

$b\bar{b}$ 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) %		—
$\gamma g g$	(2.2 ±0.6) %		—
$\eta'(958)$ anything	(2.94±0.24) %		—
$J/\psi(1S)$ 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
$p\bar{p}$	< 5 × 10 ⁻⁴	90%	4636
$\pi^0 \pi^+ \pi^-$	< 1.84 × 10 ⁻⁵	90%	4725
$D^*(2010)^\pm$ anything	(2.52±0.20) %		—
\bar{d} anything	(2.86±0.28) × 10 ⁻⁵		—

Radiative decays

$\gamma\pi^+ \pi^-$	(6.3 ±1.8) × 10 ⁻⁵		4728
$\gamma\pi^0 \pi^0$	(1.7 ±0.7) × 10 ⁻⁵		4728
$\gamma\pi^0 \eta$	< 2.4 × 10 ⁻⁶	90%	4713
$\gamma K^+ K^-$	[a] (1.14±0.13) × 10 ⁻⁵		4704
$\gamma p\bar{p}$	[b] < 6 × 10 ⁻⁶	90%	4636
$\gamma 2h^+ 2h^-$	(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

$\gamma 2\pi^+ 2\pi^- K^+ K^-$	$(2.4 \pm 1.2) \times 10^{-4}$		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
$\gamma \eta'(958)$	$< 1.9 \times 10^{-6}$	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%	4574
$\gamma f_0(1710) \rightarrow \gamma K^+ K^-$	$< 7 \times 10^{-6}$	90%	—
$\gamma f_0(1710) \rightarrow \gamma \pi^0 \pi^0$	$< 1.4 \times 10^{-6}$	90%	—
$\gamma f_0(1710) \rightarrow \gamma \eta \eta$	$< 1.8 \times 10^{-6}$	90%	—
$\gamma f_4(2050)$	$< 5.3 \times 10^{-5}$	90%	4515
$\gamma f_0(2200) \rightarrow \gamma K^+ K^-$	$< 2 \times 10^{-4}$	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%	—
$\gamma f_J(2220) \rightarrow \gamma p \bar{p}$	$< 1.1 \times 10^{-6}$	90%	—
$\gamma \eta(2225) \rightarrow \gamma \phi \phi$	$< 3 \times 10^{-3}$	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
$\gamma X(3872) \rightarrow \pi^+ \pi^- J/\psi$	$< 1.6 \times 10^{-6}$	90%	—
$\gamma X(3872) \rightarrow \pi^+ \pi^- \pi^0 J/\psi$	$< 2.8 \times 10^{-6}$	90%	—
$\gamma X(3915) \rightarrow \omega J/\psi$	$< 3.0 \times 10^{-6}$	90%	—
$\gamma X(4140) \rightarrow \phi J/\psi$	$< 2.2 \times 10^{-6}$	90%	—
γX	[c] $< 4.5 \times 10^{-6}$	90%	—
$\gamma X \bar{X} (m_X < 3.1 \text{ GeV})$	[d] $< 1 \times 10^{-3}$	90%	—
$\gamma X \bar{X} (m_X < 4.5 \text{ GeV})$	[e] $< 2.4 \times 10^{-4}$	90%	—
$\gamma X \rightarrow \gamma + \geq 4 \text{ prongs}$	[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] $< 5.0 \times 10^{-5}$	90%	—

Lepton Family number (LF) violating modes

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

invisible		$< 3.0 \times 10^{-4}$	90%	—
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$\chi_{b0}(1P)$ ^[h]

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

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)
$\gamma \Upsilon(1S)$	(1.76±0.35) %		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

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

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

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)
$\gamma \Upsilon(1S)$	(33.9±2.2) %		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±1.2) $\times 10^{-4}$		4863
$2\pi^+ 2\pi^- K^+ K^- 2\pi^0$	(8.6±3.2) $\times 10^{-4}$		4845
$3\pi^+ 2\pi^- K^- K_S^0 \pi^0$	(9.3±3.3) $\times 10^{-4}$		4844
$3\pi^+ 3\pi^-$	(1.9±0.6) $\times 10^{-4}$		4921
$3\pi^+ 3\pi^- 2\pi^0$	(1.7±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

$h_b(1P)$

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

Mass $m = 9898.6 \pm 1.4$ MeV

$h_b(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\eta_b(1S)\gamma$	seen	495

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

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

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)
$\gamma \Upsilon(1S)$	$(19.1 \pm 1.2) \%$		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

