$b\overline{b}$ MESONS

$\Upsilon(1S)$

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

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)	Confidence level	p (MeV/c)
$\tau^+\tau^-$	(2.60 ±0.10) %		4384
e^+e^-	(2.38 ±0.11) %		4730
$\mu^+\mu^-$	(2.48 ±0.05) %		4729
Hadronic decays			
ggg	(81.7 ±0.7) %		–
γgg	(2.2 ±0.6) %		–
$\eta'(958)$ anything	(2.94 ±0.24) %		–
$J/\psi(1S)$ anything	(6.5 ±0.7) $\times 10^{-4}$		4223
χ_{c0} anything	$< 5 \times 10^{-3}$	90%	–
χ_{c1} anything	(2.3 ±0.7) $\times 10^{-4}$		–
χ_{c2} anything	(3.4 ±1.0) $\times 10^{-4}$		–
$\psi(2S)$ anything	(2.7 ±0.9) $\times 10^{-4}$		–
$\rho\pi$	$< 3.68 \times 10^{-6}$	90%	4697
$\omega\pi^0$	$< 3.90 \times 10^{-6}$	90%	4697
$\pi^+\pi^-$	$< 5 \times 10^{-4}$	90%	4728
K^+K^-	$< 5 \times 10^{-4}$	90%	4704
$p\overline{p}$	$< 5 \times 10^{-4}$	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
$K^*(892)^0 K^-\pi^+ +$ c.c.	(4.4 ±0.8) $\times 10^{-6}$		4667
$\phi f_2'(1525)$	$< 1.63 \times 10^{-6}$	90%	4549
$\omega f_2(1270)$	$< 1.79 \times 10^{-6}$	90%	4611
$\rho(770)a_2(1320)$	$< 2.24 \times 10^{-6}$	90%	4605
$K^*(892)^0\overline{K}_2^*(1430)^0 +$ c.c.	(3.0 ±0.8) $\times 10^{-6}$		4579
$K_1(1270)^\pm K^\mp$	$< 2.41 \times 10^{-6}$	90%	4631
$K_1(1400)^\pm K^\mp$	(1.0 ±0.4) $\times 10^{-6}$		4613
$b_1(1235)^\pm\pi^\mp$	$< 1.25 \times 10^{-6}$	90%	4649
$\pi^+\pi^-\pi^0\pi^0$	(1.28 ±0.30) $\times 10^{-5}$		4720
$K_S^0 K^+\pi^- +$ c.c.	(1.6 ±0.4) $\times 10^{-6}$		4696
$K^*(892)^0\overline{K}^0 +$ c.c.	(2.9 ±0.9) $\times 10^{-6}$		4675

