$b\overline{b}$ 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)
$\tau^+\tau^-$	$(2.67^{+0.14}_{-0.16})$ %		4384
e^+e^-	(2.38±0.11) %		4730
$\mu^+\mu^-$	(2.48±0.05) %		4729
Hadronic decays			
$\eta'(958)$ anything	(2.8 ±0.4) %		–
$J/\psi(1S)$ anything	(6.5 ±0.7) × 10^{-4}		4223
χ_{c0} anything	< 5 × 10^{-3}	90%	–
χ_{c1} anything	(2.3 ±0.7) × 10^{-4}		–
χ_{c2} anything	(3.4 ±1.0) × 10^{-4}		–
$\psi(2S)$ anything	(2.7 ±0.9) × 10^{-4}		–
$\rho\pi$	< 2 × 10^{-4}	90%	4697
$\pi^+\pi^-$	< 5 × 10^{-4}	90%	4728
K^+K^-	< 5 × 10^{-4}	90%	4704
$p\overline{p}$	< 5 × 10^{-4}	90%	4636
$\pi^0\pi^+\pi^-$	< 1.84 × 10^{-5}	90%	4725
Radiative decays			
$\gamma\pi^+\pi^-$	(6.3 ±1.8) × 10^{-5}		4728
$\gamma\pi^0\pi^0$	(1.7 ±0.7) × 10^{-5}		4728
K^+K^- with 2<$m_{K^+K^-}$ <3 GeV	(1.14±0.13) × 10^{-5}		–
$\gamma p\overline{p}$ with 2<$m_{p\overline{p}}$ <3 GeV	< 6 × 10^{-6}	90%	–
$\gamma 2h^+2h^-$	(7.0 ±1.5) × 10^{-4}		4720
$\gamma 3h^+3h^-$	(5.4 ±2.0) × 10^{-4}		4703
$\gamma 4h^+4h^-$	(7.4 ±3.5) × 10^{-4}		4679
$\gamma\pi^+\pi^-K^+K^-$	(2.9 ±0.9) × 10^{-4}		4686
$\gamma 2\pi^+2\pi^-$	(2.5 ±0.9) × 10^{-4}		4720
$\gamma 3\pi^+3\pi^-$	(2.5 ±1.2) × 10^{-4}		4703
$\gamma 2\pi^+2\pi^-K^+K^-$	(2.4 ±1.2) × 10^{-4}		4658
$\gamma\pi^+\pi^-p\overline{p}$	(1.5 ±0.6) × 10^{-4}		4604
$\gamma 2\pi^+2\pi^-p\overline{p}$	(4 ±6) × 10^{-5}		4563
$\gamma 2K^+2K^-$	(2.0 ±2.0) × 10^{-5}		4601

$\gamma\eta'(958)$	< 1.6	$\times 10^{-5}$	90%	4682
$\gamma\eta$	< 2.1	$\times 10^{-5}$	90%	4714
$\gamma f_0(980)$	< 3	$\times 10^{-5}$	90%	4679
$\gamma f_2'(1525)$	$(3.7\ ^{+1.2}_{-1.1}\ )$	$\times 10^{-5}$		4607
$\gamma f_2(1270)$	(1.00 ± 0.10)	$\times 10^{-4}$		4644
$\gamma\eta(1405)$	< 8.2	$\times 10^{-5}$	90%	4625
$\gamma f_0(1710)$	< 1.8	$\times 10^{-4}$	90%	4574
$\gamma f_4(2050)$	< 5.3	$\times 10^{-5}$	90%	4513
$\gamma f_0(2200) \rightarrow \gamma K^+K^-$	< 2	$\times 10^{-4}$	90%	4475
$\gamma f_J(2220) \rightarrow \gamma K^+K^-$	< 8	$\times 10^{-7}$	90%	4469
$\gamma f_J(2220) \rightarrow \gamma\pi^+\pi^-$	< 6	$\times 10^{-7}$	90%	–
$\gamma f_J(2220) \rightarrow \gamma p\overline{p}$	< 1.1	$\times 10^{-6}$	90%	–
$\gamma\eta(2225) \rightarrow \gamma\phi\phi$	< 3	$\times 10^{-3}$	90%	4469
γX (X = pseudoscalar with $m<$ 7.2 GeV)	< 3	$\times 10^{-5}$	90%	–
$\gamma X\overline{X}$ ($X\overline{X}$ = vectors with $m<$ 3.1 GeV)	< 1	$\times 10^{-3}$	90%	–

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

$I^G(J^{PC}) = 0^+(0^{++})$
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)
$\gamma\Upsilon(1S)$	<6 %	90%	391

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

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

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

$\chi_{b1}(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\gamma\Upsilon(1S)$	(35 ± 8) %	423

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

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

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

$\chi_{b2}(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\gamma\,\Upsilon(1S)$	(22±4) %	442

