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

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

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

[1] 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.

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

[4] 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

### $\Gamma(\Upsilon(1S)\gamma)/\Gamma_{total}$ $\Gamma_1/\Gamma$

| VALUE | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **seen** | 169 | [5] 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 | $p\overline{p} \to \gamma\mu^+\mu^- X$ |

[5] 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 $\chi_{b1}(3P)$.

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

| VALUE | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **seen** | 169 | [6] 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 | $pp \to \gamma\mu^+\mu^- X$ |

[6] 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 $\chi_{b1}(3P)$.

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

| VALUE | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **seen** | 182 | AAIJ | 14BI | LHCB | $pp \to \gamma\mu^+\mu^- X$ |

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


| | | | | |
|---|---|---|---|---|
| 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.) |