$\Upsilon(2S)$

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

Mass $m = 10.02326 \pm 0.00031$ GeV

$m_{\Upsilon(3S)} - m_{\Upsilon(2S)} = 331.50 \pm 0.13$ 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	ρ (MeV/c)
$\Upsilon(1S)\pi^+\pi^-$	(17.92 ± 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
$\Upsilon(1S)\pi^0$	< 1.8	$\times 10^{-4}$ CL=90%	531
$\Upsilon(1S)\eta$	(2.34 ± 0.31) $\times 10^{-4}$		126
$J/\psi(1S)$ anything	< 6	$\times 10^{-3}$ CL=90%	4533
\bar{d} anything	(3.4 ± 0.6) $\times 10^{-5}$		—
hadrons	(94 ± 11) %		—
ggg	(58.8 ± 1.2) %		—
γgg	(8.8 ± 1.1) %		—

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
$\gamma X(3872) \rightarrow \pi^+\pi^- J/\psi$	< 8	$\times 10^{-7}$ CL=90%	—
$\gamma X(3872) \rightarrow \pi^+\pi^-\pi^0 J/\psi$	< 2.4	$\times 10^{-6}$ CL=90%	—
$\gamma X(3915) \rightarrow \omega J/\psi$	< 2.8	$\times 10^{-6}$ CL=90%	—
$\gamma X(4140) \rightarrow \phi J/\psi$	< 1.2	$\times 10^{-6}$ CL=90%	—
$\gamma X(4350) \rightarrow \phi J/\psi$	< 1.3	$\times 10^{-6}$ CL=90%	—
$\gamma\eta_b(1S)$	(3.9 ± 1.5) $\times 10^{-4}$		612
$\gamma X \rightarrow \gamma + \geq 4$ prongs	[<i>i</i>] < 1.95	$\times 10^{-4}$ CL=95%	—
$\gamma A^0 \rightarrow \gamma$ hadrons	< 8	$\times 10^{-5}$ CL=90%	—

Lepton Family number (*LF*) violating modes

$e^\pm \tau^\mp$	<i>LF</i>	< 3.2	$\times 10^{-6}$ CL=90%	4854
$\mu^\pm \tau^\mp$	<i>LF</i>	< 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
$\pi^+\pi^- \Upsilon(1S)$	$(6.6 \pm 1.6) \times 10^{-3}$	623

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

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

J needs confirmation.

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

$\chi_{b0}(2P)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\gamma \Upsilon(2S)$	$(4.6 \pm 2.1) \%$		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

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

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

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)
$\omega \Upsilon(1S)$	$(1.63^{+0.40}_{-0.34})\%$		135
$\gamma \Upsilon(2S)$	$(19.9 \pm 1.9)\%$		230
$\gamma \Upsilon(1S)$	$(9.2 \pm 0.8)\%$	1.1	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

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

$I^G(J^{PC}) = 0^+(2^{++})$
 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)	Scale factor/ Confidence level	p (MeV/c)
$\omega \Upsilon(1S)$	$(1.10^{+0.34}_{-0.30})\%$		194
$\gamma \Upsilon(2S)$	$(10.6 \pm 2.6)\%$	S=2.0	242
$\gamma \Upsilon(1S)$	$(7.0 \pm 0.7)\%$		777
$\pi\pi \chi_{b2}(1P)$	$(5.1 \pm 0.9) \times 10^{-3}$		229
$D^0 X$	$< 2.4\%$	CL=90%	—
$\pi^+ \pi^- K^+ K^- \pi^0$	$< 1.1 \times 10^{-4}$	CL=90%	5082
$2\pi^+ \pi^- K^- K_S^0$	$< 9 \times 10^{-5}$	CL=90%	5082
$2\pi^+ \pi^- K^- K_S^0 2\pi^0$	$< 7 \times 10^{-4}$	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
$3\pi^+ 2\pi^- K^- K_S^0 \pi^0$	$< 4 \times 10^{-4}$	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

$\Upsilon(3S)$

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

Mass $m = 10.3552 \pm 0.0005$ GeV

$m_{\Upsilon(3S)} - m_{\Upsilon(2S)} = 331.50 \pm 0.13$ 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	$(10.6 \pm 0.8) \%$		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%	427
$h_b(1P) \pi^0 \rightarrow \gamma \eta_b(1S) \pi^0$	$(4.3 \pm 1.4) \times 10^{-4}$		—
$h_b(1P) \pi^+ \pi^-$	$< 1.2 \times 10^{-4}$	CL=90%	353
$\tau^+ \tau^-$	$(2.29 \pm 0.30) \%$		4863
$\mu^+ \mu^-$	$(2.18 \pm 0.21) \%$	S=2.1	5177
$e^+ e^-$	seen		5178
$g g g$	$(35.7 \pm 2.6) \%$		—
$\gamma g g$	$(9.7 \pm 1.8) \times 10^{-3}$		—
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
$\gamma \chi_{b2}(1P)$	$(9.9 \pm 1.3) \times 10^{-3}$	S=2.0	434
$\gamma A^0 \rightarrow \gamma$ hadrons	$< 8 \times 10^{-5}$	CL=90%	—

