	—
$\gamma X \rightarrow \gamma + \geq 4 \text{ prongs}$	[e] $< 1.78 \times 10^{-4}$ CL=95%	—
$\gamma A^0 \rightarrow \gamma\mu^+\mu^-$	[f] $< 9 \times 10^{-6}$ CL=90%	—
$\gamma A^0 \rightarrow \gamma\tau^+\tau^-$	[a] $< 1.30 \times 10^{-4}$ CL=90%	—
$\gamma A^0 \rightarrow \gamma g g$	[g] $< 1\%$ CL=90%	—
$\gamma A^0 \rightarrow \gamma s\bar{s}$	[g] $< 1 \times 10^{-3}$ CL=90%	—

Lepton Family number (*LF*) violating modes

$e^{\pm}\mu^{\mp}$	<i>LF</i>	< 3.9	$\times 10^{-7}$	CL=90%	4730
$\mu^{\pm}\tau^{\mp}$	<i>LF</i>	< 2.7	$\times 10^{-6}$	CL=90%	4563
$e^{\pm}\tau^{\mp}$	<i>LF</i>	< 2.7	$\times 10^{-6}$	CL=90%	4563
$\gamma e^{\pm}\mu^{\mp}$	<i>LF</i>	< 4.2	$\times 10^{-7}$	CL=90%	4730
$\gamma\mu^{\pm}\tau^{\mp}$	<i>LF</i>	< 6.1	$\times 10^{-6}$	CL=90%	4563
$\gamma e^{\pm}\tau^{\mp}$	<i>LF</i>	< 6.5	$\times 10^{-6}$	CL=90%	4563

Other decays

invisible	< 3.0	$\times 10^{-4}$	CL=90%	—
hadrons	(96 ± 4) %			—

$\chi_{b0}(1P)$

$I^G(J^{PC}) = 0^+(0^{++})$
J needs confirmation.

Mass $m = 9859.44 \pm 0.42 \pm 0.31$ MeV

$\chi_{b0}(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	$\frac{p}{(\text{MeV}/c)}$
$\gamma \Upsilon(1S)$	(1.94±0.27) %		391
$D^0 X$	< 10.4 %	90%	—
$\pi^+\pi^-K^+K^-\pi^0$	< 1.6 $\times 10^{-4}$	90%	4875
$2\pi^+\pi^-K^-K_S^0$	< 5 $\times 10^{-5}$	90%	4875
$2\pi^+\pi^-K^-K_S^02\pi^0$	< 5 $\times 10^{-4}$	90%	4846
$2\pi^+2\pi^-2\pi^0$	< 2.1 $\times 10^{-4}$	90%	4905
$2\pi^+2\pi^-K^+K^-$	(1.1 ±0.6) $\times 10^{-4}$		4861
$2\pi^+2\pi^-K^+K^-\pi^0$	< 2.7 $\times 10^{-4}$	90%	4846
$2\pi^+2\pi^-K^+K^-2\pi^0$	< 5 $\times 10^{-4}$	90%	4828
$3\pi^+2\pi^-K^-K_S^0\pi^0$	< 1.6 $\times 10^{-4}$	90%	4827
$3\pi^+3\pi^-$	< 8 $\times 10^{-5}$	90%	4904
$3\pi^+3\pi^-2\pi^0$	< 6 $\times 10^{-4}$	90%	4881
$3\pi^+3\pi^-K^+K^-$	(2.4 ±1.2) $\times 10^{-4}$		4827
$3\pi^+3\pi^-K^+K^-\pi^0$	< 1.0 $\times 10^{-3}$	90%	4808
$4\pi^+4\pi^-$	< 8 $\times 10^{-5}$	90%	4880
$4\pi^+4\pi^-2\pi^0$	< 2.1 $\times 10^{-3}$	90%	4850
$J/\psi J/\psi$	< 7 $\times 10^{-5}$	90%	3836
$J/\psi\psi(2S)$	< 1.2 $\times 10^{-4}$	90%	3571
$\psi(2S)\psi(2S)$	< 3.1 $\times 10^{-5}$	90%	3273
$J/\psi(1S)$ anything	< 2.3 $\times 10^{-3}$	90%	—

$\chi_{b1}(1P)$

$I^G(J^{PC}) = 0^+(1^{++})$
J needs confirmation.

