

$b\bar{b}$ 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)
$\tau^+ \tau^-$	(2.50±0.07) %		4384
$e^+ e^-$	(2.48±0.07) %		4730
$\mu^+ \mu^-$	(2.48±0.05) %		4729

Hadronic decays

ggg	(81.7 ±0.7) %		—
$\gamma g g$	(2.21±0.22) %		—
$\eta'(958)$ 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% 4679
$\gamma f'_2(1525)$	$(3.7 \begin{smallmatrix} +1.2 \\ -1.1 \end{smallmatrix}) \times 10^{-5}$		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% 4261
$\gamma \chi_{c0}$	< 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] < 3	$\times 10^{-5}$	90% —
$\gamma X \bar{X}$	[d] < 1	$\times 10^{-3}$	90% —
$\gamma X \rightarrow \gamma + \geq 4$ prongs	[e] < 1.78	$\times 10^{-4}$	95% —
$\gamma a_1^0 \rightarrow \gamma \mu^+ \mu^-$	[f] < 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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$\chi_{b0}(1P)$ [g]

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

J needs confirmation.

$$\text{Mass } m = 9859.44 \pm 0.42 \pm 0.31 \text{ MeV}$$

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

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

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

J needs confirmation.

$$\text{Mass } m = 9892.78 \pm 0.26 \pm 0.31 \text{ MeV}$$

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

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

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

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)
$\gamma \Upsilon(1S)$	$(22 \pm 4) \%$		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

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)
$\Upsilon(1S)\pi^+\pi^-$	(18.1 \pm 0.4) %		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
$\Upsilon(1S)\pi^0$	< 1.8	$\times 10^{-4}$ CL=90%	531
$\Upsilon(1S)\eta$	(2.1 $^{+0.8}_{-0.7}$) $\times 10^{-4}$		126
$J/\psi(1S)$ anything	< 6	$\times 10^{-3}$ CL=90%	4533
\bar{d} anything	(3.4 \pm 0.6) $\times 10^{-5}$		–
hadrons	(94 \pm 11) %		–
ggg	(58.8 \pm 1.2) %		–
γgg	(1.87 \pm 0.28) %		–

Radiative decays

$\gamma\chi_{b1}(1P)$	(6.9 \pm 0.4) %		130
$\gamma\chi_{b2}(1P)$	(7.15 \pm 0.35) %		110
$\gamma\chi_{b0}(1P)$	(3.8 \pm 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
$\gamma\eta_b(1S)$	(3.9 \pm 1.5) $\times 10^{-4}$		612
$\gamma X \rightarrow \gamma + \geq 4$ prongs	$[h] < 1.95$	$\times 10^{-4}$ CL=95%	–

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

$\Upsilon(1D)$

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

$$\text{Mass } m = 10163.7 \pm 1.4 \text{ MeV} \quad (S = 1.7)$$

$\Upsilon(1D)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\gamma\gamma\Upsilon(1S)$	seen	679

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

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

J needs confirmation.

$$\text{Mass } m = 10.2325 \pm 0.0004 \pm 0.0005 \text{ GeV}$$

$\chi_{b0}(2P)$ 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

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

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

J needs confirmation.

$$\text{Mass } m = 10.25546 \pm 0.00022 \pm 0.00050 \text{ GeV}$$

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

$\chi_{b1}(2P)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor	P (MeV/c)
$\omega \Upsilon(1S)$	$(1.63^{+0.40}_{-0.34}) \%$		135
$\gamma \Upsilon(2S)$	$(21 \pm 4) \%$	1.5	230
$\gamma \Upsilon(1S)$	$(8.5 \pm 1.3) \%$	1.3	764
$\pi\pi \chi_{b1}(1P)$	$(8.6 \pm 3.1) \times 10^{-3}$		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

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

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

J needs confirmation.

