

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

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

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
<b>10513.42 ± 0.41 ± 0.53</b>		<sup>1</sup> SIRUNYAN	18N CMS	$pp \rightarrow \gamma \mu^+ \mu^- X$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
10515.7 $\begin{smallmatrix} + 2.2 \\ - 3.9 \end{smallmatrix}$ $\begin{smallmatrix} + 1.5 \\ - 2.1 \end{smallmatrix}$	169	<sup>2</sup> AAIJ	14BG LHCB	$pp \rightarrow \gamma \mu^+ \mu^- X$
10512.1 ± 2.1 ± 0.9	351	<sup>3</sup> AAIJ	14BG LHCB	$pp \rightarrow \gamma \mu^+ \mu^- X$
10511.3 ± 1.7 ± 2.5	182	<sup>4</sup> AAIJ	14BI LHCB	$pp \rightarrow \gamma \mu^+ \mu^- X$
10530 ± 5 ± 9		<sup>5</sup> AAD	12A ATLS	$pp \rightarrow \gamma \mu^+ \mu^- X$
10551 ± 14 ± 17		<sup>5</sup> ABAZOV	12Q D0	$p\bar{p} \rightarrow \gamma \mu^+ \mu^- X$

<sup>1</sup> 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.

<sup>2</sup> From  $\chi_{b1}(3P) \rightarrow \Upsilon(1S, 2S)\gamma$  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  $\chi_{b1}(3P)$ .

<sup>3</sup> 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.

<sup>4</sup> From  $\chi_{b1}(3P) \rightarrow \Upsilon(3S)\gamma$  transition assuming  $m_{\chi_{b2}(3P)} - m_{\chi_{b1}(3P)} = 10.5 \pm 1.5$  MeV.

<sup>5</sup> The mass barycenter of the merged lineshapes from the  $J = 1$  and 2 states.

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

Mode	Fraction ( $\Gamma_i/\Gamma$ )
$\Gamma_1$ $\Upsilon(1S)\gamma$	seen
$\Gamma_2$ $\Upsilon(2S)\gamma$	seen
$\Gamma_3$ $\Upsilon(3S)\gamma$	seen

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

$\Gamma(\Upsilon(1S)\gamma)/\Gamma_{\text{total}}$	$\Gamma_1/\Gamma$			
VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
<b>seen</b>	169	<sup>1</sup> AAIJ	14BG LHCB	$pp \rightarrow \gamma \mu^+ \mu^- X$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
seen		AAD	12A ATLS	$pp \rightarrow \gamma \mu^+ \mu^- X$
seen		ABAZOV	12Q D0	$p\bar{p} \rightarrow \gamma \mu^+ \mu^- X$

<sup>1</sup> From  $\chi_{b1}(3P) \rightarrow \Upsilon(1S, 2S)\gamma$  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  $\chi_{b1}(3P)$ .

$\Gamma(\Upsilon(2S)\gamma)/\Gamma_{\text{total}}$   $\Gamma_2/\Gamma$

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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<b>seen</b>	169	<sup>1</sup> AAIJ	14BG LHCB	$pp \rightarrow \gamma\mu^+\mu^- X$
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• • • We do not use the following data for averages, fits, limits, etc. • • •

seen		AAD	12A ATLS	$pp \rightarrow \gamma\mu^+\mu^- X$
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<sup>1</sup>From  $\chi_{b1}(3P) \rightarrow \Upsilon(1S, 2S)\gamma$  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  $\chi_{b1}(3P)$ .

$\Gamma(\Upsilon(3S)\gamma)/\Gamma_{\text{total}}$   $\Gamma_3/\Gamma$

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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<b>seen</b>		SIRUNYAN	18N CMS	$pp \rightarrow \gamma\mu^+\mu^- X$
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<b>seen</b>	182	AAIJ	14BI LHCB	$pp \rightarrow \gamma\mu^+\mu^- X$
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**$\chi_{b1}(3P)$  REFERENCES**

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