$\gamma\chi_{b1}(1P)$	$(9 \pm 5) \times 10^{-4}$	S=1.9	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%	—
$\gamma\eta_b(1S)$	$(5.1 \pm 0.7) \times 10^{-4}$		919
$\gamma X \rightarrow \gamma + \geq 4$ prongs	$[j] < 2.2 \times 10^{-4}$	CL=95%	—
$\gamma a_1^0 \rightarrow \gamma \tau^+ \tau^-$	$[k] < 1.6 \times 10^{-4}$	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

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

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

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)
$B\bar{B}$	> 96 %	95%	327
$B^+ B^-$	(51.3 ± 0.6) %		332
D_s^+ anything + c.c.	(17.8 ± 2.6) %		—
$B^0 \bar{B}^0$	(48.7 ± 0.6) %		327
$J/\psi K_S^0 (J/\psi, \eta_c) K_S^0$	$< 4 \times 10^{-7}$	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
$J/\psi(1S)$ anything	$< 1.9 \times 10^{-4}$	95%	—
D^{*+} anything + c.c.	< 7.4 %	90%	5099
ϕ anything	(7.1 ± 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
$\Upsilon(1S)\eta$	$(1.96 \pm 0.11) \times 10^{-4}$		924
$\Upsilon(2S)\pi^+\pi^-$	$(8.6 \pm 1.3) \times 10^{-5}$		468
$h_b(1P)\pi^+\pi^-$	not seen		601
\bar{d} anything	$< 1.3 \times 10^{-5}$	90%	—

$\Upsilon(10860)$

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

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)
$B\bar{B}X$	(75.9 $^{+2.7}_{-4.0}$) %		—
$B\bar{B}$	(5.5 ± 1.0) %		1303
$B\bar{B}^* + \text{c.c.}$	(13.7 ± 1.6) %		—
$B^*\bar{B}^*$	(38.1 ± 3.4) %		1102
$B\bar{B}^{(*)}\pi$	< 19.7 %	90%	990
$B\bar{B}\pi$	(0.0 ± 1.2) %		990
$B^*\bar{B}\pi + B\bar{B}^*\pi$	(7.3 ± 2.3) %		—
$B^*\bar{B}^*\pi$	(1.0 ± 1.4) %		701
$B\bar{B}\pi\pi$	< 8.9 %	90%	504
$B_s^{(*)}\bar{B}_s^{(*)}$	(19.9 ± 3.0) %		877
$B_s\bar{B}_s$	(5 ± 5) $\times 10^{-3}$		877
$B_s\bar{B}_s^* + \text{c.c.}$	(1.5 ± 0.7) %		—
$B_s^*\bar{B}_s^*$	(17.9 ± 2.8) %		495
no open-bottom	(4.2 $^{+5.0}_{-0.6}$) %		—
e^+e^-	(5.6 ± 3.1) $\times 10^{-6}$		5438
$\Upsilon(1S)\pi^+\pi^-$	(5.3 ± 0.6) $\times 10^{-3}$		1297
$\Upsilon(2S)\pi^+\pi^-$	(7.8 ± 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 $^{+1.0}_{-1.3}$) $\times 10^{-3}$		895
$h_b(2P)\pi^+\pi^-$	(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 $m = 11.019 \pm 0.008$ GeVFull 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] $2m_\tau < M(\tau^+ \tau^-) < 7500$ MeV[b] $2 < m_{K^+ K^-} < 3$ GeV[c] $X =$ scalar with $m < 8.0$ GeV[d] $X \bar{X} =$ vectors with $m < 3.1$ GeV[e] X and $\bar{X} =$ zero spin with $m < 4.5$ GeV[f] 1.5 GeV $< m_X < 5.0$ GeV[g] $201 < M(\mu^+ \mu^-) < 3565$ MeV

[h] Spectroscopic labeling for these states is theoretical, pending experimental information.

[i] 1.5 GeV $< m_X < 5.0$ GeV[j] 1.5 GeV $< m_X < 5.0$ GeV[k] For $m_{\tau^+ \tau^-}$ in the ranges 4.03–9.52 and 9.61–10.10 GeV.