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

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

| *VALUE* (GeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **10.2321±0.0006 OUR AVERAGE** | | | | |
| 10.2312±0.0008±0.0012 | [1] HEINTZ | 92 | CSB2 | $e^+e^- \rightarrow \gamma X, \ell^+\ell^-\gamma\gamma$ |
| 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 $\gamma$ 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.

## $\gamma$ ENERGY IN $\Upsilon(3S)$ DECAY

| *VALUE* (MeV) | *EVTS* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|
| **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 | $e^+e^- \rightarrow \ell^+\ell^-\gamma\gamma$ |
| 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 ($\Gamma_i/\Gamma$) |
|---|---|---|
| $\Gamma_1$ | $\gamma\,\Upsilon(2S)$ | (4.6±2.1) % |
| $\Gamma_2$ | $\gamma\,\Upsilon(1S)$ | (9 ±6 ) $\times 10^{-3}$ |

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

### $\Gamma(\gamma\,\Upsilon(2S))/\Gamma_{total}$ — $\Gamma_1/\Gamma$

| *VALUE* | *CL%* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|
| **<0.089** | 90 | [5] CRAWFORD | 92B | CLE2 | $e^+e^- \rightarrow \ell^+\ell^-\gamma\gamma$ |
| **0.046±0.020±0.007** | | [6] HEINTZ | 92 | CSB2 | $e^+e^- \rightarrow \ell^+\ell^-\gamma\gamma$ |

[5] Using B($\Upsilon(2S) \rightarrow \mu^+\mu^-$) = (1.37 ± 0.26)%, B($\Upsilon(3S) \rightarrow \gamma\gamma\,\Upsilon(2S)$)×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 ± 0.10)%, B($\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P)$) = (6.0 ± 0.4 ± 0.6)% and assuming $e\mu$ universality. Supersedes HEINTZ 91.

### $\Gamma(\gamma\,\Upsilon(1S))/\Gamma_{total}$ — $\Gamma_2/\Gamma$

| *VALUE* | *CL%* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|
| **<0.025** | 90 | [7] CRAWFORD | 92B | CLE2 | $e^+e^- \to \ell^+\ell^-\gamma\gamma$ |
| **0.009±0.006±0.001** | | [8] HEINTZ | 92 | CSB2 | $e^+e^- \to \ell^+\ell^-\gamma\gamma$ |

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

[8] Using B($\Upsilon(1S) \to \mu^+\mu^-$) = (2.57 ± 0.07)%, B($\Upsilon(3S) \to \gamma\chi_{b0}(2P)$) = (6.0 ± 0.4 ± 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 *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.) |
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## OTHER RELATED PAPERS


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