$\chi_{b1}(2P)$

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

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

$\chi_{b1}(2P)$ MASS

VALUE (GeV)	DOCUMENT ID		TECN	COMMENT
10.2552±0.0005 OUR AVERAGE				
10.2547±0.0004±0.0010	[1] HEINTZ	92	CSB2	$e^+e^- \to \gamma X, \ell^+\ell^-\gamma\gamma$
10.2553±0.0005	[2] MORRISON	91	CLE2	$e^+e^- \to \gamma X$

[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 evaluation.

$m_{\chi_{b1}(2P)} - m_{\chi_{b0}(2P)}$

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
23.5±0.7±0.7	[3] HEINTZ	92	CSB2	$e^+e^- \to \gamma X, \ell^+\ell^-\gamma\gamma$

[3] From the average photon energy for inclusive and exclusive events. Supersedes NARAIN 91.

γ ENERGY IN $\Upsilon(3S)$ DECAY

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
99.90±0.26 OUR AVERAGE					
99 ±1	169	CRAWFORD	92B	CLE2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$
100.1 ±0.4	11147	[4] HEINTZ	92	CSB2	$e^+e^- \to \gamma X$
100.2 ±0.5	223	[5] HEINTZ	92	CSB2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$
99.5 ±0.1 ±0.5	25759	MORRISON	91	CLE2	$e^+e^- \to \gamma X$

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

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

$\chi_{b1}(2P)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Scale factor
Γ_1	$\gamma\,\Upsilon(2S)$	(21 ±4) %	1.5
Γ_2	$\gamma\,\Upsilon(1S)$	(8.5±1.3) %	1.3

$\chi_{b1}(2P)$ BRANCHING RATIOS

$\Gamma(\gamma\Upsilon(2S))/\Gamma_{total}$ — Γ_1/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.21 ±0.04 OUR AVERAGE	Error includes scale factor of 1.5.			
0.356±0.042±0.092	[6] CRAWFORD	92B	CLE2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$
0.199±0.020±0.022	[7] HEINTZ	92	CSB2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$

[6] Using B($\Upsilon(2S) \to \mu^+\mu^-$) = (1.37 ± 0.26)%, B($\Upsilon(3S) \to \gamma\gamma\Upsilon(2S)$)×2 B($\Upsilon(2S) \to \mu^+\mu^-$) = (10.23 ± 1.20 ± 1.26)×10^{-4}, and B($\Upsilon(3S) \to \gamma\chi_{b1}(2P)$) = $0.105^{+0.003}_{-0.002}$ ± 0.013.

[7] Using B($\Upsilon(2S) \to \mu^+\mu^-$) = (1.44 ± 0.10)%, B($\Upsilon(3S) \to \gamma\chi_{b1}(2P)$) = (11.5 ± 0.5 ± 0.5)% and assuming $e\mu$ universality. Supersedes HEINTZ 91.

$\Gamma(\gamma\Upsilon(1S))/\Gamma_{total}$ — Γ_2/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.085±0.013 OUR AVERAGE	Error includes scale factor of 1.3.			
0.120±0.021±0.021	[8] CRAWFORD	92B	CLE2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$
0.080±0.009±0.007	[9] HEINTZ	92	CSB2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$

[8] Using B($\Upsilon(1S) \to \mu^+\mu^-$) = (2.57 ± 0.07)%, B($\Upsilon(3S) \to \gamma\gamma\Upsilon(1S)$)×2 B($\Upsilon(1S) \to \mu^+\mu^-$) = (6.47 ± 1.12 ± 0.82) × 10^{-4} and B($\Upsilon(3S) \to \gamma\chi_{b1}(2P)$) = $0.105^{+0.003}_{-0.002}$ ± 0.013.

[9] Using B($\Upsilon(1S) \to \mu^+\mu^-$)=(2.57 ± 0.07)%, B($\Upsilon(3S) \to \gamma\chi_{b1}(2P)$) = (11.5 ± 0.5 ± 0.5)% and assuming $e\mu$ universality. Supersedes HEINTZ 91.

$\chi_{b1}(2P)$ REFERENCES

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

OTHER RELATED PAPERS

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