$K^*(892)^- K^+ +$ c.c.	$<$ 1.11	$\times 10^{-6}$	90%	4675
$D^*(2010)^\pm$ anything	(2.52 $\pm$0.20) %			–
$\overline{d}$ anything	(2.86 $\pm$0.28) $\times 10^{-5}$			–
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
$\gamma\pi^0\eta$		$<$ 2.4	$\times 10^{-6}$	90%	4713
$\gamma K^+ K^-$	[a]	(1.14 $\pm$0.13) $\times 10^{-5}$			4704
$\gamma p\overline{p}$	[b]	$<$ 6	$\times 10^{-6}$	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) $\times 10^{-4}$			4658
$\gamma\pi^+\pi^- p\overline{p}$		(1.5 $\pm$0.6) $\times 10^{-4}$			4604
$\gamma 2\pi^+ 2\pi^- p\overline{p}$		(4 $\pm$6) $\times 10^{-5}$			4563
$\gamma 2K^+ 2K^-$		(2.0 $\pm$2.0) $\times 10^{-5}$			4601
$\gamma\eta'(958)$		$<$ 1.9	$\times 10^{-6}$	90%	4682
$\gamma\eta$		$<$ 1.0	$\times 10^{-6}$	90%	4714
$\gamma f_0(980)$		$<$ 3	$\times 10^{-5}$	90%	4678
$\gamma f_2'(1525)$		(3.8 $\pm$0.9) $\times 10^{-5}$			4607
$\gamma f_2(1270)$		(1.01 $\pm$0.09) $\times 10^{-4}$			4644
$\gamma\eta(1405)$		$<$ 8.2	$\times 10^{-5}$	90%	4625
$\gamma f_0(1500)$		$<$ 1.5	$\times 10^{-5}$	90%	4610
$\gamma f_0(1710)$		$<$ 2.6	$\times 10^{-4}$	90%	4573
$\gamma f_0(1710) \to \gamma K^+ K^-$		$<$ 7	$\times 10^{-6}$	90%	–
$\gamma f_0(1710) \to \gamma\pi^0\pi^0$		$<$ 1.4	$\times 10^{-6}$	90%	–
$\gamma f_0(1710) \to \gamma\eta\eta$		$<$ 1.8	$\times 10^{-6}$	90%	–
$\gamma f_4(2050)$		$<$ 5.3	$\times 10^{-5}$	90%	4515
$\gamma f_0(2200) \to \gamma K^+ K^-$		$<$ 2	$\times 10^{-4}$	90%	4475
$\gamma f_J(2220) \to \gamma K^+ K^-$		$<$ 8	$\times 10^{-7}$	90%	4469
$\gamma f_J(2220) \to \gamma\pi^+\pi^-$		$<$ 6	$\times 10^{-7}$	90%	–
$\gamma f_J(2220) \to \gamma p\overline{p}$		$<$ 1.1	$\times 10^{-6}$	90%	–
$\gamma\eta(2225) \to \gamma\phi\phi$		$<$ 3	$\times 10^{-3}$	90%	4469
$\gamma\eta_c(1S)$		$<$ 5.7	$\times 10^{-5}$	90%	4260
$\gamma\chi_{c0}$		$<$ 6.5	$\times 10^{-4}$	90%	4114
$\gamma\chi_{c1}$		$<$ 2.3	$\times 10^{-5}$	90%	4079
$\gamma\chi_{c2}$		$<$ 7.6	$\times 10^{-6}$	90%	4062
$\gamma X(3872) \to \pi^+\pi^- J/\psi$		$<$ 1.6	$\times 10^{-6}$	90%	–
$\gamma X(3872) \to \pi^+\pi^-\pi^0 J/\psi$		$<$ 2.8	$\times 10^{-6}$	90%	–

$\gamma\chi_{c0}(2P) \rightarrow \omega J/\psi$		$<$	3.0	$\times 10^{-6}$	90%	–
$\gamma X(4140) \rightarrow \phi J/\psi$		$<$	2.2	$\times 10^{-6}$	90%	–
γX	[c]	$<$	4.5	$\times 10^{-6}$	90%	–
$\gamma X\overline{X}(m_X < 3.1$ GeV)	[d]	$<$	1	$\times 10^{-3}$	90%	–
$\gamma X\overline{X}(m_X < 4.5$ GeV)	[e]	$<$	2.4	$\times 10^{-4}$	90%	–
$\gamma X \rightarrow \gamma +\geq 4$ prongs	[f]	$<$	1.78	$\times 10^{-4}$	95%	–
$\gamma a_1^0 \rightarrow \gamma\mu^+\mu^-$	[g]	$<$	9	$\times 10^{-6}$	90%	–
$\gamma a_1^0 \rightarrow \gamma\tau^+\tau^-$	[a]	$<$	1.30	$\times 10^{-4}$	90%	–
$\gamma a_1^0 \rightarrow \gamma g g$	[h]	$<$	1	%	90%	–
$\gamma a_1^0 \rightarrow \gamma s\overline{s}$	[h]	$<$	1	$\times 10^{-3}$	90%	–
Lepton Family number (*LF*) violating modes						
$\mu^\pm\tau^\mp$	*LF*	$<$	6.0	$\times 10^{-6}$	95%	4563
Other decays						
invisible		$<$	3.0	$\times 10^{-4}$	90%	–

$\chi_{b0}(1P)$ [i]

$I^G(J^{PC}) = 0^+(0^{++})$
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	p (MeV/c)
$\gamma\Upsilon(1S)$	(1.76±0.35) %		391
D^0X	$<$ 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

$\chi_{b1}(1P)$ [i]

