$\chi_{b1}(3P)$

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

Observed in the radiative decay to $\Upsilon(1S, 2S, 3S)$, therefore $C = +$.
J needs confirmation.

$\chi_{b1}(3P)$ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
10513.42± 0.41± 0.53		[1] SIRUNYAN	18N	CMS	$pp \to \gamma\mu^+\mu^- X$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$10515.7\ ^{+\ 2.2}_{-\ 3.9}\ ^{+\ 1.5}_{-\ 2.1}$	169	[2] AAIJ	14BG	LHCB	$pp \to \gamma\mu^+\mu^- X$
10512.1 ± 2.1 ± 0.9	351	[3] AAIJ	14BG	LHCB	$pp \to \gamma\mu^+\mu^- X$
10511.3 ± 1.7 ± 2.5	182	[4] AAIJ	14BI	LHCB	$pp \to \gamma\mu^+\mu^- X$
10530 ± 5 ± 9		[5] AAD	12A	ATLS	$pp \to \gamma\mu^+\mu^- X$
10551 ±14 ±17		[5] ABAZOV	12Q	D0	$p\overline{p} \to \gamma\mu^+\mu^- X$

[1] Systematic error includes an additional 0.5 MeV for the uncertainty on the $\Upsilon(3S)$ mass. Also measures $m_{\chi_{b2}(3P)} - m_{\chi_{b1}(3P)} = 10.60 \pm 0.64 \pm 0.17$ MeV. A total of 372 $\chi_{b1}(3P)$ and $\chi_{b2}(3P)$ events was observed.

[2] From $\chi_{b1}(3P) \to \Upsilon(1S, 2S)\gamma$ transitions assuming $m_{\chi_{b2}(3P)} - m_{\chi_{b1}(3P)} = 10.5 \pm 1.5$ MeV and allowing for ±30% variation in the $\chi_{b2}(3P)$ production rate relative to that of $\chi_{b1}(3P)$.

[3] The mass of the $\chi_{b1}(3P)$ state obtained by combining the results of AAIJ 14BG with that of AAIJ 14BI. The first uncertainty is experimental and the second attributable to the unknown mass splitting, assumed to be $m_{\chi_{b2}(3P)} - m_{\chi_{b1}(3P)} = 10.5 \pm 1.5$ MeV.

[4] From $\chi_{b1}(3P) \to \Upsilon(3S)\gamma$ transition assuming $m_{\chi_{b2}(3P)} - m_{\chi_{b1}(3P)} = 10.5 \pm 1.5$ MeV.

[5] The mass barycenter of the merged lineshapes from the $J = 1$ and 2 states.

$\chi_{b1}(3P)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$\Upsilon(1S)\gamma$	seen
Γ_2	$\Upsilon(2S)\gamma$	seen
Γ_3	$\Upsilon(3S)\gamma$	seen

$\chi_{b1}(3P)$ BRANCHING RATIOS

$\Gamma(\Upsilon(1S)\gamma)/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
seen	169	[1] AAIJ	14BG	LHCB	$pp \to \gamma\mu^+\mu^- X$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
seen		AAD	12A	ATLS	$pp \to \gamma\mu^+\mu^- X$
seen		ABAZOV	12Q	D0	$p\overline{p} \to \gamma\mu^+\mu^- X$

[1] From $\chi_{b1}(3P) \to \Upsilon(1S, 2S)\gamma$ transitions assuming $m_{\chi_{b2}(3P)} - m_{\chi_{b1}(3P)} = 10.5 \pm 1.5$ MeV and allowing for ±30% variation in the $\chi_{b2}(3P)$ production rate relative to that of $\chi_{b1}(3P)$.

$\Gamma(\Upsilon(2S)\gamma)/\Gamma_{\text{total}}$ Γ_2/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
seen	169	[1] AAIJ	14BG	LHCB	$pp \to \gamma\mu^+\mu^- X$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
seen		AAD	12A	ATLS	$pp \to \gamma\mu^+\mu^- X$

[1] From $\chi_{b1}(3P) \to \Upsilon(1S,2S)\gamma$ transitions assuming $m_{\chi_{b2}(3P)} - m_{\chi_{b1}(3P)} = 10.5 \pm 1.5$ MeV and allowing for $\pm 30\%$ variation in the $\chi_{b2}(3P)$ production rate relative to that of $\chi_{b1}(3P)$.

$\Gamma(\Upsilon(3S)\gamma)/\Gamma_{\text{total}}$ Γ_3/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
seen		SIRUNYAN	18N	CMS	$pp \to \gamma\mu^+\mu^- X$
seen	182	AAIJ	14BI	LHCB	$pp \to \gamma\mu^+\mu^- X$

$\chi_{b1}(3P)$ REFERENCES

SIRUNYAN	18N	PRL 121 092002	A.M. Sirunyan *et al.*	(CMS Collab.)
AAIJ	14BG	JHEP 1410 088	R. Aaij *et al.*	(LHCb Collab.)
AAIJ	14BI	EPJ C74 3092	R. Aaij *et al.*	(LHCb Collab.)
AAD	12A	PRL 108 152001	G. Aad *et al.*	(ATLAS Collab.)
ABAZOV	12Q	PR D86 031103	V.M. Abazov *et al.*	(D0 Collab.)