Mass $m = 9892.78 \pm 0.26 \pm 0.31$ MeV

$m_{\chi_{b1}(1P)} - m_{\Upsilon(1S)} = 432.10 \pm 0.28$ MeV

$\chi_{b1}(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	P (MeV/c)
$\gamma \Upsilon(1S)$	(35.2 $\pm$ 2.0) %		423
$D^0 X$	(12.6 $\pm$ 2.2) %		—
$\pi^+ \pi^- K^+ K^- \pi^0$	(2.0 $\pm$ 0.6) $\times 10^{-4}$		4892
$2\pi^+ \pi^- K^- K_S^0$	(1.3 $\pm$ 0.5) $\times 10^{-4}$		4892
$2\pi^+ \pi^- K^- K_S^0 2\pi^0$	< 6 $\times 10^{-4}$	90%	4863
$2\pi^+ 2\pi^- 2\pi^0$	(8.0 $\pm$ 2.5) $\times 10^{-4}$		4921
$2\pi^+ 2\pi^- K^+ K^-$	(1.5 $\pm$ 0.5) $\times 10^{-4}$		4878
$2\pi^+ 2\pi^- K^+ K^- \pi^0$	(3.5 $\pm$ 1.2) $\times 10^{-4}$		4863
$2\pi^+ 2\pi^- K^+ K^- 2\pi^0$	(8.6 $\pm$ 3.2) $\times 10^{-4}$		4845
$3\pi^+ 2\pi^- K^- K_S^0 \pi^0$	(9.3 $\pm$ 3.3) $\times 10^{-4}$		4844
$3\pi^+ 3\pi^-$	(1.9 $\pm$ 0.6) $\times 10^{-4}$		4921
$3\pi^+ 3\pi^- 2\pi^0$	(1.7 $\pm$ 0.5) $\times 10^{-3}$		4898
$3\pi^+ 3\pi^- K^+ K^-$	(2.6 $\pm$ 0.8) $\times 10^{-4}$		4844
$3\pi^+ 3\pi^- K^+ K^- \pi^0$	(7.5 $\pm$ 2.6) $\times 10^{-4}$		4825
$4\pi^+ 4\pi^-$	(2.6 $\pm$ 0.9) $\times 10^{-4}$		4897
$4\pi^+ 4\pi^- 2\pi^0$	(1.4 $\pm$ 0.6) $\times 10^{-3}$		4867
ω anything	(4.9 $\pm$ 1.4) %		—
ωX_{tetra}	< 4.44 $\times 10^{-4}$	90%	—
$J/\psi J/\psi$	< 2.7 $\times 10^{-5}$	90%	3857
$J/\psi \psi(2S)$	< 1.7 $\times 10^{-5}$	90%	3594
$\psi(2S) \psi(2S)$	< 6 $\times 10^{-5}$	90%	3298
$J/\psi(1S)$ anything	< 1.1 $\times 10^{-3}$	90%	—
$J/\psi(1S) X_{tetra}$	< 2.27 $\times 10^{-4}$	90%	—

$h_b(1P)$

$I^G(J^{PC}) = 0^-(1^{+-})$

Mass $m = 9899.3 \pm 0.8$ MeV

$h_b(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	P (MeV/c)
$\eta_b(1S) \gamma$	(52 $^{+6}_{-5}$) %		488
$\Upsilon(1S) \pi^0$	< 1.8 $\times 10^{-3}$	90%	408

$\chi_{b2}(1P)$

$I^G(J^{PC}) = 0^+(2^{++})$
 J needs confirmation.

Mass $m = 9912.21 \pm 0.26 \pm 0.31$ MeV

$\chi_{b2}(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\gamma \Upsilon(1S)$	$(18.0 \pm 1.0) \%$		442
$D^0 X$	$< 7.9 \%$	90%	—
$\pi^+ \pi^- K^+ K^- \pi^0$	$(8 \pm 5) \times 10^{-5}$		4902
$2\pi^+ \pi^- K^- K_S^0$	$< 1.0 \times 10^{-4}$	90%	4901
$2\pi^+ \pi^- K^- K_S^0 2\pi^0$	$(5.3 \pm 2.4) \times 10^{-4}$		4873
$2\pi^+ 2\pi^- 2\pi^0$	$(3.5 \pm 1.4) \times 10^{-4}$		4931
$2\pi^+ 2\pi^- K^+ K^-$	$(1.1 \pm 0.4) \times 10^{-4}$		4888
$2\pi^+ 2\pi^- K^+ K^- \pi^0$	$(2.1 \pm 0.9) \times 10^{-4}$		4872
$2\pi^+ 2\pi^- K^+ K^- 2\pi^0$	$(3.9 \pm 1.8) \times 10^{-4}$		4855
$3\pi^+ 2\pi^- K^- K_S^0 \pi^0$	$< 5 \times 10^{-4}$	90%	4854
$3\pi^+ 3\pi^-$	$(7.0 \pm 3.1) \times 10^{-5}$		4931
$3\pi^+ 3\pi^- 2\pi^0$	$(1.0 \pm 0.4) \times 10^{-3}$		4908
$3\pi^+ 3\pi^- K^+ K^-$	$< 8 \times 10^{-5}$	90%	4854
$3\pi^+ 3\pi^- K^+ K^- \pi^0$	$(3.6 \pm 1.5) \times 10^{-4}$		4835
$4\pi^+ 4\pi^-$	$(8 \pm 4) \times 10^{-5}$		4907
$4\pi^+ 4\pi^- 2\pi^0$	$(1.8 \pm 0.7) \times 10^{-3}$		4877
$J/\psi J/\psi$	$< 4 \times 10^{-5}$	90%	3869
$J/\psi \psi(2S)$	$< 5 \times 10^{-5}$	90%	3608
$\psi(2S) \psi(2S)$	$< 1.6 \times 10^{-5}$	90%	3313
$J/\psi(1S)$ anything	$(1.5 \pm 0.4) \times 10^{-3}$		—

$\Upsilon(2S)$

$I^G(J^{PC}) = 0^-(1^{--})$

Mass $m = 10023.4 \pm 0.5$ MeV
 $m_{\Upsilon(2S)} - m_{\Upsilon(1S)} = 562.81 \pm 0.11$ MeV
Full width $\Gamma = 31.98 \pm 2.63$ keV

