

$\eta_b(2S)$

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

OMITTED FROM SUMMARY TABLE

Quantum numbers shown are quark-model predictions.

| $\eta_b(2S)$ MASS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                        |      |                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------------------|------|---------------------------------------------------------|
| VALUE (MeV)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | EVTs       | DOCUMENT ID            | TECN | COMMENT                                                 |
| $9999.0 \pm 3.5^{+2.8}_{-1.9}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 26k        | <sup>1</sup> MIZUK     | 12   | BELL $e^+e^- \rightarrow \gamma\pi^+\pi^- +$<br>hadrons |
| • • • We do not use the following data for averages, fits, limits, etc. • • •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |            |                        |      |                                                         |
| $9974.6 \pm 2.3 \pm 2.1$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | $11 \pm 4$ | <sup>2,3,4</sup> DOBBS | 12   | $\Upsilon(2S) \rightarrow \gamma$ hadrons               |
| <sup>1</sup> Assuming $\Gamma_{\eta_b(2S)} = 4.9$ MeV. Not independent of the corresponding mass difference measurement.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |                        |      |                                                         |
| <sup>2</sup> SANDILYA 13 (Belle Collab.) search for such a state reconstructed in the same 26 exclusive hadronic final states as DOBBS 12 using a sample of $(157.8 \pm 3.6) \times 10^6$ $\Upsilon(2S)$ decays or about 17 times larger and find no evidence for a signal. Their 90% C.L. upper limit on the branching fraction $B(\Upsilon(2S) \rightarrow \eta_b(2S)\gamma) \times \sum_i B(\eta_b(2S) \rightarrow X_i) < 4.9 \times 10^{-6}$ , summed over the exclusive hadronic final states $X_i$ , is an order of magnitude smaller than that reported by DOBBS 12. |            |                        |      |                                                         |
| <sup>3</sup> Obtained by analyzing CLEO III data but not authored by the CLEO Collaboration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |            |                        |      |                                                         |
| <sup>4</sup> Assuming $\Gamma_{\eta_b(2S)} = 5$ MeV. Not independent of the corresponding mass difference measurement.                                                                                                                                                                                                                                                                                                                                                                                                                                                      |            |                        |      |                                                         |

| $m\Upsilon(2S) - m_{\eta_b(2S)}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |            |                        |      |                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------------------|------|---------------------------------------------------------|
| VALUE (MeV)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | EVTs       | DOCUMENT ID            | TECN | COMMENT                                                 |
| $24.3 \pm 3.5^{+2.8}_{-1.9}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 26k        | <sup>5</sup> MIZUK     | 12   | BELL $e^+e^- \rightarrow \gamma\pi^+\pi^- +$<br>hadrons |
| • • • We do not use the following data for averages, fits, limits, etc. • • •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |            |                        |      |                                                         |
| $48.7 \pm 2.3 \pm 2.1$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | $11 \pm 4$ | <sup>6,7,8</sup> DOBBS | 12   | $\Upsilon(2S) \rightarrow \gamma$ hadrons               |
| <sup>5</sup> Assuming $\Gamma_{\eta_b(2S)} = 4.9$ MeV. Not independent of the corresponding mass measurement.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |            |                        |      |                                                         |
| <sup>6</sup> SANDILYA 13 (Belle Collab.) search for such a state reconstructed in the same 26 exclusive hadronic final states as DOBBS 12 using a sample of $(157.8 \pm 3.6) \times 10^6$ $\Upsilon(2S)$ decays or about 17 times larger and find no evidence for a signal. Their 90% C.L. upper limit on the branching fraction $B(\Upsilon(2S) \rightarrow \eta_b(2S)\gamma) \times \sum_i B(\eta_b(2S) \rightarrow X_i) < 4.9 \times 10^{-6}$ , summed over the exclusive hadronic final states $X_i$ , is an order of magnitude smaller than that reported by DOBBS 12. |            |                        |      |                                                         |
| <sup>7</sup> Obtained by analyzing CLEO III data but not authored by the CLEO Collaboration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |            |                        |      |                                                         |
| <sup>8</sup> Assuming $\Gamma_{\eta_b(2S)} = 5$ MeV. Not independent of the corresponding mass measurement.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |            |                        |      |                                                         |

| $\eta_b(2S)$ WIDTH |     |             |      |                                                    |
|--------------------|-----|-------------|------|----------------------------------------------------|
| VALUE (MeV)        | CL% | DOCUMENT ID | TECN | COMMENT                                            |
| $<24$              | 90  | MIZUK       | 12   | BELL $e^+e^- \rightarrow \gamma\pi^+\pi^-$ hadrons |

$\eta_b(2S)$  DECAY MODES

| Mode               | Fraction ( $\Gamma_i/\Gamma$ ) |
|--------------------|--------------------------------|
| $\Gamma_1$ hadrons | seen                           |

$\eta_b(2S)$  BRANCHING RATIOS

| $\Gamma(\text{hadrons})/\Gamma_{\text{total}}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |      |         | $\Gamma_1/\Gamma$                             |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|---------|-----------------------------------------------|
| VALUE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | EVS  | DOCUMENT ID | TECN | COMMENT |                                               |
| seen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 26k  | MIZUK       | 12   | BELL    | $e^+e^- \rightarrow \gamma\pi^+\pi^-$ hadrons |
| • • • We do not use the following data for averages, fits, limits, etc. • • •                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |      |         |                                               |
| seen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 9,10 | DOBBS       | 12   |         | $\Upsilon(2S) \rightarrow \gamma$ hadrons     |
| <sup>9</sup> SANDILYA 13 (Belle Collab.) search for such a state reconstructed in the same 26 exclusive hadronic final states as DOBBS 12 using a sample of $(157.8 \pm 3.6) \times 10^6$ $\Upsilon(2S)$ decays or about 17 times larger and find no evidence for a signal. Their 90% C.L. upper limit on the branching fraction $B(\Upsilon(2S) \rightarrow \eta_b(2S)\gamma) \times \sum_i B(\eta_b(2S) \rightarrow X_i) < 4.9 \times 10^{-6}$ , summed over the exclusive hadronic final states $X_i$ , is an order of magnitude smaller than that reported by DOBBS 12. |      |             |      |         |                                               |
| <sup>10</sup> Obtained by analyzing CLEO III data but not authored by the CLEO Collaboration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |      |         |                                               |

$\eta_b(2S)$  REFERENCES

|          |    |                |                           |                 |
|----------|----|----------------|---------------------------|-----------------|
| SANDILYA | 13 | PRL 111 112001 | S. Sandilya <i>et al.</i> | (BELLE Collab.) |
| DOBBS    | 12 | PRL 109 082001 | S. Dobbs <i>et al.</i>    |                 |
| MIZUK    | 12 | PRL 109 232002 | R. Mizuk <i>et al.</i>    | (BELLE Collab.) |