$b\bar{b}$ MESONS

$\Upsilon(1S)$

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

Mass $m = 9460.37 \pm 0.21$ MeV (S = 2.7)
Full width $\Gamma = 52.5 \pm 1.8$ keV
$\Gamma_{ee} = 1.32 \pm 0.05$ keV

$\Upsilon(1S)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\tau^+\tau^-$	$(2.67^{+0.14}_{-0.16})$ %		4384
e^+e^-	(2.52±0.17) %		4730
$\mu^+\mu^-$	(2.48±0.07) %	S=1.1	4729
Hadronic decays			
$J/\psi(1S)$anything	$(1.1 \pm 0.4) \times 10^{-3}$		4223
$\rho\pi$	$< 2 \times 10^{-4}$	CL=90%	4698
$\pi^+\pi^-$	$< 5 \times 10^{-4}$	CL=90%	4728
K^+K^-	$< 5 \times 10^{-4}$	CL=90%	4704
$p\bar{p}$	$< 5 \times 10^{-4}$	CL=90%	4636
Radiative decays			
$\gamma 2h^+2h^-$	$(7.0 \pm 1.5) \times 10^{-4}$		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
$\gamma\pi^+\pi^-p\bar{p}$	$(1.5 \pm 0.6) \times 10^{-4}$		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
$\gamma\eta'(958)$	$< 1.3 \times 10^{-3}$	CL=90%	4682
$\gamma\eta$	$< 3.5 \times 10^{-4}$	CL=90%	4714
$\gamma f_2'(1525)$	$< 1.4 \times 10^{-4}$	CL=90%	4607
$\gamma f_2(1270)$	$< 1.3 \times 10^{-4}$	CL=90%	4644
$\gamma\eta(1440)$	$< 8.2 \times 10^{-5}$	CL=90%	4624
$\gamma f_J(1710) \rightarrow \gamma K\overline{K}$	$< 2.6 \times 10^{-4}$	CL=90%	4576

$\gamma f_0(2200) \rightarrow \gamma K^+ K^-$	< 2	$\times 10^{-4}$	CL=90%	4475
$\gamma f_J(2220) \rightarrow \gamma K^+ K^-$	< 1.5	$\times 10^{-5}$	CL=90%	4469
$\gamma \eta(2225) \rightarrow \gamma \phi \phi$	< 3	$\times 10^{-3}$	CL=90%	4469
γX	< 3	$\times 10^{-5}$	CL=90%	–
X = pseudoscalar with $m < 7.2$ GeV)				
$\gamma X \overline{X}$	< 1	$\times 10^{-3}$	CL=90%	–
$X\overline{X}$ = vectors with $m < 3.1$ GeV)				

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

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

Mass $m = 9859.8 \pm 1.3$ MeV

$\chi_{b0}(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\gamma \Upsilon(1S)$	<6 %	90%	391

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

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

Mass $m = 9891.9 \pm 0.7$ MeV

$\chi_{b1}(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\gamma \Upsilon(1S)$	(35±8) %	422

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

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

Mass $m = 9913.2 \pm 0.6$ MeV

$\chi_{b2}(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\gamma \Upsilon(1S)$	(22±4) %	443

$\Upsilon(2S)$

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

Mass $m = 10.02330 \pm 0.00031$ GeV
Full width $\Gamma = 44 \pm 7$ keV
$\Gamma_{ee} = 0.52 \pm 0.03$ keV

$\Upsilon(2S)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\Upsilon(1S)\pi^+\pi^-$	(18.5 ±0.8) %		475
$\Upsilon(1S)\pi^0\pi^0$	(8.8 ±1.1) %		480
$\tau^+\tau^-$	(1.7 ±1.6) %		4686

$\mu^+\mu^-$	(1.31±0.21) %			5011
e^+e^-	seen			5012
$\Upsilon(1S)\pi^0$	< 8	$\times 10^{-3}$	90%	531
$\Upsilon(1S)\eta$	< 2	$\times 10^{-3}$	90%	127
$J/\psi(1S)$anything	< 6	$\times 10^{-3}$	90%	4533
Radiative decays				
$\gamma\chi_{b1}(1P)$	(6.7 ±0.9) %			131
$\gamma\chi_{b2}(1P)$	(6.6 ±0.9) %			110
$\gamma\chi_{b0}(1P)$	(4.3 ±1.0) %			162
$\gamma f_J(1710)$	< 5.9	$\times 10^{-4}$	90%	4866
$\gamma f_2'(1525)$	< 5.3	$\times 10^{-4}$	90%	4896
$\gamma f_2(1270)$	< 2.41	$\times 10^{-4}$	90%	4931

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

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

Mass $m = 10.2321 \pm 0.0006$ GeV

$\chi_{b0}(2P)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\gamma\Upsilon(2S)$	(4.6±2.1) %	210
$\gamma\Upsilon(1S)$	(9 ±6) $\times 10^{-3}$	746

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

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

Mass $m = 10.2552 \pm 0.0005$ 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)
$\gamma\Upsilon(2S)$	(21 ±4) %	1.5	229
$\gamma\Upsilon(1S)$	(8.5±1.3) %	1.3	764

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

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

Mass $m = 10.2685 \pm 0.0004$ 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)
$\gamma\Upsilon(2S)$	(16.2±2.4) %	242
$\gamma\Upsilon(1S)$	(7.1±1.0) %	776

$\Upsilon(3S)$

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

Mass $m = 10.3553 \pm 0.0005$ GeV
Full width $\Gamma = 26.3 \pm 3.5$ keV

$\Upsilon(3S)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor	p (MeV/c)
$\Upsilon(2S)$anything	(10.6 ±0.8) %		296
$\Upsilon(2S)\pi^+\pi^-$	(2.8 ±0.6) %	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) %		814
$\Upsilon(1S)\pi^0\pi^0$	(2.06±0.28) %		816
$\mu^+\mu^-$	(1.81±0.17) %		5177
e^+e^-	seen		5177
Radiative decays			
$\gamma\chi_{b2}(2P)$	(11.4 ±0.8) %	1.3	87
$\gamma\chi_{b1}(2P)$	(11.3 ±0.6) %		100
$\gamma\chi_{b0}(2P)$	(5.4 ±0.6) %	1.1	123

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

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

Mass $m = 10.5800 \pm 0.0035$ GeV
Full width $\Gamma = 21 \pm 4$ MeV (S = 2.3)
$\Gamma_{ee} = 0.248 \pm 0.031$ keV (S = 1.3)

$\Upsilon(4S)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$B\overline{B}$	dominant		–
e^+e^-	$(2.8\pm0.7)\times10^{-5}$		5290
$J/\psi(3097)$anything	$(2.2\pm0.7)\times10^{-3}$		–
D^{*+}anything + c.c.	< 7.4 %	90%	5099
ϕanything	$< 2.3 \times 10^{-3}$	90%	5240
$\Upsilon(1S)$anything	$< 4 \times 10^{-3}$	90%	1053
non-$B\overline{B}$	< 4 %	95%	–

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

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)
$e^+ e^-$	$(2.8 \pm 0.7) \times 10^{-6}$	5432

$\Upsilon(11020)$ $I^G(J^{PC}) = ?^?(1^{--})$

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)
$e^+ e^-$	$(1.6 \pm 0.5) \times 10^{-6}$	5509