$\Upsilon(2S)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\Upsilon(1S)\pi^+\pi^-$	$(17.85 \pm 0.26) \%$		475
$\Upsilon(1S)\pi^0\pi^0$	$(8.6 \pm 0.4) \%$		480
$\tau^+\tau^-$	$(2.00 \pm 0.21) \%$		4686
$\mu^+\mu^-$	$(1.93 \pm 0.17) \%$	S=2.2	5011
e^+e^-	$(1.91 \pm 0.16) \%$		5012
$\Upsilon(1S)\pi^0$	< 4	$\times 10^{-5}$ CL=90%	531
$\Upsilon(1S)\eta$	$(2.9 \pm 0.4) \times 10^{-4}$	S=2.0	126
$J/\psi(1S)$ anything	< 6	$\times 10^{-3}$ CL=90%	4533
$J/\psi(1S)\eta_c$	< 5.4	$\times 10^{-6}$ CL=90%	3984
$J/\psi(1S)\chi_{c0}$	< 3.4	$\times 10^{-6}$ CL=90%	3808
$J/\psi(1S)\chi_{c1}$	< 1.2	$\times 10^{-6}$ CL=90%	3765
$J/\psi(1S)\chi_{c2}$	< 2.0	$\times 10^{-6}$ CL=90%	3745
$J/\psi(1S)\eta_c(2S)$	< 2.5	$\times 10^{-6}$ CL=90%	3706
$J/\psi(1S)X(3940)$	< 2.0	$\times 10^{-6}$ CL=90%	3555
$J/\psi(1S)X(4160)$	< 2.0	$\times 10^{-6}$ CL=90%	3442
χ_{c1} anything	$(2.2 \pm 0.5) \times 10^{-4}$		—
$\chi_{c1}(1P)^0 X_{tetra}$	< 3.67	$\times 10^{-5}$ CL=90%	—
χ_{c2} anything	$(2.3 \pm 0.8) \times 10^{-4}$		—
$\psi(2S)\eta_c$	< 5.1	$\times 10^{-6}$ CL=90%	3732
$\psi(2S)\chi_{c0}$	< 4.7	$\times 10^{-6}$ CL=90%	3536
$\psi(2S)\chi_{c1}$	< 2.5	$\times 10^{-6}$ CL=90%	3488
$\psi(2S)\chi_{c2}$	< 1.9	$\times 10^{-6}$ CL=90%	3464
$\psi(2S)\eta_c(2S)$	< 3.3	$\times 10^{-6}$ CL=90%	3422
$\psi(2S)X(3940)$	< 3.9	$\times 10^{-6}$ CL=90%	3250
$\psi(2S)X(4160)$	< 3.9	$\times 10^{-6}$ CL=90%	3120
$T_{c\bar{c}1}(3900)^+ T_{c\bar{c}1}(3900)^-$	< 1.0	$\times 10^{-6}$ CL=90%	—
$T_{c\bar{c}1}(4200)^+ T_{c\bar{c}1}(4200)^-$	< 1.67	$\times 10^{-5}$ CL=90%	—
$T_{c\bar{c}1}(3900)^\pm T_{c\bar{c}1}(4200)^\mp$	< 7.3	$\times 10^{-6}$ CL=90%	—
$T_{c\bar{c}}(4050)^+ T_{c\bar{c}}(4050)^-$	< 1.35	$\times 10^{-5}$ CL=90%	—
$T_{c\bar{c}}(4250)^+ T_{c\bar{c}}(4250)^-$	< 2.67	$\times 10^{-5}$ CL=90%	—
$T_{c\bar{c}}(4050)^\pm T_{c\bar{c}}(4250)^\mp$	< 2.72	$\times 10^{-5}$ CL=90%	—
$T_{c\bar{c}1}(4430)^+ T_{c\bar{c}1}(4430)^-$	< 2.03	$\times 10^{-5}$ CL=90%	—
$T_{c\bar{c}}(4055)^\pm T_{c\bar{c}}(4055)^\mp$	< 1.11	$\times 10^{-5}$ CL=90%	—
$T_{c\bar{c}}(4055)^\pm T_{c\bar{c}1}(4430)^\mp$	< 2.11	$\times 10^{-5}$ CL=90%	—
$^2\overline{H}$ anything	$(2.78^{+0.30}_{-0.26}) \times 10^{-5}$	S=1.2	—
hadrons	$(94 \pm 11) \%$		—
ggg	$(58.8 \pm 1.2) \%$		—
γgg	$(1.87 \pm 0.28) \%$		—
$\phi K^+ K^-$	$(1.6 \pm 0.4) \times 10^{-6}$		4910
$\omega \pi^+ \pi^-$	< 2.58	$\times 10^{-6}$ CL=90%	4977
$K^*(892)^0 K^- \pi^+ + \text{c.c.}$	$(2.3 \pm 0.7) \times 10^{-6}$		4952

