

$b\bar{b}$ MESONS

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

$\eta_b(1S)$

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

Mass $m = 9398.7 \pm 2.0$ MeV ($S = 1.5$)

Full width $\Gamma = 10_{-4}^{+5}$ MeV

$\eta_b(1S)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	ρ (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

$\Upsilon(1S)$

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

Mass $m = 9460.30 \pm 0.26$ MeV ($S = 3.3$)

Full width $\Gamma = 54.02 \pm 1.25$ keV

$\Gamma_{ee} = 1.340 \pm 0.018$ keV

$\Upsilon(1S)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	ρ (MeV/c)
$\tau^+\tau^-$	(2.60 \pm 0.10) %		4384
e^+e^-	(2.38 \pm 0.11) %		4730
$\mu^+\mu^-$	(2.48 \pm 0.05) %		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%	3018
$X(4350)$ anything, $X \rightarrow$	< 8.1	$\times 10^{-6}$	CL=90%	—
$J/\psi(1S)\phi$				
$Z_c(3900)^\pm$ anything, $Z_c \rightarrow$	< 1.3	$\times 10^{-5}$	CL=90%	—
$J/\psi(1S)\pi^\pm$				
$Z_c(4200)^\pm$ anything, $Z_c \rightarrow$	< 6.0	$\times 10^{-5}$	CL=90%	—
$J/\psi(1S)\pi^\pm$				
$Z_c(4430)^\pm$ anything, $Z_c \rightarrow$	< 4.9	$\times 10^{-5}$	CL=90%	—
$J/\psi(1S)\pi^\pm$				
X_{cs}^\pm anything, $X \rightarrow$	< 5.7	$\times 10^{-6}$	CL=90%	—
$J/\psi K^\pm$				
$\chi_{c1}(3872)$ anything, $\chi_{c1} \rightarrow$	< 9.5	$\times 10^{-6}$	CL=90%	—
$J/\psi(1S)\pi^+\pi^-$				
$\psi(4260)$ anything, $\psi \rightarrow$	< 3.8	$\times 10^{-5}$	CL=90%	—
$J/\psi(1S)\pi^+\pi^-$				
$\psi(4260)$ anything, $\psi \rightarrow$	< 7.5	$\times 10^{-6}$	CL=90%	—
$J/\psi(1S)K^+K^-$				
$\chi_{c1}(4140)$ anything, $\chi_{c1} \rightarrow$	< 5.2	$\times 10^{-6}$	CL=90%	—
$J/\psi(1S)\phi$				
χ_{c0} anything	< 4	$\times 10^{-3}$	CL=90%	—
χ_{c1} anything	(1.90 ± 0.35)	$\times 10^{-4}$		—
$\chi_{c1}(1P)X_{tetra}$	< 3.78	$\times 10^{-5}$	CL=90%	—
χ_{c2} anything	(2.8 ± 0.8)	$\times 10^{-4}$		—
$\psi(2S)$ anything	(1.23 ± 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%	2642
$\psi(4260)$ anything, $\psi \rightarrow$	< 7.9	$\times 10^{-5}$	CL=90%	—
$\psi(2S)\pi^+\pi^-$				
$\psi(4360)$ anything, $\psi \rightarrow$	< 5.2	$\times 10^{-5}$	CL=90%	—
$\psi(2S)\pi^+\pi^-$				
$\psi(4660)$ anything, $\psi \rightarrow$	< 2.2	$\times 10^{-5}$	CL=90%	—
$\psi(2S)\pi^+\pi^-$				
$X(4050)^\pm$ anything, $X \rightarrow$	< 8.8	$\times 10^{-5}$	CL=90%	—
$\psi(2S)\pi^\pm$				
$Z_c(4430)^\pm$ anything, $Z_c \rightarrow$	< 6.7	$\times 10^{-5}$	CL=90%	—
$\psi(2S)\pi^\pm$				
$Z_c(4200)^+Z_c(4200)^-$	< 2.23	$\times 10^{-5}$	CL=90%	—
$Z_c(3900)^\pm Z_c(4200)^\mp$	< 8.1	$\times 10^{-6}$	CL=90%	—
$Z_c(3900)^+Z_c(3900)^-$	< 1.8	$\times 10^{-6}$	CL=90%	—