$I^G(J^{PC}) = 0^+(1^{++})$
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)
$\gamma\,\Upsilon(1S)$	(33.9±2.2) %		423
$D^0\,X$	(12.6±2.2) %		–
$\pi^+\pi^-K^+K^-\pi^0$	(2.0±0.6) × 10^{-4}		4892
$2\pi^+\pi^-K^-K^0_S$	(1.3±0.5) × 10^{-4}		4892
$2\pi^+\pi^-K^-K^0_S2\pi^0$	< 6 × 10^{-4}	90%	4863
$2\pi^+2\pi^-2\pi^0$	(8.0±2.5) × 10^{-4}		4921
$2\pi^+2\pi^-K^+K^-$	(1.5±0.5) × 10^{-4}		4878
$2\pi^+2\pi^-K^+K^-\pi^0$	(3.5±1.2) × 10^{-4}		4863
$2\pi^+2\pi^-K^+K^-2\pi^0$	(8.6±3.2) × 10^{-4}		4845
$3\pi^+2\pi^-K^-K^0_S\pi^0$	(9.3±3.3) × 10^{-4}		4844
$3\pi^+3\pi^-$	(1.9±0.6) × 10^{-4}		4921
$3\pi^+3\pi^-2\pi^0$	(1.7±0.5) × 10^{-3}		4898
$3\pi^+3\pi^-K^+K^-$	(2.6±0.8) × 10^{-4}		4844
$3\pi^+3\pi^-K^+K^-\pi^0$	(7.5±2.6) × 10^{-4}		4825
$4\pi^+4\pi^-$	(2.6±0.9) × 10^{-4}		4897
$4\pi^+4\pi^-2\pi^0$	(1.4±0.6) × 10^{-3}		4867
$J/\psi\,J/\psi$	< 2.7 × 10^{-5}	90%	3857
$J/\psi\,\psi(2S)$	< 1.7 × 10^{-5}	90%	3594
$\psi(2S)\psi(2S)$	< 6 × 10^{-5}	90%	3298

$h_b(1P)$

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

Mass $m = 9899.3 \pm 1.0$ MeV

$h_b(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\eta_b(1S)\gamma$	(49^{+8}_{-7}) %	489

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

$I^G(J^{PC}) = 0^+(2^{++})$
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)
$\gamma\,\Upsilon(1S)$	(19.1±1.2) %		442
$D^0 X$	< 7.9 %	90%	–
$\pi^+\pi^- K^+ K^- \pi^0$	(8 ±5) × 10^{-5}		4902
$2\pi^+\pi^- K^- K^0_S$	< 1.0 × 10^{-4}	90%	4901
$2\pi^+\pi^- K^- K^0_S 2\pi^0$	(5.3±2.4) × 10^{-4}		4873
$2\pi^+ 2\pi^- 2\pi^0$	(3.5±1.4) × 10^{-4}		4931
$2\pi^+ 2\pi^- K^+ K^-$	(1.1±0.4) × 10^{-4}		4888
$2\pi^+ 2\pi^- K^+ K^- \pi^0$	(2.1±0.9) × 10^{-4}		4872
$2\pi^+ 2\pi^- K^+ K^- 2\pi^0$	(3.9±1.8) × 10^{-4}		4855
$3\pi^+ 2\pi^- K^- K^0_S \pi^0$	< 5 × 10^{-4}	90%	4854
$3\pi^+ 3\pi^-$	(7.0±3.1) × 10^{-5}		4931
$3\pi^+ 3\pi^- 2\pi^0$	(1.0±0.4) × 10^{-3}		4908
$3\pi^+ 3\pi^- K^+ K^-$	< 8 × 10^{-5}	90%	4854
$3\pi^+ 3\pi^- K^+ K^- \pi^0$	(3.6±1.5) × 10^{-4}		4835
$4\pi^+ 4\pi^-$	(8 ±4) × 10^{-5}		4907
$4\pi^+ 4\pi^- 2\pi^0$	(1.8±0.7) × 10^{-3}		4877
$J/\psi\,J/\psi$	< 4 × 10^{-5}	90%	3869
$J/\psi\,\psi(2S)$	< 5 × 10^{-5}	90%	3608
$\psi(2S)\psi(2S)$	< 1.6 × 10^{-5}	90%	3313

$\Upsilon(2S)$

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

Mass $m = 10023.26 \pm 0.31$ MeV
$m_{\Upsilon(3S)} - m_{\Upsilon(2S)} = 331.50 \pm 0.13$ MeV
Full width $\Gamma = 31.98 \pm 2.63$ keV
$\Gamma_{ee} = 0.612 \pm 0.011$ keV