$\phi f'_2(1525)$	< 1.33	$\times 10^{-6}$	CL=90%	4843
$\omega f_2(1270)$	< 5.7	$\times 10^{-7}$	CL=90%	4899
$\rho(770) a_2(1320)$	< 8.8	$\times 10^{-7}$	CL=90%	4894
$K^*(892)^0 \bar{K}_2^*(1430)^0 + \text{c.c.}$	(1.5 ± 0.6)	$\times 10^{-6}$		4869
$K_1(1270)^\pm K^\mp$	< 3.22	$\times 10^{-6}$	CL=90%	4921
$K_1(1400)^\pm K^\mp$	< 8.3	$\times 10^{-7}$	CL=90%	4901
$b_1(1235)^\pm \pi^\mp$	< 4.0	$\times 10^{-7}$	CL=90%	4935
$\rho \pi$	< 1.16	$\times 10^{-6}$	CL=90%	4981
$\pi^+ \pi^- \pi^0$	< 8.0	$\times 10^{-7}$	CL=90%	5007
$\omega \pi^0$	< 1.63	$\times 10^{-6}$	CL=90%	4980
$\pi^+ \pi^- \pi^0 \pi^0$	(1.30 ± 0.28)	$\times 10^{-5}$		5002
$K_S^0 K^+ \pi^- + \text{c.c.}$	(1.14 ± 0.33)	$\times 10^{-6}$		4979
$K^*(892)^0 \bar{K}^0 + \text{c.c.}$	< 4.22	$\times 10^{-6}$	CL=90%	4959
$K^*(892)^- K^+ + \text{c.c.}$	< 1.45	$\times 10^{-6}$	CL=90%	4960
$f_1(1285) \text{ anything}$	(2.2 ± 1.6)	$\times 10^{-3}$		—
$f_1(1285) X_{tetra}$	< 6.47	$\times 10^{-5}$	CL=90%	—
$D_s^+ D_{s1}(2536)^-, D_{s1}^- \rightarrow$ $K^- D^*(2007)^0$	(1.6 ± 0.4)	$\times 10^{-5}$		—
$D_s^+ D_{s1}(2536)^-, D_{s1}^- \rightarrow$ $K_S^0 D^*(2010)^-$	(8.4 ± 2.3)	$\times 10^{-6}$		—
$D_s^{*+} D_{s1}(2536)^-, D_{s1}^- \rightarrow$ $K^- D^*(2007)^0$	(1.4 ± 0.4)	$\times 10^{-5}$		—
$D_s^{*+} D_{s1}(2536)^-, D_{s1}^- \rightarrow$ $K_S^0 D^*(2010)^-$	(8.2 ± 3.1)	$\times 10^{-6}$		—
$D_s^+ D_{s2}^*(2573)^-, D_{s2}^{*-} \rightarrow$ $K^- D^0$	(1.4 ± 0.4)	$\times 10^{-5}$		—
$D_s^+ D_{s2}^*(2573)^-, D_{s2}^{*-} \rightarrow$ $K_S^0 D^-$	(6.9 ± 3.0)	$\times 10^{-6}$		—
$D_s^{*+} D_{s2}^*(2573)^-, D_{s2}^{*-} \rightarrow$ $K^- D^0$	(9 ± 5)	$\times 10^{-6}$		—
$D_s^{*+} D_{s2}^*(2573)^-, D_{s2}^{*-} \rightarrow$ $K_S^0 D^-$	(5 ± 6)	$\times 10^{-6}$		—
Sum of 100 exclusive modes	(2.90 ± 0.30)	$\times 10^{-3}$		—

Radiative decays

$\gamma \chi_{b1}(1P)$	(6.9 ± 0.4)	%		130
$\gamma \chi_{b2}(1P)$	(7.15 ± 0.35)	%		111
$\gamma \chi_{b0}(1P)$	(3.8 ± 0.4)	%		163
$\gamma f_0(1710)$	< 5.9	$\times 10^{-4}$	CL=90%	4862
$\gamma f'_2(1525)$	< 5.3	$\times 10^{-4}$	CL=90%	4897
$\gamma f_2(1270)$	< 2.41	$\times 10^{-4}$	CL=90%	4931
$\gamma \eta_c(1S)$	< 2.7	$\times 10^{-5}$	CL=90%	4568
$\gamma \chi_{c0}$	< 1.0	$\times 10^{-4}$	CL=90%	4430

$\gamma\chi_{c1}$	< 3.6	$\times 10^{-6}$	CL=90%	4397
$\gamma\chi_{c2}$	< 1.5	$\times 10^{-5}$	CL=90%	4381
$\gamma\chi_{c1}(3872)$	< 1.8	$\times 10^{-5}$	CL=90%	4264
$\gamma\chi_{c1}(3872), \chi_{c1} \rightarrow \pi^+\pi^-\pi^0 J/\psi$	< 2.4	$\times 10^{-6}$	CL=90%	—
$\gamma\chi_{c0}(3915) \rightarrow \omega J/\psi$	< 2.8	$\times 10^{-6}$	CL=90%	—
$\gamma\chi_{c1}(4140) \rightarrow \phi J/\psi$	< 1.2	$\times 10^{-6}$	CL=90%	—
$\gamma X(4350) \rightarrow \phi J/\psi$	< 1.3	$\times 10^{-6}$	CL=90%	—
$\gamma\eta_b(1S)$	$(5.5 \pm_{-0.9}^{+1.1}) \times 10^{-4}$		S=1.2	605
$\gamma\eta_b(1S) \rightarrow \gamma$ Sum of 26 exclusive modes	< 3.7	$\times 10^{-6}$	CL=90%	—
$\gamma X_{b\bar{b}} \rightarrow \gamma$ Sum of 26 exclusive modes	< 4.9	$\times 10^{-6}$	CL=90%	—
$\gamma X \rightarrow \gamma + \geq 4$ prongs	$[h] < 1.95$	$\times 10^{-4}$	CL=95%	—
$\gamma A^0 \rightarrow \gamma$ hadrons	< 8	$\times 10^{-5}$	CL=90%	—
$\gamma A^0 \rightarrow \gamma\mu^+\mu^-$	< 8.3	$\times 10^{-6}$	CL=90%	—

Lepton Family number (*LF*) violating modes

$e^\pm \tau^\mp$	<i>LF</i>	< 1.12	$\times 10^{-6}$	CL=90%	4854
$\mu^\pm \tau^\mp$	<i>LF</i>	< 2.3	$\times 10^{-7}$	CL=90%	4854

$\Upsilon_2(1D)$

$I^G(J^{PC}) = 0^-(2^--)$

was $\Upsilon(1D)$

Mass $m = 10163.7 \pm 1.4$ MeV (S = 1.7)

$\Upsilon_2(1D)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\gamma\gamma \Upsilon(1S)$	seen	679
$\gamma\chi_{bJ}(1P)$	seen	300
$\eta \Upsilon(1S)$	not seen	426
$\pi^+\pi^- \Upsilon(1S)$	$(6.6\pm1.6) \times 10^{-3}$	623

$\chi_{b0}(2P)$

$I^G(J^{PC}) = 0^+(0^{++})$
 J needs confirmation.