$X(4050)^+ X(4050)^-$	< 1.58	$\times 10^{-5}$	CL=90%	—
$X(4250)^+ X(4250)^-$	< 2.66	$\times 10^{-5}$	CL=90%	—
$X(4050)^\pm X(4250)^\mp$	< 4.42	$\times 10^{-5}$	CL=90%	—
$Z_c(4430)^+ Z_c(4430)^-$	< 2.03	$\times 10^{-5}$	CL=90%	—
$X(4055)^\pm X(4055)^\mp$	< 2.33	$\times 10^{-5}$	CL=90%	—
$X(4055)^\pm Z_c(4430)^\mp$	< 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
$\rho\bar{p}$	< 5	$\times 10^{-4}$	CL=90%	4636
$\pi^+\pi^-\pi^0$	(2.1 ± 0.8)	$\times 10^{-6}$		4725
ϕK^+K^-	(2.4 ± 0.5)	$\times 10^{-6}$		4622
$\omega\pi^+\pi^-$	(4.5 ± 1.0)	$\times 10^{-6}$		4694
$K^*(892)^0 K^-\pi^+ + \text{c.c.}$	(4.4 ± 0.8)	$\times 10^{-6}$		4667
$\phi f'_2(1525)$	< 1.63	$\times 10^{-6}$	CL=90%	4549
$\omega f_2(1270)$	< 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 ± 0.8)	$\times 10^{-6}$		4579
$K_1(1270)^\pm K^\mp$	< 2.41	$\times 10^{-6}$	CL=90%	4631
$K_1(1400)^\pm K^\mp$	(1.0 ± 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 ± 0.30)	$\times 10^{-5}$		4720
$K_S^0 K^+\pi^- + \text{c.c.}$	(1.6 ± 0.4)	$\times 10^{-6}$		4696
$K^*(892)^0 \bar{K}^0 + \text{c.c.}$	(2.9 ± 0.9)	$\times 10^{-6}$		4675
$K^*(892)^- K^+ + \text{c.c.}$	< 1.11	$\times 10^{-6}$	CL=90%	4675
$f_1(1285)$ anything	(4.6 ± 3.1)	$\times 10^{-3}$		—
$D^*(2010)^\pm$ anything	(2.52 ± 0.20)	%		—
$\frac{f_1(1285)}{2} X_{tetra}$	< 6.24	$\times 10^{-5}$	CL=90%	—
2H anything	(2.85 ± 0.25)	$\times 10^{-5}$		—
Sum of 100 exclusive modes	(1.200 ± 0.017)	%		—

