

$\chi_{b0}(2P)$

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

J needs confirmation.

Observed in radiative decay of the $\Upsilon(3S)$, therefore $C = +$. Branching ratio requires E1 transition, M1 is strongly disfavored, therefore $P = +$.

$\chi_{b0}(2P)$ MASS

<u>VALUE (GeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
10.2321 ± 0.0006 OUR AVERAGE			
10.2312 ± 0.0008 ± 0.0012	¹ HEINTZ 92	CSB2	$e^+e^- \rightarrow \gamma X, l^+l^- \gamma \gamma$
10.2323 ± 0.0007	² MORRISON 91	CLE2	$e^+e^- \rightarrow \gamma X$

¹ From the average photon energy for inclusive and exclusive events and assuming $\Upsilon(3S)$ mass = 10355.3 ± 0.5 MeV. Supersedes HEINTZ 91 and NARAIN 91.

² From γ energy below assuming $\Upsilon(3S)$ mass = 10355.3 ± 0.5 MeV. The error on the $\Upsilon(3S)$ mass is not included in the individual measurements. It is included in the final average.

γ ENERGY IN $\Upsilon(3S)$ DECAY

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
122.8 ± 0.5 OUR AVERAGE Error includes scale factor of 1.1.				
123.0 ± 0.8	4959	³ HEINTZ 92	CSB2	$e^+e^- \rightarrow \gamma X$
124.6 ± 1.4	17	⁴ HEINTZ 92	CSB2	$e^+e^- \rightarrow l^+l^- \gamma \gamma$
122.3 ± 0.3 ± 0.6	9903	MORRISON 91	CLE2	$e^+e^- \rightarrow \gamma X$

³ A systematic uncertainty on the energy scale of 0.9% not included. Supersedes NARAIN 91.

⁴ A systematic uncertainty on the energy scale of 0.9% not included. Supersedes HEINTZ 91.

$\chi_{b0}(2P)$ DECAY MODES

Mode	Fraction (Γ_i/Γ)
$\Gamma_1 \quad \gamma \Upsilon(2S)$	(4.6 ± 2.1) %
$\Gamma_2 \quad \gamma \Upsilon(1S)$	(9 ± 6) × 10 ⁻³

$\chi_{b0}(2P)$ BRANCHING RATIOS

<u>$\Gamma(\gamma \Upsilon(2S))/\Gamma_{\text{total}}$</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	<u>Γ_1/Γ</u>
< 0.089	90	⁵ CRAWFORD 92B	CLE2	$e^+e^- \rightarrow l^+l^- \gamma \gamma$	
0.046 ± 0.020 ± 0.007		⁶ HEINTZ 92	CSB2	$e^+e^- \rightarrow l^+l^- \gamma \gamma$	

⁵ Using $B(\Upsilon(2S) \rightarrow \mu^+\mu^-) = (1.37 \pm 0.26)\%$, $B(\Upsilon(3S) \rightarrow \gamma \gamma \Upsilon(2S)) \times 2 B(\Upsilon(2S) \rightarrow \mu^+\mu^-) < 1.19 \times 10^{-4}$, and $B(\Upsilon(3S) \rightarrow \chi_{b0}(2P)\gamma) = 0.049$.

⁶ Using $B(\Upsilon(2S) \rightarrow \mu^+\mu^-) = (1.44 \pm 0.10)\%$, $B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P)) = (6.0 \pm 0.4 \pm 0.6)\%$ and assuming $e\mu$ universality. Supersedes HEINTZ 91.

$\Gamma(\gamma \Upsilon(1S))/\Gamma_{\text{total}}$	Γ_2/Γ			
<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<0.025	90	⁷ CRAWFORD 92B	CLE2	$e^+e^- \rightarrow \ell^+\ell^-\gamma\gamma$
$0.009 \pm 0.006 \pm 0.001$		⁸ HEINTZ 92	CSB2	$e^+e^- \rightarrow \ell^+\ell^-\gamma\gamma$

⁷ Using $B(\Upsilon(1S) \rightarrow \mu^+\mu^-) = (2.57 \pm 0.07)\%$, $B(\Upsilon(3S) \rightarrow \gamma\gamma \Upsilon(1S)) \times 2 B(\Upsilon(1S) \rightarrow \mu^+\mu^-) < 0.63 \times 10^{-4}$, and $B(\Upsilon(3S) \rightarrow \chi_{b0}(2P)\gamma) = 0.049$.

⁸ Using $B(\Upsilon(1S) \rightarrow \mu^+\mu^-) = (2.57 \pm 0.07)\%$, $B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P)) = (6.0 \pm 0.4 \pm 0.6)\%$ and assuming $e\mu$ universality. Supersedes HEINTZ 91.

$\chi_{b0}(2P)$ REFERENCES

CRAWFORD	92B	PL B294 139	G. Crawford, R. Fulton	(CLEO Collab.)
HEINTZ	92	PR D46 1928	U. Heintz <i>et al.</i>	(CUSB II Collab.)
HEINTZ	91	PRL 66 1563	U. Heintz <i>et al.</i>	(CUSB Collab.)
MORRISON	91	PRL 67 1696	R.J. Morrison <i>et al.</i>	(CLEO Collab.)
NARAIN	91	PRL 66 3113	M. Narain <i>et al.</i>	(CUSB Collab.)

OTHER RELATED PAPERS

EIGEN	82	PRL 49 1616	G. Eigen <i>et al.</i>	(CUSB Collab.)
HAN	82	PRL 49 1612	K. Han <i>et al.</i>	(CUSB Collab.)