## $\psi(3823)$
### was $X(3823)$

$I^G(J^{PC}) = ??(2^{--})$

$J$, $P$ need confirmation.

Seen by BHARDWAJ 13 in $B \to \chi_{c1} \gamma K$ and ABLIKIM 15S in $e^+ e^- \to \pi^+ \pi^- \gamma \chi_{c1}$ decays as a narrow peak in the invariant mass distribution of the $\chi_{c1} \gamma$ system. Properties consistent with the $\psi_2(1^3D_2)$ $c\bar{c}$ state.

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## $\psi(3823)$ MASS

| VALUE (MeV) | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **3822.2±1.2 OUR AVERAGE** | | | | | |
| 3821.7±1.3±0.7 | 19 ± 5 | [1] ABLIKIM | 15S | BES3 | $e^+ e^- \to \pi^+ \pi^- \chi_{c1} \gamma$ |
| 3823.1±1.8±0.7 | 33 ± 10 | [2] BHARDWAJ | 13 | BELL | $B \to \chi_{c1} \gamma K$ |

[1] From a simultaneous unbinned maximum likelihood fit of $e^+ e^- \to \pi^+ \pi^- \chi_{c1} \gamma$ data (the $\pi^+ \pi^-$ recoil mass) taken at $\sqrt{s}$ values of 4.23, 4.26, 4.36, 4.42, and 4.60 GeV to simulated events including both $\psi(2S) \to \chi_{c1} \gamma$ and $\psi(3823) \to \chi_{c1} \gamma$ together, with floating mass scale offset for $\psi(2S)$, floating $\psi(3823)$ mass, and zero $\psi(3823)$ width, resulting in a significance of $5.9\sigma$ when including systematic uncertainties.

[2] From a simultaneous fit to $B^\pm \to (\chi_{c1} \gamma) K^\pm$ and $B^0 \to (\chi_{c1} \gamma) K^0_S$ with significance $4.0\sigma$ including systematics. Corrected for the measured $\psi(2S)$ mass using $B \to \psi(2S) K \to (\gamma \chi_{c1}) K$ decays.

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## $\psi(3823)$ WIDTH

| VALUE (MeV) | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **<16** | 90 | [1] ABLIKIM | 15S | BES3 | $e^+ e^- \to \pi^+ \pi^- \chi_{c1} \gamma$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| <24 | 90 | [2] BHARDWAJ | 13 | BELL | $B \to \chi_{c1} \gamma K$ |

[1] From a fit of $e^+ e^- \to \pi^+ \pi^- \chi_{c1} \gamma$ data (the $\pi^+ \pi^-$ recoil mass) taken at $\sqrt{s}$ values of 4.23, 4.26, 4.36, 4.42, and 4.60 GeV to a Breit-Wigner function with the mass fixed from the likelihood fit above, Gaussian resolution smearing, and floating width.

[2] From a simultaneous fit to $B^\pm \to (\chi_{c1} \gamma) K^\pm$ and $B^0 \to (\chi_{c1} \gamma) K^0_S$ with significance $4.0\sigma$ including systematics.

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## $\psi(3823)$ DECAY MODES

| | Mode | Fraction ($\Gamma_i/\Gamma$) |
|---|---|---|
| $\Gamma_1$ | $\chi_{c1} \gamma$ | seen |
| $\Gamma_2$ | $\chi_{c2} \gamma$ | not seen |

# $\psi(3823)$ BRANCHING RATIOS

## $\Gamma(\chi_{c1}\gamma)/\Gamma_{total}$ $\qquad\qquad$ $\Gamma_1/\Gamma$

| VALUE | EVTS | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|
| **seen** | $33 \pm 10$ | [1] BHARDWAJ 13 | BELL | $B^+ \to \chi_{c1}\gamma K^+$ |

[1] Reported B($B^\pm \to \psi(3823)K^\pm$) × B($\psi(3823) \to \gamma\chi_{c1}$) = $(9.7 \pm 2.8 \pm 1.1) \times 10^{-6}$ with statistical significance $3.8\sigma$.

## $\Gamma(\chi_{c2}\gamma)/\Gamma_{total}$ $\qquad\qquad$ $\Gamma_2/\Gamma$

| VALUE | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|
| not seen | [1] ABLIKIM 15S | BES3 | $e^+e^- \to \pi^+\pi^-\chi_{c2}\gamma$ |
| **not seen** | [2] BHARDWAJ 13 | BELL | $B^+ \to \chi_{c2}\gamma K^+$ |

[1] From a simultaneous unbinned maximum likelihood fit of $e^+e^- \to \pi^+\pi^-\chi_{c2}\gamma$ data (the $\pi^+\pi^-$ recoil mass) taken at $\sqrt{s}$ values of 4.23, 4.26, 4.36, 4.42, and 4.60 GeV to simulated events including both $\psi(2S) \to \chi_{c2}\gamma$ and $\psi(3823) \to \chi_{c2}\gamma$ together, with floating mass scale offset for $\psi(2S)$, $\psi(3823)$ mass floating (fixed to that above), and zero $\psi(3823)$ width.

[2] Reported B($B^\pm \to \psi(3823)K^\pm$) × B($\psi(3823) \to \gamma\chi_{c2}$) < $3.6 \times 10^{-6}$ at 90% CL.

## $\Gamma(\chi_{c2}\gamma)/\Gamma(\chi_{c1}\gamma)$ $\qquad\qquad$ $\Gamma_2/\Gamma_1$

| VALUE | CL% | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|
| **<0.41** | 90 | BHARDWAJ 13 | BELL | $B^+ \to \chi_{c1/c2}\gamma K^+$ |

• • • We do not use the following data for averages, fits, limits, etc. • • •

| VALUE | CL% | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|
| <0.42 | 90 | [1] ABLIKIM 15S | BES3 | $e^+e^- \to \pi^+\pi^-\chi_{c1}\gamma$ |

[1] From a simultaneous unbinned maximum likelihood fit of $e^+e^- \to \pi^+\pi^-\chi_{c1(2)}\gamma$ data (the $\pi^+\pi^-$ recoil mass) taken at $\sqrt{s}$ values of 4.23, 4.26, 4.36, 4.42, and 4.60 GeV to simulated events including both $\psi(2S) \to \chi_{c1(2)}\gamma$ and $\psi(3823) \to \chi_{c1(2)}\gamma$ together, with floating mass scale offset for $\psi(2S)$, $\psi(3823)$ mass floating (fixed to that above), and zero $\psi(3823)$ width.

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# $\psi(3823)$ REFERENCES

| ABLIKIM | 15S | PRL 115 011803 | M. Ablikim *et al.* | (BES III Collab.) |
|---|---|---|---|---|
| BHARDWAJ | 13 | PRL 111 032001 | V. Bhardwaj *et al.* | (BELLE Collab.) |