Radiative decays

$\gamma\pi^+\pi^-$	(6.3 ± 1.8)	$\times 10^{-5}$		4728
$\gamma\pi^0\pi^0$	(1.7 ± 0.7)	$\times 10^{-5}$		4728
$\gamma\pi\pi$ (S-wave)	(4.6 ± 0.7)	$\times 10^{-5}$		4728
$\gamma\pi^0\eta$	< 2.4	$\times 10^{-6}$	CL=90%	4713
γK^+K^-	[a] (1.14 ± 0.13)	$\times 10^{-5}$		4704
$\gamma p\bar{p}$	[b] < 6	$\times 10^{-6}$	CL=90%	4636
$\gamma 2h^+2h^-$	(7.0 ± 1.5)	$\times 10^{-4}$		4720
$\gamma 3h^+3h^-$	(5.4 ± 2.0)	$\times 10^{-4}$		4703
$\gamma 4h^+4h^-$	(7.4 ± 3.5)	$\times 10^{-4}$		4679
$\gamma\pi^+\pi^- K^+K^-$	(2.9 ± 0.9)	$\times 10^{-4}$		4686
$\gamma 2\pi^+2\pi^-$	(2.5 ± 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)	$\times 10^{-4}$		4658
$\gamma \pi^+ \pi^- p \bar{p}$	(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)	$\times 10^{-5}$		4607
$\gamma f_2(1270)$	(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%	4610
$\gamma f_0(1500) \rightarrow \gamma K^+ K^-$	(1.0 \pm 0.4)	$\times 10^{-5}$		—
$\gamma f_0(1710)$	< 2.6	$\times 10^{-4}$	CL=90%	4577
$\gamma f_0(1710) \rightarrow \gamma K^+ K^-$	(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
$\gamma \eta_c(1S)$	< 5.7	$\times 10^{-5}$	CL=90%	4260
$\gamma \chi_{c0}$	< 6.5	$\times 10^{-4}$	CL=90%	4114
$\gamma \chi_{c1}$	< 2.3	$\times 10^{-5}$	CL=90%	4079
$\gamma \chi_{c2}$	< 7.6	$\times 10^{-6}$	CL=90%	4062
$\gamma \chi_{c1}(3872) \rightarrow \pi^+ \pi^- J/\psi$	< 1.6	$\times 10^{-6}$	CL=90%	—
$\gamma \chi_{c1}(3872) \rightarrow \pi^+ \pi^- \pi^0 J/\psi$	< 2.8	$\times 10^{-6}$	CL=90%	—
$\gamma X(3915) \rightarrow \omega J/\psi$	< 3.0	$\times 10^{-6}$	CL=90%	—
$\gamma \chi_{c1}(4140) \rightarrow \phi J/\psi$	< 2.2	$\times 10^{-6}$	CL=90%	—
γX	[c] < 4.5	$\times 10^{-6}$	CL=90%	—
$\gamma X \bar{X} (m_X < 3.1 \text{ GeV})$	[d] < 1	$\times 10^{-3}$	CL=90%	—
$\gamma X \bar{X} (m_X < 4.5 \text{ GeV})$	[e] < 2.4	$\times 10^{-4}$	CL=90%	—
$\gamma X \rightarrow \gamma + \geq 4 \text{ prongs}$	[f] < 1.78	$\times 10^{-4}$	CL=95%	—
$\gamma a_1^0 \rightarrow \gamma \mu^+ \mu^-$	[g] < 9	$\times 10^{-6}$	CL=90%	—
$\gamma a_1^0 \rightarrow \gamma \tau^+ \tau^-$	[a] < 1.30	$\times 10^{-4}$	CL=90%	—
$\gamma a_1^0 \rightarrow \gamma g g$	[h] < 1	%	CL=90%	—
$\gamma a_1^0 \rightarrow \gamma s \bar{s}$	[h] < 1	$\times 10^{-3}$	CL=90%	—

Lepton Family number (LF) violating modes

$\mu^\pm \tau^\mp$	LF	< 6.0	$\times 10^{-6}$	CL=95%	4563
--------------------	----	-------	------------------	--------	------

Other decaysinvisible $< 3.0 \times 10^{-4}$ CL=90% — **$\chi_{b0}(1P)$** [i]

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

 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	p (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
$2\pi^+ \pi^- K^- K_S^0 2\pi^0$	< 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]

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

 J needs confirmation.

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

$\chi_{b1}(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\gamma \Upsilon(1S)$	(35.2 ± 2.0) %		423
$D^0 X$	(12.6 ± 2.2) %		—
$\pi^+ \pi^- K^+ K^- \pi^0$	(2.0 ± 0.6) $\times 10^{-4}$		4892
$2\pi^+ \pi^- K^- K_S^0$	(1.3 ± 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 ± 2.5) $\times 10^{-4}$		4921
$2\pi^+ 2\pi^- K^+ K^-$	(1.5 ± 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%	—

 $h_b(1P)$

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

$$\text{Mass } m = 9899.3 \pm 0.8 \text{ MeV}$$

$h_b(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\eta_b(1S)\gamma$	$(52^{+6}_{-5}) \%$	488

 $\chi_{b2}(1P)$ [i]

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

 J needs confirmation.

$$\text{Mass } m = 9912.21 \pm 0.26 \pm 0.31 \text{ MeV}$$

$\chi_{b2}(1P)$ 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	$(1.5 \pm 0.4) \times 10^{-3}$		–