Mass $m = 10232.5 \pm 0.4 \pm 0.5$ MeV

$\chi_{b0}(2P)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\gamma \Upsilon(2S)$	$(1.38 \pm 0.30) \%$		207
$\gamma \Upsilon(1S)$	$(3.8 \pm 1.7) \times 10^{-3}$		743
$D^0 X$	$< 8.2 \%$	90%	—
$\pi^+ \pi^- K^+ K^- \pi^0$	$< 3.4 \times 10^{-5}$	90%	5064
$2\pi^+ \pi^- K^- K_S^0$	$< 5 \times 10^{-5}$	90%	5063
$2\pi^+ \pi^- K^- K_S^0 2\pi^0$	$< 2.2 \times 10^{-4}$	90%	5036
$2\pi^+ 2\pi^- 2\pi^0$	$< 2.4 \times 10^{-4}$	90%	5092
$2\pi^+ 2\pi^- K^+ K^-$	$< 1.5 \times 10^{-4}$	90%	5050
$2\pi^+ 2\pi^- K^+ K^- \pi^0$	$< 2.2 \times 10^{-4}$	90%	5035
$2\pi^+ 2\pi^- K^+ K^- 2\pi^0$	$< 1.1 \times 10^{-3}$	90%	5019
$3\pi^+ 2\pi^- K^- K_S^0 \pi^0$	$< 7 \times 10^{-4}$	90%	5018
$3\pi^+ 3\pi^-$	$< 7 \times 10^{-5}$	90%	5091
$3\pi^+ 3\pi^- 2\pi^0$	$< 1.2 \times 10^{-3}$	90%	5070
$3\pi^+ 3\pi^- K^+ K^-$	$< 1.5 \times 10^{-4}$	90%	5017
$3\pi^+ 3\pi^- K^+ K^- \pi^0$	$< 7 \times 10^{-4}$	90%	4999
$4\pi^+ 4\pi^-$	$< 1.7 \times 10^{-4}$	90%	5069
$4\pi^+ 4\pi^- 2\pi^0$	$< 6 \times 10^{-4}$	90%	5039

 $\chi_{b1}(2P)$

$$J^G(J^{PC}) = 0^+(1^{++})$$

 J needs confirmation.

$$\text{Mass } m = 10255.46 \pm 0.22 \pm 0.50 \text{ MeV}$$

$$m_{\chi_{b1}(2P)} - m_{\chi_{b0}(2P)} = 23.5 \pm 1.0 \text{ MeV}$$

$$m_{\chi_{b1}(2P)} - m_{\Upsilon(1S)} = 793.6 \pm 0.8 \text{ MeV}$$

$\chi_{b1}(2P)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\omega \Upsilon(1S)$	$(1.63^{+0.40}_{-0.34}) \%$	134
$\gamma \Upsilon(2S)$	$(18.1 \pm 1.9) \%$	229
$\gamma \Upsilon(1S)$	$(9.9 \pm 1.0) \%$	764
$\pi \pi \chi_{b1}(1P)$	$(9.1 \pm 1.3) \times 10^{-3}$	238
$D^0 X$	$(8.8 \pm 1.7) \%$	—
$\pi^+ \pi^- K^+ K^- \pi^0$	$(3.1 \pm 1.0) \times 10^{-4}$	5075
$2\pi^+ \pi^- K^- K_S^0$	$(1.1 \pm 0.5) \times 10^{-4}$	5075
$2\pi^+ \pi^- K^- K_S^0 2\pi^0$	$(7.7 \pm 3.2) \times 10^{-4}$	5047
$2\pi^+ 2\pi^- 2\pi^0$	$(5.9 \pm 2.0) \times 10^{-4}$	5104
$2\pi^+ 2\pi^- K^+ K^-$	$(10 \pm 4) \times 10^{-5}$	5062
$2\pi^+ 2\pi^- K^+ K^- \pi^0$	$(5.5 \pm 1.8) \times 10^{-4}$	5047
$2\pi^+ 2\pi^- K^+ K^- 2\pi^0$	$(10 \pm 4) \times 10^{-4}$	5030
$3\pi^+ 2\pi^- K^- K_S^0 \pi^0$	$(6.7 \pm 2.6) \times 10^{-4}$	5029

$3\pi^+ 3\pi^-$	$(1.2 \pm 0.4) \times 10^{-4}$	5103
$3\pi^+ 3\pi^- 2\pi^0$	$(1.2 \pm 0.4) \times 10^{-3}$	5081
$3\pi^+ 3\pi^- K^+ K^-$	$(2.0 \pm 0.8) \times 10^{-4}$	5029
$3\pi^+ 3\pi^- K^+ K^- \pi^0$	$(6.1 \pm 2.2) \times 10^{-4}$	5011
$4\pi^+ 4\pi^-$	$(1.7 \pm 0.6) \times 10^{-4}$	5080
$4\pi^+ 4\pi^- 2\pi^0$	$(1.9 \pm 0.7) \times 10^{-3}$	5051

 $h_b(2P)$

$$I^G(J^{PC}) = 0^-(1^{+-})$$

Mass $m = 10259.8 \pm 1.2$ MeV

$h_b(2P)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	P (MeV/c)
hadrons	not seen	—	—
$\eta_b(1S)\gamma$	$(22 \pm 5) \%$		825
$\eta_b(2S)\gamma$	$(48 \pm 13) \%$		257
$\Upsilon(1S)\eta$	$(7.1^{+4.0}_{-3.3}) \times 10^{-3}$		559
$\Upsilon(1S)\pi^0$	$< 1.8 \times 10^{-3}$	90%	757

 $\chi_{b2}(2P)$

$$I^G(J^{PC}) = 0^+(2^{++})$$

 J needs confirmation.Mass $m = 10268.65 \pm 0.22 \pm 0.50$ MeV

$$m_{\chi_{b2}(2P)} - m_{\chi_{b1}(2P)} = 13.2 \pm 0.4 \text{ MeV} \quad (S = 1.8)$$