$$\text{Mass } m = 10.26865 \pm 0.00022 \pm 0.00050 \text{ GeV}$$

$$m_{\chi_{b2}(2P)} - m_{\chi_{b1}(2P)} = 13.5 \pm 0.6 \text{ MeV}$$

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

$\Upsilon(3S)$

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

$$\text{Mass } m = 10.3552 \pm 0.0005 \text{ GeV}$$

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

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

$\Upsilon(3S)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\Upsilon(2S)$ anything	(10.6 \pm 0.8) %		296
$\Upsilon(2S)\pi^+\pi^-$	(2.45 \pm 0.23) %	S=1.1	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
$\Upsilon(1S)\pi^+\pi^-$	(4.40 \pm 0.10) %		813
$\Upsilon(1S)\pi^0\pi^0$	(2.20 \pm 0.13) %		816
$\Upsilon(1S)\eta$	< 1.8 $\times 10^{-4}$	CL=90%	677
$\Upsilon(1S)\pi^0$	< 7 $\times 10^{-5}$	CL=90%	846
$\tau^+\tau^-$	(2.29 \pm 0.30) %		4863
$\mu^+\mu^-$	(2.18 \pm 0.21) %	S=2.1	5177
e^+e^-	seen		5178
ggg	(35.7 \pm 2.6) %		–
γgg	(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
$\gamma\chi_{b2}(1P)$	< 1.9 %	CL=90%	434
$\gamma\chi_{b1}(1P)$	< 1.7 $\times 10^{-3}$	CL=90%	452
$\gamma\chi_{b0}(1P)$	(3.0 \pm 1.1) $\times 10^{-3}$		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	[i] < 2.2 $\times 10^{-4}$	CL=95%	–
$\gamma a_1^0 \rightarrow \gamma\tau^+\tau^-$	[j] < 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 $\Upsilon(10580)$**

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

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%	328
B^+B^-	(51.6 \pm 0.6) %		334
D_s^+ anything + c.c.	(17.8 \pm 2.6) %		–
$B^0\bar{B}^0$	(48.4 \pm 0.6) %		328
$J/\psi K_S^0(J/\psi, \eta_c) K_S^0$	< 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 \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 0.11) $\times 10^{-4}$		924
$\Upsilon(2S)\pi^+\pi^-$	(8.6 \pm 1.3) $\times 10^{-5}$		468
\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)
e^+e^-	(5.6 \pm 3.1) $\times 10^{-6}$		5438
$B\bar{B}X$	(71 \pm 6) %		–
$B\bar{B}$	(5.5 \pm 1.0) %		1303
$B\bar{B}^* +$ c.c.	(13.7 \pm 1.6) %		–
$B^*\bar{B}^*$	(38.1 \pm 3.4) %		1102
$B\bar{B}^{(*)}\pi$	< 19.7 %	90%	991
$B\bar{B}\pi$	(0.0 \pm 1.2) %		991
$B^*\bar{B}\pi + B\bar{B}^*\pi$	(7.3 \pm 2.3) %		–
$B^*\bar{B}^*\pi$	(1.0 \pm 1.4) %		701
$B\bar{B}\pi\pi$	< 8.9 %	90%	505
$B_s^{(*)}\bar{B}_s^{(*)}$	(19.3 \pm 2.9) %		880

$B_s \bar{B}_s$	$(5 \pm 5) \times 10^{-3}$	880
$B_s \bar{B}_s^* + \text{c.c.}$	$(1.4 \pm 0.6) \%$	—
$B_s^* \bar{B}_s^*$	$(17.4 \pm 2.7) \%$	496
$\gamma(1S) \pi^+ \pi^-$	$(5.3 \pm 0.6) \times 10^{-3}$	1297
$\gamma(2S) \pi^+ \pi^-$	$(7.8 \pm 1.3) \times 10^{-3}$	774
$\gamma(3S) \pi^+ \pi^-$	$(4.8 \begin{smallmatrix} +1.9 \\ -1.7 \end{smallmatrix}) \times 10^{-3}$	429
$\gamma(1S) K^+ K^-$	$(6.1 \pm 1.8) \times 10^{-4}$	947

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.	$(72 \pm 6) \%$	—

$\Upsilon(11020)$

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

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] $2m_\tau < M(\tau^+ \tau^-) < 7500$ MeV.

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

[c] X = pseudoscalar with $m < 7.2$ GeV

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

[e] 1.5 GeV $< m_X < 5.0$ GeV

[f] $201 < M(\mu^+ \mu^-) < 3565$ MeV.

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

[h] 1.5 GeV $< m_X < 5.0$ GeV

[i] 1.5 GeV $< m_X < 5.0$ GeV

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