$\Upsilon(2S)$

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

$$\text{Mass } m = 10023.26 \pm 0.31 \text{ MeV}$$

$$m_{\Upsilon(3S)} - m_{\Upsilon(2S)} = 331.50 \pm 0.13 \text{ MeV}$$

$$\text{Full width } \Gamma = 31.98 \pm 2.63 \text{ keV}$$

$$\Gamma_{ee} = 0.612 \pm 0.011 \text{ keV}$$

$\Upsilon(2S)$ 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%	3744
$J/\psi(1S)\eta_c(2S)$	$< 2.5 \times 10^{-6}$	CL=90%	3707
$J/\psi(1S)X(3940)$	$< 2.0 \times 10^{-6}$	CL=90%	3555
$J/\psi(1S)X(4160)$	$< 2.0 \times 10^{-6}$	CL=90%	3440
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%	3118
$Z_c(3900)^+ Z_c(3900)^-$	< 1.0	$\times 10^{-6}$	CL=90%	—
$Z_c(4200)^+ Z_c(4200)^-$	< 1.67	$\times 10^{-5}$	CL=90%	—
$Z_c(3900)^\pm Z_c(4200)^\mp$	< 7.3	$\times 10^{-6}$	CL=90%	—
$X(4050)^+ X(4050)^-$	< 1.35	$\times 10^{-5}$	CL=90%	—
$X(4250)^+ X(4250)^-$	< 2.67	$\times 10^{-5}$	CL=90%	—
$X(4050)^\pm X(4250)^\mp$	< 2.72	$\times 10^{-5}$	CL=90%	—
$Z_c(4430)^+ Z_c(4430)^-$	< 2.03	$\times 10^{-5}$	CL=90%	—
$X(4055)^\pm X(4055)^\mp$	< 1.11	$\times 10^{-5}$	CL=90%	—
$X(4055)^\pm Z_c(4430)^\mp$	< 2.11	$\times 10^{-5}$	CL=90%	—
$\overline{2H}$ anything	$(2.78^{+0.30}_{-0.26})$	$\times 10^{-5}$	S=1.2	—
hadrons	(94 ± 11)	%		—
ggg	(58.8 ± 1.2)	%		—
$\gamma g g$	(1.87 ± 0.28)	%		—
$\phi K^+ K^-$	(1.6 ± 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 ± 0.7)	$\times 10^{-6}$		4952
$\phi f'_2(1525)$	< 1.33	$\times 10^{-6}$	CL=90%	4841
$\omega f_2(1270)$	< 5.7	$\times 10^{-7}$	CL=90%	4899
$\rho(770) a_2(1320)$	< 8.8	$\times 10^{-7}$	CL=90%	4894
$K^*(892)^0 \overline{K}_2^*(1430)^0 + \text{c.c.}$	(1.5 ± 0.6)	$\times 10^{-6}$		4869
$K_1(1270)^\pm K^\mp$	< 3.22	$\times 10^{-6}$	CL=90%	4918
$K_1(1400)^\pm K^\mp$	< 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
$K^*(892)^0 \overline{K}^0 + \text{c.c.}$	< 4.22	$\times 10^{-6}$	CL=90%	4959
$K^*(892)^- K^+ + \text{c.c.}$	< 1.45	$\times 10^{-6}$	CL=90%	4960
$f_1(1285)$ anything	(2.2 ± 1.6)	$\times 10^{-3}$		—
$f_1(1285) X_{tetra}$	< 6.47	$\times 10^{-5}$	CL=90%	—
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)	%		110
$\gamma \chi_{b0}(1P)$	(3.8 ± 0.4)	%		162
$\gamma f_0(1710)$	< 5.9	$\times 10^{-4}$	CL=90%	4867
$\gamma f'_2(1525)$	< 5.3	$\times 10^{-4}$	CL=90%	4896
$\gamma f_2(1270)$	< 2.41	$\times 10^{-4}$	CL=90%	4930
$\gamma \eta_c(1S)$	< 2.7	$\times 10^{-5}$	CL=90%	4567
$\gamma \chi_{c0}$	< 1.0	$\times 10^{-4}$	CL=90%	4430

γX_{c1}	< 3.6	$\times 10^{-6}$	CL=90%	4397
γX_{c2}	< 1.5	$\times 10^{-5}$	CL=90%	4381
$\gamma X_{c1}(3872) \rightarrow \pi^+ \pi^- J/\psi$	< 8	$\times 10^{-7}$	CL=90%	—
$\gamma X_{c1}(3872) \rightarrow \pi^+ \pi^- \pi^0 J/\psi$	< 2.4	$\times 10^{-6}$	CL=90%	—
$\gamma X(3915) \rightarrow \omega J/\psi$	< 2.8	$\times 10^{-6}$	CL=90%	—
$\gamma X_{c1}(4140) \rightarrow \phi J/\psi$	< 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 ± 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	$[j] < 1.95$	$\times 10^{-4}$	CL=95%	—
$\gamma A^0 \rightarrow \gamma$ hadrons	< 8	$\times 10^{-5}$	CL=90%	—
$\gamma a_1^0 \rightarrow \gamma \mu^+ \mu^-$	< 8.3	$\times 10^{-6}$	CL=90%	—