$\chi_{b2}(2P)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	P (MeV/c)
$\omega \Upsilon(1S)$	$(1.10^{+0.34}_{-0.30}) \%$		194
$\gamma \Upsilon(2S)$	$(8.9 \pm 1.2) \%$		242
$\gamma \Upsilon(1S)$	$(6.6 \pm 0.8) \%$		776
$\pi\pi\chi_{b2}(1P)$	$(5.1 \pm 0.9) \times 10^{-3}$		229
$D^0 X$	$< 2.4 \%$	90%	—
$\pi^+ \pi^- K^+ K^- \pi^0$	$< 1.1 \times 10^{-4}$	90%	5082
$2\pi^+ \pi^- K^- K_S^0$	$< 9 \times 10^{-5}$	90%	5082
$2\pi^+ \pi^- K^- K_S^0 2\pi^0$	$< 7 \times 10^{-4}$	90%	5054
$2\pi^+ 2\pi^- 2\pi^0$	$(3.9 \pm 1.6) \times 10^{-4}$		5110
$2\pi^+ 2\pi^- K^+ K^-$	$(9 \pm 4) \times 10^{-5}$		5068
$2\pi^+ 2\pi^- K^+ K^- \pi^0$	$(2.4 \pm 1.1) \times 10^{-4}$		5054
$2\pi^+ 2\pi^- K^+ K^- 2\pi^0$	$(4.7 \pm 2.3) \times 10^{-4}$		5037
$3\pi^+ 2\pi^- K^- K_S^0 \pi^0$	$< 4 \times 10^{-4}$	90%	5036
$3\pi^+ 3\pi^-$	$(9 \pm 4) \times 10^{-5}$		5110

$3\pi^+ 3\pi^- 2\pi^0$	$(1.2 \pm 0.4) \times 10^{-3}$	5088
$3\pi^+ 3\pi^- K^+ K^-$	$(1.4 \pm 0.7) \times 10^{-4}$	5036
$3\pi^+ 3\pi^- K^+ K^- \pi^0$	$(4.2 \pm 1.7) \times 10^{-4}$	5017
$4\pi^+ 4\pi^-$	$(9 \pm 5) \times 10^{-5}$	5087
$4\pi^+ 4\pi^- 2\pi^0$	$(1.3 \pm 0.5) \times 10^{-3}$	5058

$\Upsilon(3S)$

$J^{PC} = 0^{--}(1^{--})$

Mass $m = 10355.1 \pm 0.5$ MeV
 $m_{\Upsilon(3S)} - m_{\Upsilon(2S)} = 331.82 \pm 0.08$ MeV (S = 1.9)
Full width $\Gamma = 20.32 \pm 1.85$ keV

$\Upsilon(3S)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\Upsilon(2S)$ anything	$(10.6 \pm 0.8) \%$		296
$\Upsilon(2S) \pi^+ \pi^-$	$(2.82 \pm 0.18) \%$	S=1.6	176
$\Upsilon(2S) \pi^0 \pi^0$	$(1.85 \pm 0.14) \%$		190
$\Upsilon(2S) \gamma \gamma$	$(5.0 \pm 0.7) \%$		326
$\Upsilon(2S) \pi^0$	$< 5.1 \times 10^{-4}$	CL=90%	298
$\Upsilon(1S) \pi^+ \pi^-$	$(4.37 \pm 0.08) \%$		813
$\Upsilon(1S) \pi^0 \pi^0$	$(2.20 \pm 0.13) \%$		816
$\Upsilon(1S) \eta$	$< 1 \times 10^{-4}$	CL=90%	677
$\Upsilon(1S) \pi^0$	$< 7 \times 10^{-5}$	CL=90%	846
$h_b(1P) \pi^0$	$< 1.2 \times 10^{-3}$	CL=90%	426
$h_b(1P) \pi^0 \rightarrow \gamma \eta_b(1S) \pi^0$	$(4.3 \pm 1.4) \times 10^{-4}$		—
$h_b(1P) \pi^+ \pi^-$	$< 1.2 \times 10^{-4}$	CL=90%	352
$\tau^+ \tau^-$	$(2.29 \pm 0.30) \%$		4863
$\mu^+ \mu^-$	$(2.18 \pm 0.21) \%$	S=2.1	5176
$e^+ e^-$	$(2.18 \pm 0.20) \%$		5178
hadrons	$(93 \pm 12) \%$		—
$g g g$	$(35.7 \pm 2.6) \%$		—
$\gamma g g$	$(9.7 \pm 1.8) \times 10^{-3}$		—
2H anything	$(2.33 \pm 0.33) \times 10^{-5}$		—

Radiative decays

$\gamma \chi_{b2}(2P)$	$(13.1 \pm 1.6) \%$	S=3.4	86
$\gamma \chi_{b1}(2P)$	$(12.6 \pm 1.2) \%$	S=2.4	99
$\gamma \chi_{b0}(2P)$	$(5.9 \pm 0.6) \%$	S=1.4	122
$\gamma \chi_{b2}(1P)$	$(10.0 \pm 1.0) \times 10^{-3}$	S=1.7	433
$\gamma \chi_{b1}(1P)$	$(9 \pm 5) \times 10^{-4}$	S=1.8	452
$\gamma \chi_{b0}(1P)$	$(2.7 \pm 0.4) \times 10^{-3}$		484
$\gamma \eta_b(2S)$	$< 6.2 \times 10^{-4}$	CL=90%	350