$\Upsilon(2S)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\Upsilon(1S)\pi^+\pi^-$	(17.85± 0.26) %		475
$\Upsilon(1S)\pi^0\pi^0$	(8.6 ± 0.4) %		480
$\tau^+\tau^-$	(2.00± 0.21) %		4686
$\mu^+\mu^-$	(1.93± 0.17) %	S=2.2	5011
e^+e^-	(1.91± 0.16) %		5012
$\Upsilon(1S)\pi^0$	< 4 × 10^{-5}	CL=90%	531
$\Upsilon(1S)\eta$	(2.9 ± 0.4) × 10^{-4}	S=2.0	126
$J/\psi(1S)$ anything	< 6 × 10^{-3}	CL=90%	4533
$\overline{d}$ anything	(3.4 ± 0.6) × 10^{-5}		–

hadrons	(94 ±11) %			–
$g\,g\,g$	(58.8 ± 1.2) %			–
$\gamma\,g\,g$	(8.8 ± 1.1) %			–
$\phi K^+ K^-$	(1.6 ± 0.4) $\times 10^{-6}$			4910
$\omega\pi^+\pi^-$	< 2.58	$\times 10^{-6}$	CL=90%	4977
$K^*(892)^0 K^-\pi^+$ + 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
$K^*(892)^0\,\overline{K}_2^*(1430)^0$ + 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
$K_S^0 K^+\pi^-$ + c.c.	(1.14± 0.33) $\times 10^{-6}$			4979
$K^*(892)^0\overline{K}^0$ + c.c.	< 4.22	$\times 10^{-6}$	CL=90%	4959
$K^*(892)^- K^+$ + c.c.	< 1.45	$\times 10^{-6}$	CL=90%	4960
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%	4864
$\gamma f_2'(1525)$	< 5.3	$\times 10^{-4}$	CL=90%	4896
$\gamma f_2(1270)$	< 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
$\gamma X(3872) \to \pi^+\pi^- J/\psi$	< 8	$\times 10^{-7}$	CL=90%	–
$\gamma X(3872) \to \pi^+\pi^-\pi^0 J/\psi$	< 2.4	$\times 10^{-6}$	CL=90%	–
$\gamma\chi_{c0}(2P) \to \omega J/\psi$	< 2.8	$\times 10^{-6}$	CL=90%	–
$\gamma X(4140) \to \phi J/\psi$	< 1.2	$\times 10^{-6}$	CL=90%	–
$\gamma X(4350) \to \phi J/\psi$	< 1.3	$\times 10^{-6}$	CL=90%	–
$\gamma\eta_b(1S)$	(3.9 ± 1.5) $\times 10^{-4}$			606
$\gamma\eta_b(1S) \to \gamma$Sum of 26 exclusive modes	< 3.7	$\times 10^{-6}$	CL=90%	–
$\gamma X_{b\overline{b}} \to \gamma$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

$\Upsilon(1D)$

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

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

$\Upsilon(1D)$ 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
$\pi^+\pi^-\,\Upsilon(1S)$	$(6.6\pm1.6)\times10^{-3}$	623

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

$I^G(J^{PC}) = 0^+(0^{++})$
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)
$\gamma\,\Upsilon(2S)$	(4.6 ± 2.1) %		207
$\gamma\,\Upsilon(1S)$	$(9 \pm 6) \times 10^{-3}$		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

$\chi_{b1}(2P)$ [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)	Scale factor	p (MeV/c)
$\omega\,\Upsilon(1S)$	$(\ 1.63^{+0.40}_{-0.34})$ %		135
$\gamma\,\Upsilon(2S)$	(19.9 ±1.9) %		230
$\gamma\,\Upsilon(1S)$	(9.2 ±0.8) %	1.1	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
$2\pi^+\pi^- K^- K^0_S$	(1.1 ±0.5) $\times 10^{-4}$		5075
$2\pi^+\pi^- K^- K^0_S 2\pi^0$	(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
$3\pi^+ 2\pi^- K^- K^0_S\pi^0$	(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]

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

Mass $m = 10268.65 \pm 0.22 \pm 0.50$ MeV
$m_{\chi_{b2}(2P)} - m_{\chi_{b1}(2P)} = 13.5 \pm 0.6$ MeV