Lepton Family number (LF) violating modes

$e^\pm \tau^\mp$	LF	< 3.2	$\times 10^{-6}$	CL=90%	4854
$\mu^\pm \tau^\mp$	LF	< 3.3	$\times 10^{-6}$	CL=90%	4854

$\Upsilon_2(1D)$

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

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
$\pi^+ \pi^- \Upsilon(1S)$	$(6.6 \pm 1.6) \times 10^{-3}$	623

$\chi_{b0}(2P)$ [i]

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

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%
$2\pi^+ \pi^- K^- K_S^0$	< 5	$\times 10^{-5}$	90%
$2\pi^+ \pi^- K^- K_S^0 2\pi^0$	< 2.2	$\times 10^{-4}$	90%

$2\pi^+2\pi^-2\pi^0$	< 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

$\chi_{b1}(2P)$ ^[i]

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

Mass $m = 10255.46 \pm 0.22 \pm 0.50$ MeV

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

$\chi_{b1}(2P)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\omega \Upsilon(1S)$	($1.63^{+0.40}_{-0.34}$) %	135
$\gamma \Upsilon(2S)$	(18.1 ± 1.9) %	230
$\gamma \Upsilon(1S)$	(9.9 ± 1.0) %	764
$\pi\pi\chi_{b1}(1P)$	(9.1 ± 1.3) $\times 10^{-3}$	238
$D^0 X$	(8.8 ± 1.7) %	—
$\pi^+\pi^-K^+K^-\pi^0$	(3.1 ± 1.0) $\times 10^{-4}$	5075
$2\pi^+\pi^-K^-K_S^0$	(1.1 ± 0.5) $\times 10^{-4}$	5075
$2\pi^+\pi^-K^-K_S^02\pi^0$	(7.7 ± 3.2) $\times 10^{-4}$	5047
$2\pi^+2\pi^-2\pi^0$	(5.9 ± 2.0) $\times 10^{-4}$	5104
$2\pi^+2\pi^-K^+K^-$	(10 ± 4) $\times 10^{-5}$	5062
$2\pi^+2\pi^-K^+K^-\pi^0$	(5.5 ± 1.8) $\times 10^{-4}$	5047
$2\pi^+2\pi^-K^+K^-2\pi^0$	(10 ± 4) $\times 10^{-4}$	5030
$3\pi^+2\pi^-K^-K_S^0\pi^0$	(6.7 ± 2.6) $\times 10^{-4}$	5029
$3\pi^+3\pi^-$	(1.2 ± 0.4) $\times 10^{-4}$	5103
$3\pi^+3\pi^-2\pi^0$	(1.2 ± 0.4) $\times 10^{-3}$	5081
$3\pi^+3\pi^-K^+K^-$	(2.0 ± 0.8) $\times 10^{-4}$	5029
$3\pi^+3\pi^-K^+K^-\pi^0$	(6.1 ± 2.2) $\times 10^{-4}$	5011
$4\pi^+4\pi^-$	(1.7 ± 0.6) $\times 10^{-4}$	5080
$4\pi^+4\pi^-2\pi^0$	(1.9 ± 0.7) $\times 10^{-3}$	5051

$\chi_{b2}(2P)$ [i]

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

J needs confirmation.

$$\text{Mass } m = 10268.65 \pm 0.22 \pm 0.50 \text{ MeV}$$

$$m_{\chi_{b2}(2P)} - m_{\chi_{b1}(2P)} = 13.10 \pm 0.24 \text{ MeV}$$

$\chi_{b2}(2P)$ 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
$\gamma \Upsilon(1S)$	$(6.6 \pm 0.8) \%$		777
$\pi\pi \chi_{b2}(1P)$	$(5.1 \pm 0.9) \times 10^{-3}$		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