$\gamma\eta_b(1S)$	$(5.1 \pm 0.7) \times 10^{-4}$	912
$\gamma A^0 \rightarrow \gamma \text{hadrons}$	$< 8 \times 10^{-5}$	CL=90% —
$\gamma X \rightarrow \gamma + \geq 4 \text{ prongs}$	$[i] < 2.2 \times 10^{-4}$	CL=95% —
$\gamma A^0 \rightarrow \gamma \mu^+ \mu^-$	$< 5.5 \times 10^{-6}$	CL=90% —
$\gamma A^0 \rightarrow \gamma \tau^+ \tau^-$	$[j] < 1.6 \times 10^{-4}$	CL=90% —

Lepton Family number (*LF*) violating modes

$e^\pm \tau^\mp$	<i>LF</i>	$< 4.2 \times 10^{-6}$	CL=90%	5025
$e^\pm \mu^\mp$	<i>LF</i>	$< 3.6 \times 10^{-7}$	CL=90%	5177
$\mu^\pm \tau^\mp$	<i>LF</i>	$< 3.1 \times 10^{-6}$	CL=90%	5025

$\chi_{b1}(3P)$

$I^G(J^{PC}) = 0^+(1^{++})$
J needs confirmation.

Mass *m* = 10513.4 ± 0.7 MeV

$\chi_{b1}(3P)$ DECAY MODES	Fraction (Γ_i/Γ)	<i>p</i> (MeV/c)
$\Upsilon(1S)\gamma$	seen	1000
$\Upsilon(2S)\gamma$	seen	479
$\Upsilon(3S)\gamma$	seen	157

$\chi_{b2}(3P)$

$I^G(J^{PC}) = 0^+(2^{++})$
J needs confirmation.

Mass *m* = 10524.0 ± 0.8 MeV

$\chi_{b2}(3P)$ DECAY MODES	Fraction (Γ_i/Γ)	<i>p</i> (MeV/c)
$\Upsilon(3S)\gamma$	seen	168

$\Upsilon(4S)$

$I^G(J^{PC}) = 0^-(1^{--})$

also known as $\Upsilon(10580)$
Mass *m* = 10579.4 ± 1.2 MeV
Full width Γ = 20.5 ± 2.5 MeV

$\Upsilon(4S)$ DECAY MODES	Fraction (Γ_i/Γ)		Confidence level	ρ (MeV/c)
$B\bar{B}$	> 96	%	95%	326
B^+B^-	(51.4 $\pm$ 0.6)	%		331
D_s^+ anything + c.c.	(17.8 $\pm$ 2.6)	%		—
$B^0\bar{B}^0$	(48.6 $\pm$ 0.6)	%		326
$J/\psi K_S^0 + (J/\psi, \eta_c) K_S^0$	< 4	$\times 10^{-7}$	90%	—
non- $B\bar{B}$	< 4	%	95%	—
e^+e^-	(1.57 $\pm$ 0.08)	$\times 10^{-5}$		5290
$\rho^+\rho^-$	< 5.7	$\times 10^{-6}$	90%	5233
$K^*(892)^0\bar{K}^0$	< 2.0	$\times 10^{-6}$	90%	5240
$J/\psi(1S)$ anything	< 1.9	$\times 10^{-4}$	95%	—
D^{*+} anything + c.c.	< 7.4	%	90%	5099
ϕ anything	(7.1 $\pm$ 0.6)	%		5240
$\phi\eta$	< 1.8	$\times 10^{-6}$	90%	5226
$\phi\eta'$	< 4.3	$\times 10^{-6}$	90%	5196
$\rho\eta$	< 1.3	$\times 10^{-6}$	90%	5247
$\rho\eta'$	< 2.5	$\times 10^{-6}$	90%	5217
$\Upsilon(1S)$ anything	< 4	$\times 10^{-3}$	90%	1053
$\Upsilon(1S)\pi^+\pi^-$	(8.2 $\pm$ 0.4)	$\times 10^{-5}$		1026
$\Upsilon(1S)\eta$	(1.81 $\pm$ 0.18)	$\times 10^{-4}$		924
$\Upsilon(1S)\eta'$	(3.4 $\pm$ 0.9)	$\times 10^{-5}$		—
$\Upsilon(2S)\pi^+\pi^-$	(8.2 $\pm$ 0.8)	$\times 10^{-5}$		468
$h_b(1P)\pi^+\pi^-$	not seen			600
$h_b(1P)\eta$	(2.18 $\pm$ 0.21)	$\times 10^{-3}$		390
$\eta_b(1S)\omega$	< 1.8	$\times 10^{-4}$	90%	—
2H anything	< 1.3	$\times 10^{-5}$	90%	—
Double Radiative Decays				
$\gamma\gamma \Upsilon(D) \rightarrow \gamma\gamma\eta \Upsilon(1S)$	< 2.3	$\times 10^{-5}$	90%	—