$\chi_{b2}(2P)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\omega\,\Upsilon(1S)$	$(\ 1.10^{+0.34}_{-0.30})$ %		194
$\gamma\,\Upsilon(2S)$	(10.6 ±2.6) %	S=2.0	242
$\gamma\,\Upsilon(1S)$	(7.0 ±0.7) %		777
$\pi\pi\,\chi_{b2}(1P)$	(5.1 ±0.9) $\times 10^{-3}$		229
$D^0 X$	< 2.4 %	CL=90%	–
$\pi^+\pi^- K^+ K^-\pi^0$	< 1.1 $\times 10^{-4}$	CL=90%	5082
$2\pi^+\pi^- K^- K^0_S$	< 9 $\times 10^{-5}$	CL=90%	5082

$2\pi^+\pi^- K^- K^0_S 2\pi^0$	$< 7 \times 10^{-4}$	CL=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
$3\pi^+ 2\pi^- K^- K^0_S \pi^0$	$< 4 \times 10^{-4}$	CL=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

$\Upsilon(3S)$

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

Mass $m = 10355.2 \pm 0.5$ MeV
$m_{\Upsilon(3S)} - m_{\Upsilon(2S)} = 331.50 \pm 0.13$ MeV
Full width $\Gamma = 20.32 \pm 1.85$ keV
$\Gamma_{ee} = 0.443 \pm 0.008$ keV

$\Upsilon(3S)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\Upsilon(2S)$ anything	(10.6 ± 0.8) %		296
$\Upsilon(2S)\pi^+\pi^-$	(2.82 ± 0.18) %	S=1.6	177
$\Upsilon(2S)\pi^0\pi^0$	(1.85 ± 0.14) %		190
$\Upsilon(2S)\gamma\gamma$	(5.0 ± 0.7) %		327
$\Upsilon(2S)\pi^0$	$< 5.1 \times 10^{-4}$	CL=90%	298
$\Upsilon(1S)\pi^+\pi^-$	(4.37 ± 0.08) %		813
$\Upsilon(1S)\pi^0\pi^0$	(2.20 ± 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%	353
$\tau^+\tau^-$	(2.29 ± 0.30) %		4863
$\mu^+\mu^-$	(2.18 ± 0.21) %	S=2.1	5177
e^+e^-	seen		5178
ggg	(35.7 ± 2.6) %		–
γgg	$(9.7 \pm 1.8) \times 10^{-3}$		–

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
$\gamma\chi_{b2}(1P)$		(9.9 ±1.3) $\times 10^{-3}$		S=2.0	434
$\gamma A^0 \rightarrow$ γhadrons		< 8	$\times 10^{-5}$	CL=90%	–
$\gamma\chi_{b1}(1P)$		(9 ±5) $\times 10^{-4}$		S=1.9	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) $\times 10^{-4}$			913
$\gamma X \rightarrow$ $\gamma +\geq 4$ 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

$\chi_b(3P)$

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

Mass $m = 10534 \pm 9$ MeV

$\chi_b(3P)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Upsilon(1S)\gamma$	seen	1019
$\Upsilon(2S)\gamma$	seen	498

$\Upsilon(4S)$ or $\Upsilon(10580)$

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

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)
$B\overline{B}$	> 96	%	95%	327
B^+B^-	(51.4 ±0.6) %			332
D_s^+ anything + c.c.	(17.8 ±2.6) %			–
$B^0\overline{B}^0$	(48.6 ±0.6) %			327
$J/\psi K_S^0(J/\psi,\ \eta_c)K_S^0$	< 4	$\times 10^{-7}$	90%	–
non-$B\overline{B}$	< 4	%	95%	–
e^+e^-	(1.57±0.08)	$\times 10^{-5}$		5290
$\rho^+\rho^-$	< 5.7	$\times 10^{-6}$	90%	5233

$K^*(892)^0\overline{K}^0$	< 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
$\Upsilon(1S)\pi^+\pi^-$	(8.1 $\pm$0.6)	$\times 10^{-5}$		1026
$\Upsilon(1S)\eta$	(1.96$\pm$0.28)	$\times 10^{-4}$		924
$\Upsilon(2S)\pi^+\pi^-$	(8.6 $\pm$1.3)	$\times 10^{-5}$		468
$h_b(1P)\pi^+\pi^-$	not seen			600
$\overline{d}$ anything	< 1.3	$\times 10^{-5}$	90%	–