$\Upsilon(3S)$

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

$$\text{Mass } m = 10355.2 \pm 0.5 \text{ MeV}$$

$$m_{\Upsilon(3S)} - m_{\Upsilon(2S)} = 331.50 \pm 0.13 \text{ MeV}$$

$$\text{Full width } \Gamma = 20.32 \pm 1.85 \text{ keV}$$

$$\Gamma_{ee} = 0.443 \pm 0.008 \text{ keV}$$

$\Upsilon(3S)$ 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	177
$\Upsilon(2S) \pi^0 \pi^0$	$(1.85 \pm 0.14) \%$		190
$\Upsilon(2S) \gamma \gamma$	$(5.0 \pm 0.7) \%$		327
$\Upsilon(2S) \pi^0$	< 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 ± 1.4)	$\times 10^{-4}$		—
$h_b(1P)\pi^+\pi^-$	< 1.2	$\times 10^{-4}$	CL=90%	353
$\tau^+\tau^-$	(2.29 ± 0.30)	%		4863
$\mu^+\mu^-$	(2.18 ± 0.21)	%	S=2.1	5177
e^+e^-	(2.18 ± 0.20)	%		5178
hadrons	(93 ± 12)	%		—
ggg	(35.7 ± 2.6)	%		—
γgg	(9.7 ± 1.8)	$\times 10^{-3}$		—
2H anything	(2.33 ± 0.33)	$\times 10^{-5}$		—

Radiative decays

$\gamma\chi_{b2}(2P)$	(13.1 ± 1.6)	%	S=3.4	86
$\gamma\chi_{b1}(2P)$	(12.6 ± 1.2)	%	S=2.4	99
$\gamma\chi_{b0}(2P)$	(5.9 ± 0.6)	%	S=1.4	122
$\gamma\chi_{b2}(1P)$	(10.0 ± 1.0)	$\times 10^{-3}$	S=1.7	434
$\gamma\chi_{b1}(1P)$	(9 ± 5)	$\times 10^{-4}$	S=1.8	452
$\gamma\chi_{b0}(1P)$	(2.7 ± 0.4)	$\times 10^{-3}$		484
$\gamma\eta_b(2S)$	< 6.2	$\times 10^{-4}$	CL=90%	350
$\gamma\eta_b(1S)$	(5.1 ± 0.7)	$\times 10^{-4}$		912
$\gamma A^0 \rightarrow \gamma$ hadrons	< 8	$\times 10^{-5}$	CL=90%	—
$\gamma X \rightarrow \gamma + \geq 4$ prongs	$[k] < 2.2$	$\times 10^{-4}$	CL=95%	—
$\gamma a_1^0 \rightarrow \gamma\mu^+\mu^-$	< 5.5	$\times 10^{-6}$	CL=90%	—
$\gamma a_1^0 \rightarrow \gamma\tau^+\tau^-$	$[l] < 1.6$	$\times 10^{-4}$	CL=90%	—

Lepton Family number (LF) violating modes

$e^\pm\tau^\mp$	LF	< 4.2	$\times 10^{-6}$	CL=90%	5025
$\mu^\pm\tau^\mp$	LF	< 3.1	$\times 10^{-6}$	CL=90%	5025

$\chi_{b1}(3P)$

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

Mass $m = 10513.4 \pm 0.7$ MeV

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

$\chi_{b2}(3P)$

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

 Mass $m = 10524.0 \pm 0.8$ MeV

$\chi_{b2}(3P)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Upsilon(3S)\gamma$	seen	167

 $\Upsilon(4S)$

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

 Mass $m = 10579.4 \pm 1.2$ MeV

 Full width $\Gamma = 20.5 \pm 2.5$ MeV

 $\Gamma_{ee} = 0.272 \pm 0.029$ keV ($S = 1.5$)

$\Upsilon(4S)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (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
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%	—