$\Upsilon(2S)$

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

Mass $m = 10.02326 \pm 0.00031$ GeV
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)
$\Upsilon(1S)\pi^+\pi^-$	(18.8 ±0.6) %		475
$\Upsilon(1S)\pi^0\pi^0$	(9.0 ±0.8) %		480
$\tau^+\tau^-$	(1.7 ±1.6) %		4686
$\mu^+\mu^-$	(1.93±0.17) %	S=2.2	5011
e^+e^-	(1.91±0.16) %		5012
$\Upsilon(1S)\pi^0$	< 1.1 $\times 10^{-3}$	CL=90%	531
$\Upsilon(1S)\eta$	< 2 $\times 10^{-3}$	CL=90%	127
$J/\psi(1S)$ anything	< 6 $\times 10^{-3}$	CL=90%	4533
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%	4930
$\gamma\eta_b(1S)$	< 5.1 $\times 10^{-4}$	CL=90%	697

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

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

Mass $m = 10.2325 \pm 0.0004 \pm 0.0005$ GeV

$\chi_{b0}(2P)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\gamma\,\Upsilon(2S)$	(4.6±2.1) %	207
$\gamma\,\Upsilon(1S)$	(9 ±6) $\times 10^{-3}$	743

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

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

Mass $m = 10.25546 \pm 0.00022 \pm 0.00050$ GeV
$m_{\chi_{b1}(2P)} - m_{\chi_{b0}(2P)} = 23.5 \pm 1.0$ MeV

$\chi_{b1}(2P)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor	p (MeV/c)
$\omega\,\Upsilon(1S)$	($1.63^{+0.38}_{-0.34}$) %		135
$\gamma\,\Upsilon(2S)$	(21 ±4) %	1.5	230
$\gamma\,\Upsilon(1S)$	(8.5 ±1.3) %	1.3	764
$\pi\pi\,\chi_{b1}(1P)$	(8.6 ±3.1) $\times 10^{-3}$		238

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

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

Mass $m = 10.26865 \pm 0.00022 \pm 0.00050$ GeV
$m_{\chi_{b2}(2P)} - m_{\chi_{b1}(2P)} = 13.5 \pm 0.6$ MeV

$\chi_{b2}(2P)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\omega\,\Upsilon(1S)$	($1.10^{+0.34}_{-0.30}$) %	194
$\gamma\,\Upsilon(2S)$	(16.2 ±2.4) %	242
$\gamma\,\Upsilon(1S)$	(7.1 ±1.0) %	777
$\pi\pi\,\chi_{b2}(1P)$	(6.0 ±2.1) $\times 10^{-3}$	229

$\Upsilon(3S)$

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

Mass $m = 10.3552 \pm 0.0005$ GeV
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
$\Upsilon(2S)\pi^+\pi^-$	(2.8 ±0.6) %	S=2.2	177
$\Upsilon(2S)\pi^0\pi^0$	(2.00±0.32) %		190
$\Upsilon(2S)\gamma\gamma$	(5.0 ±0.7) %		327
$\Upsilon(1S)\pi^+\pi^-$	(4.48±0.21) %		813
$\Upsilon(1S)\pi^0\pi^0$	(2.06±0.28) %		816
$\Upsilon(1S)\eta$	< 2.2 $\times 10^{-3}$	CL=90%	677
$\mu^+\mu^-$	(2.18±0.21) %	S=2.1	5177
e^+e^-	seen		5178

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
$\gamma\chi_{b0}(1P)$	(3.0 ±1.1) $\times 10^{-3}$		484
$\gamma\eta_b(2S)$	< 6.2 $\times 10^{-4}$	CL=90%	–
$\gamma\eta_b(1S)$	< 4.3 $\times 10^{-4}$	CL=90%	1001

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

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

Mass $m = 10.5794 \pm 0.0012$ GeV
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%	330
B^+B^-	(50.6 ±0.8) %		335
D_s^+ anything + c.c.	(18.2 ±3.2) %		–
$B^0\overline{B}^0$	(49.4 ±0.8) %		330
non-$B\overline{B}$	< 4 %	95%	–
e^+e^-	(1.57±0.08) $\times 10^{-5}$		5290
$J/\psi(1S)$ anything	< 1.9 $\times 10^{-4}$	95%	–
D^{*+} anything + c.c.	< 7.4 %	90%	5099
ϕ anything	< 2.3 $\times 10^{-3}$	90%	5240
$\Upsilon(1S)$ anything	< 4 $\times 10^{-3}$	90%	1053
$\Upsilon(1S)\pi^+\pi^-$	< 1.2 $\times 10^{-4}$	90%	1026
$\Upsilon(2S)\pi^+\pi^-$	< 3.9 $\times 10^{-4}$	90%	468

$\Upsilon(10860)$

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

Mass $m = 10.865 \pm 0.008$ GeV (S = 1.1)
Full width $\Gamma = 110 \pm 13$ MeV
$\Gamma_{ee} = 0.31 \pm 0.07$ keV (S = 1.3)

$\Upsilon(10860)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
e^+e^-	(2.8± 0.7) $\times 10^{-6}$	5432
D_s anything + c.c.	(45 ±11) %	–

$\Upsilon(11020)$

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

Mass $m = 11.019 \pm 0.008$ GeV
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*] Spectroscopic labeling for these states is theoretical, pending experimental information.