$\Upsilon(10860)$ $I^G(J^{PC}) = 0^-(1^{--})$

Mass $m = 10876 \pm 11$ MeV
Full width $\Gamma = 55 \pm 28$ MeV
$\Gamma_{ee} = 0.31 \pm 0.07$ keV (S = 1.3)

$\Upsilon(10860)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$B\overline{B}X$	(76.2 $^{+2.7}_{-4.0}$) %		–
$B\overline{B}$	(5.5 $\pm$1.0) %		1303
$B\overline{B}^*$ + c.c.	(13.7 $\pm$1.6) %		–
$B^*\overline{B}^*$	(38.1 $\pm$3.4) %		1102
$B\overline{B}^{(*)}\pi$	< 19.7 %	90%	990
$B\overline{B}\pi$	(0.0 $\pm$1.2) %		990
$B^*\overline{B}\pi + B\overline{B}^*\pi$	(7.3 $\pm$2.3) %		–
$B^*\overline{B}^*\pi$	(1.0 $\pm$1.4) %		701
$B\overline{B}\pi\pi$	< 8.9 %	90%	504
$B_s^{(*)}\overline{B}_s^{(*)}$	(20.1 $\pm$3.1) %		877
$B_s\overline{B}_s$	(5 $\pm$5) $\times 10^{-3}$		877
$B_s\overline{B}_s^*$ + c.c.	(1.35$\pm$0.32) %		–
$B_s^*\overline{B}_s^*$	(17.6 $\pm$2.7) %		495
no open-bottom	(3.8 $^{+5.0}_{-0.5}$) %		–
e^+e^-	(5.6 $\pm$3.1) $\times 10^{-6}$		5438
$K^*(892)^0\overline{K}^0$	< 1.0 $\times 10^{-5}$	90%	5390
$\Upsilon(1S)\pi^+\pi^-$	(5.3 $\pm$0.6) $\times 10^{-3}$		1297
$\Upsilon(2S)\pi^+\pi^-$	(7.8 $\pm$1.3) $\times 10^{-3}$		774

$\Upsilon(3S)\pi^+\pi^-$	(4.8 $^{+1.9}_{-1.7}$) $\times 10^{-3}$	429
$\Upsilon(1S)K^+K^-$	(6.1 ± 1.8) $\times 10^{-4}$	947
$h_b(1P)\pi^+\pi^-$	(3.5 $^{+1.0}_{-1.3}$) $\times 10^{-3}$	894
$h_b(2P)\pi^+\pi^-$	(6.0 $^{+2.1}_{-1.8}$) $\times 10^{-3}$	534

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.	(108 ± 8) %	–
D_s anything + c.c.	(46 ± 6) %	–
J/ψ anything	(2.06 ± 0.21) %	–
B^0 anything + c.c.	(77 ± 8) %	–
B^+ anything + c.c.	(72 ± 6) %	–

$\Upsilon(11020)$

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

Mass $m = 11019 \pm 8$ MeV
Full width $\Gamma = 79 \pm 16$ MeV
$\Gamma_{ee} = 0.130 \pm 0.030$ keV

$\Upsilon(11020)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
e^+e^-	$(1.6 \pm 0.5) \times 10^{-6}$	5510

NOTES

[*a*] $2m_\tau < \mathrm{M}(\tau^+\tau^-) < 9.2$ GeV

[*b*] 2 GeV $< m_{K^+K^-} <$ 3 GeV

[*c*] $X =$ scalar with $m <$ 8.0 GeV

[*d*] $X\overline{X} =$ vectors with $m <$ 3.1 GeV

[*e*] X and $\overline{X} =$ zero spin with $m <$ 4.5 GeV

[*f*] 1.5 GeV $< m_X <$ 5.0 GeV

[*g*] 201 MeV $< \mathrm{M}(\mu^+\mu^-) <$ 3565 MeV

[*h*] 0.5 GeV $< m_X <$ 9.0 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 GeV $< m_X <$ 5.0 GeV

[*k*] 1.5 GeV $< m_X <$ 5.0 GeV

[*l*] For $m_{\tau^+\tau^-}$ in the ranges 4.03–9.52 and 9.61–10.10 GeV.