$Z_b(10610)$

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

Mass $m = 10607.2 \pm 2.0$ MeV

Full width $\Gamma = 18.4 \pm 2.4$ MeV

$Z_b(10610)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Upsilon(1S)\pi^+$	$(5.4^{+1.9}_{-1.5}) \times 10^{-3}$	1077
$\Upsilon(1S)\pi^0$	not seen	1077
$\Upsilon(2S)\pi^+$	$(3.6^{+1.1}_{-0.8})\%$	551
$\Upsilon(2S)\pi^0$	seen	552
$\Upsilon(3S)\pi^+$	$(2.1^{+0.8}_{-0.6})\%$	207
$\Upsilon(3S)\pi^0$	seen	210
$h_b(1P)\pi^+$	$(3.5^{+1.2}_{-0.9})\%$	671
$h_b(2P)\pi^+$	$(4.7^{+1.7}_{-1.3})\%$	313
$B^+\bar{B}^0$	not seen	505
$B^+\bar{B}^{*0} + B^{*+}\bar{B}^0$	$(85.6^{+2.1}_{-2.9})\%$	—
$B^{*+}\bar{B}^{*0}$	not seen	†

 $Z_b(10650)$

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

 I, G, C need confirmation.

Mass $m = 10652.2 \pm 1.5$ MeV

Full width $\Gamma = 11.5 \pm 2.2$ MeV

 $Z_b(10650)^-$ decay modes are charge conjugates of the modes below.

$Z_b(10650)^+$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Upsilon(1S)\pi^+$	$(1.7^{+0.8}_{-0.6}) \times 10^{-3}$	1117
$\Upsilon(2S)\pi^+$	$(1.4^{+0.6}_{-0.4})\%$	595
$\Upsilon(3S)\pi^+$	$(1.6^{+0.7}_{-0.5})\%$	259
$h_b(1P)\pi^+$	$(8.4^{+2.9}_{-2.4})\%$	714
$h_b(2P)\pi^+$	$(15 \pm 4)\%$	360
$B^+\bar{B}^0$	not seen	703
$B^+\bar{B}^{*0} + B^{*+}\bar{B}^0$	not seen	—
$B^{*+}\bar{B}^{*0}$	$(74 \pm 4 \pm 6)\%$	122

$\Upsilon(10860)$

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

$$\text{Mass } m = 10889.9^{+3.2}_{-2.6} \text{ MeV}$$

$$\text{Full width } \Gamma = 51^{+6}_{-7} \text{ MeV}$$

$$\Gamma_{ee} = 0.31 \pm 0.07 \text{ keV} \quad (S = 1.3)$$

$\Upsilon(10860)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$B\bar{B}X$	(76.2 $^{+2.7}_{-4.0}$) %		—
$B\bar{B}$	(5.5 ± 1.0) %		1331
$B\bar{B}^* + \text{c.c.}$	(13.7 ± 1.6) %		—
$B^*\bar{B}^*$	(38.1 ± 3.4) %		1138
$B\bar{B}^{(*)}\pi$	< 19.7 %	90%	1027
$B\bar{B}\pi$	(0.0 ± 1.2) %		1027
$B^*\bar{B}\pi + B\bar{B}^*\pi$	(7.3 ± 2.3) %		—
$B^*\bar{B}^*\pi$	(1.0 ± 1.4) %		756
$B\bar{B}\pi\pi$	< 8.9 %	90%	574
$B_s^{(*)}\bar{B}_s^{(*)}$	(20.1 ± 3.1) %		919
$B_s\bar{B}_s$	(5 ± 5) $\times 10^{-3}$		919
$B_s\bar{B}_s^* + \text{c.c.}$	(1.35 ± 0.32) %		—
$B_s^*\bar{B}_s^*$	(17.6 ± 2.7) %		566
no open-bottom	(3.8 $^{+5.0}_{-0.5}$) %		—
e^+e^-	(6.1 ± 1.6) $\times 10^{-6}$		5445
$K^*(892)^0\bar{K}^0$	< 1.0 $\times 10^{-5}$	90%	5397
$\Upsilon(1S)\pi^+\pi^-$	(5.3 ± 0.6) $\times 10^{-3}$		1310
$\Upsilon(2S)\pi^+\pi^-$	(7.8 ± 1.3) $\times 10^{-3}$		788
$\Upsilon(3S)\pi^+\pi^-$	(4.8 $^{+1.9}_{-1.7}$) $\times 10^{-3}$		445
$\Upsilon(1S)K^+K^-$	(6.1 ± 1.8) $\times 10^{-4}$		965
$\eta\Upsilon_J(1D)$	(4.8 ± 1.1) $\times 10^{-3}$		—
$h_b(1P)\pi^+\pi^-$	(3.5 $^{+1.0}_{-1.3}$) $\times 10^{-3}$		907
$h_b(2P)\pi^+\pi^-$	(5.7 $^{+1.7}_{-2.1}$) $\times 10^{-3}$		548
$\chi_{bJ}(1P)\pi^+\pi^-\pi^0$	(2.5 ± 2.3) $\times 10^{-3}$		899
$\chi_{b0}(1P)\pi^+\pi^-\pi^0$	< 6.3 $\times 10^{-3}$	90%	899
$\chi_{b0}(1P)\omega$	< 3.9 $\times 10^{-3}$	90%	638
$\chi_{b0}(1P)(\pi^+\pi^-\pi^0)_{\text{non-}\omega}$	< 4.8 $\times 10^{-3}$	90%	—
$\chi_{b1}(1P)\pi^+\pi^-\pi^0$	(1.85 ± 0.33) $\times 10^{-3}$		865
$\chi_{b1}(1P)\omega$	(1.57 ± 0.30) $\times 10^{-3}$		589
$\chi_{b1}(1P)(\pi^+\pi^-\pi^0)_{\text{non-}\omega}$	(5.2 ± 1.9) $\times 10^{-4}$		—
$\chi_{b2}(1P)\pi^+\pi^-\pi^0$	(1.17 ± 0.30) $\times 10^{-3}$		846