$\Upsilon(10860)$

$I^G(J^{PC}) = 0^-(1^{--})$

Mass $m = 10885.2^{+2.6}_{-1.6}$ MeV

Full width $\Gamma = 37 \pm 4$ MeV

$\Upsilon(10860)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	ρ (MeV/c)
$B\bar{B}X$	(76.2 $^{+2.7}_{-4.0}$) %		—
$B\bar{B}$	(5.5 ± 1.0) %		1322
$B\bar{B}^* + \text{c.c.}$	(13.7 ± 1.6) %		—
$B^*\bar{B}^*$	(38.1 ± 3.4) %		1127
$B\bar{B}^{(*)}\pi$	< 19.7 %	90%	1015
$B\bar{B}\pi$	(0.0 ± 1.2) %		1015
$B^*\bar{B}\pi + B\bar{B}^*\pi$	(7.3 ± 2.3) %		—
$B^*\bar{B}^*\pi$	(1.0 ± 1.4) %		739
$B\bar{B}\pi\pi$	< 8.9 %	90%	550
$B_s^{(*)}\bar{B}_s^{(*)}$	(20.1 ± 3.1) %		904
$B_s\bar{B}_s$	(5 ± 5) $\times 10^{-3}$		904
$B_s\bar{B}_s^* + \text{c.c.}$	(1.35 ± 0.32) %		—
$B_s^*\bar{B}_s^*$	(17.6 ± 2.7) %		543
no open-bottom	(3.8 $^{+5.0}_{-0.5}$) %		—
e^+e^-	(8.3 ± 2.1) $\times 10^{-6}$		5443
$K^*(892)^0\bar{K}^0$	< 1.0 $\times 10^{-5}$	90%	5395
$\Upsilon(1S)\pi^+\pi^-$	(5.3 ± 0.6) $\times 10^{-3}$		1306
$\Upsilon(1S)\eta$	(8.5 ± 1.7) $\times 10^{-4}$		1229
$\Upsilon(1S)\eta'$	< 6.9 $\times 10^{-5}$	90%	985
$\Upsilon(2S)\pi^+\pi^-$	(7.8 ± 1.3) $\times 10^{-3}$		783
$\Upsilon(2S)\eta$	(4.1 ± 0.6) $\times 10^{-3}$		639
$\Upsilon(3S)\pi^+\pi^-$	(4.8 $^{+1.9}_{-1.7}$) $\times 10^{-3}$		440
$\Upsilon(1S)K^+K^-$	(6.1 ± 1.8) $\times 10^{-4}$		959
$\eta\Upsilon_J(1D)$	(4.8 ± 1.1) $\times 10^{-3}$		—
$h_b(1P)\pi^+\pi^-$	(3.5 $^{+1.0}_{-1.3}$) $\times 10^{-3}$		903
$h_b(2P)\pi^+\pi^-$	(5.7 $^{+1.7}_{-2.1}$) $\times 10^{-3}$		544
$\chi_{bJ}(1P)\pi^+\pi^-\pi^0$	(2.5 ± 2.3) $\times 10^{-3}$		894
$\chi_{b0}(1P)\pi^+\pi^-\pi^0$	< 6.3 $\times 10^{-3}$	90%	894
$\chi_{b0}(1P)\omega$	< 3.9 $\times 10^{-3}$	90%	631
$\chi_{b0}(1P)(\pi^+\pi^-\pi^0)_{\text{non-}\omega}$	< 4.8 $\times 10^{-3}$	90%	—
$\chi_{b1}(1P)\pi^+\pi^-\pi^0$	(1.85 ± 0.33) $\times 10^{-3}$		861
$\chi_{b1}(1P)\omega$	(1.57 ± 0.30) $\times 10^{-3}$		582
$\chi_{b1}(1P)(\pi^+\pi^-\pi^0)_{\text{non-}\omega}$	(5.2 ± 1.9) $\times 10^{-4}$		—
$\chi_{b2}(1P)\pi^+\pi^-\pi^0$	(1.17 ± 0.30) $\times 10^{-3}$		841
$\chi_{b2}(1P)\omega$	(6.0 ± 2.7) $\times 10^{-4}$		552
$\chi_{b2}(1P)(\pi^+\pi^-\pi^0)_{\text{non-}\omega}$	(6 ± 4) $\times 10^{-4}$		—

$\gamma X_b \rightarrow \gamma \Upsilon(1S)\omega$	< 3.8	$\times 10^{-5}$	90%	—
$\eta_b(1S)\omega$	< 1.3	$\times 10^{-3}$	90%	1177
$\eta_b(2S)\omega$	< 5.6	$\times 10^{-3}$	90%	399

Inclusive Decays.

These decay modes are submodes of one or more of the decay modes above.

ϕ anything	$(13.8^{+2.4}_{-1.7})\%$	—
D^0 anything + c.c.	$(112 \pm 6)\%$	—
D_s anything + c.c.	$(44.7 \pm 2.6)\%$	—
J/ψ anything	$(2.06 \pm 0.21)\%$	—
B^0 anything + c.c.	$(77 \pm 8)\%$	—
B^+ anything + c.c.	$(72 \pm 6)\%$	—

$\Upsilon(11020)$	$I^G(J^{PC}) = 0^-(1^{--})$	
Mass $m = 11000 \pm 4$ MeV		
Full width $\Gamma = 24^{+8}_{-6}$ MeV		
$\Upsilon(11020)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
e^+e^-	$(5.4^{+1.9}_{-2.1}) \times 10^{-6}$	5500
$\chi_{bJ}(1P)\pi^+\pi^-\pi^0$	$(9^{+9}_{-8}) \times 10^{-3}$	1007
$\chi_{b1}(1P)\pi^+\pi^-\pi^0$	seen	975
$\chi_{b2}(1P)\pi^+\pi^-\pi^0$	seen	956

NOTES

- [a] $2m_\tau < M(\tau^+\tau^-) < 9.2$ GeV
- [b] 2 GeV $< m_{K^+K^-} < 3$ GeV
- [c] $X\bar{X}$ = vectors with $m < 3.1$ GeV
- [d] X and $\bar{X}$ = zero spin with $m < 4.5$ GeV
- [e] 1.5 GeV $< m_X < 5.0$ GeV
- [f] 201 MeV $< M(\mu^+\mu^-) < 3565$ MeV
- [g] 0.5 GeV $< m_X < 9.0$ GeV, where m_X is the invariant mass of the hadronic final state.
- [h] 1.5 GeV $< m_X < 5.0$ GeV
- [i] 1.5 GeV $< m_X < 5.0$ GeV
- [j] For $m_{\tau^+\tau^-}$ in the ranges 4.03–9.52 and 9.61–10.10 GeV.