$\chi_{b2}(1P)\omega$	$(6.0 \pm 2.7) \times 10^{-4}$	559
$\chi_{b2}(1P)(\pi^+\pi^-\pi^0)_{\text{non-}\omega}$	$(6 \pm 4) \times 10^{-4}$	—
$\gamma X_b \rightarrow \gamma \Upsilon(1S)\omega$	$< 3.8 \times 10^{-5}$	90% —

Inclusive Decays.

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

ϕ anything	$(13.8 \begin{smallmatrix} +2.4 \\ -1.7 \end{smallmatrix}) \%$	—
D^0 anything + c.c.	$(108 \pm 8) \%$	—
D_s anything + c.c.	$(46 \pm 6) \%$	—
J/ψ anything	$(2.06 \pm 0.21) \%$	—
B^0 anything + c.c.	$(77 \pm 8) \%$	—
B^+ anything + c.c.	$(72 \pm 6) \%$	—

$\Upsilon(11020)$

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

$$\text{Mass } m = 10992.9_{-3.1}^{+10.0} \text{ MeV}$$

$$\text{Full width } \Gamma = 49_{-15}^{+9} \text{ MeV}$$

$$\Gamma_{ee} = 0.130 \pm 0.030 \text{ keV}$$

$\Upsilon(11020)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
e^+e^-	$(2.7_{-0.8}^{+1.0}) \times 10^{-6}$	5496
$\chi_{bJ}(1P)\pi^+\pi^-\pi^0$	$(9 \begin{smallmatrix} +9 \\ -8 \end{smallmatrix}) \times 10^{-3}$	1001
$\chi_{b1}(1P)\pi^+\pi^-\pi^0$	seen	968
$\chi_{b2}(1P)\pi^+\pi^-\pi^0$	seen	949

NOTES

- [a] $2m_\tau < M(\tau^+\tau^-) < 9.2 \text{ GeV}$
- [b] $2 \text{ GeV} < m_{K^+K^-} < 3 \text{ GeV}$
- [c] $X = \text{scalar with } m < 8.0 \text{ GeV}$
- [d] $X\bar{X} = \text{vectors with } m < 3.1 \text{ GeV}$
- [e] $X \text{ and } \bar{X} = \text{zero spin with } m < 4.5 \text{ GeV}$
- [f] $1.5 \text{ GeV} < m_X < 5.0 \text{ GeV}$
- [g] $201 \text{ MeV} < M(\mu^+\mu^-) < 3565 \text{ MeV}$
- [h] $0.5 \text{ GeV} < m_X < 9.0 \text{ GeV}$, where m_X is the invariant mass of the hadronic final state.
- [i] Spectroscopic labeling for these states is theoretical, pending experimental information.
- [j] $1.5 \text{ GeV} < m_X < 5.0 \text{ GeV}$
- [k] $1.5 \text{ GeV} < m_X < 5.0 \text{ GeV}$
- [l] For $m_{\tau^+\tau^-}$ in the ranges 4.03–9.52 and 9.61–10.10 GeV.