

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

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

J, P need confirmation.

Seen by BHARDWAJ 13 in $B \rightarrow \chi_{c1} \gamma K$ and ABLIKIM 15S in $e^+ e^- \rightarrow \pi^+ \pi^- \gamma \chi_{c1}$ 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.

$\psi(3823)$ 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	$e^+ e^- \rightarrow \pi^+ \pi^- \chi_{c1} \gamma$
3823.1 ± 1.8 ± 0.7	33 ± 10	² BHARDWAJ	13 BELL	$B \rightarrow \chi_{c1} \gamma K$

¹ From a simultaneous unbinned maximum likelihood fit of $e^+ e^- \rightarrow \pi^+ \pi^- \chi_{c1} \gamma$ 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 $\psi(2S) \rightarrow \chi_{c1} \gamma$ and $\psi(3823) \rightarrow \chi_{c1} \gamma$ together, with floating mass scale offset for $\psi(2S)$, floating $\psi(3823)$ mass, and zero $\psi(3823)$ width, resulting in a significance of 5.9σ when including systematic uncertainties.

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

$\psi(3823)$ WIDTH

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

¹ From a fit of $e^+ e^- \rightarrow \pi^+ \pi^- \chi_{c1} \gamma$ 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 $B^\pm \rightarrow (\chi_{c1} \gamma) K^\pm$ and $B^0 \rightarrow (\chi_{c1} \gamma) K_S^0$ with significance 4.0σ including systematics.

$\psi(3823)$ DECAY MODES

Mode	Fraction (Γ_i/Γ)
Γ_1 $\chi_{c1} \gamma$	seen
Γ_2 $\chi_{c2} \gamma$	not seen

$\psi(3823)$ BRANCHING RATIOS

$\Gamma(\chi_{c1}\gamma)/\Gamma_{\text{total}}$					Γ_1/Γ
VALUE	EVTS	DOCUMENT ID	TECN	COMMENT	
seen	33 ± 10	¹ BHARDWAJ	13	BELL	$B^+ \rightarrow \chi_{c1}\gamma K^+$

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

$\Gamma(\chi_{c2}\gamma)/\Gamma_{\text{total}}$					Γ_2/Γ
VALUE		DOCUMENT ID	TECN	COMMENT	
not seen		¹ ABLIKIM	15S	BES3	$e^+e^- \rightarrow \pi^+\pi^-\chi_{c2}\gamma$
not seen		² BHARDWAJ	13	BELL	$B^+ \rightarrow \chi_{c2}\gamma K^+$

¹ From a simultaneous unbinned maximum likelihood fit of $e^+e^- \rightarrow \pi^+\pi^-\chi_{c2}\gamma$ 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 $\psi(2S) \rightarrow \chi_{c2}\gamma$ and $\psi(3823) \rightarrow \chi_{c2}\gamma$ together, with floating mass scale offset for $\psi(2S)$, $\psi(3823)$ mass floating (fixed to that above), and zero $\psi(3823)$ width.

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

$\Gamma(\chi_{c2}\gamma)/\Gamma(\chi_{c1}\gamma)$					Γ_2/Γ_1
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
<0.41	90	BHARDWAJ	13	BELL	$B^+ \rightarrow \chi_{c1/c2}\gamma K^+$

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

<0.42	90	¹ ABLIKIM	15S	BES3	$e^+e^- \rightarrow \pi^+\pi^-\chi_{c1}\gamma$
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¹ From a simultaneous unbinned maximum likelihood fit of $e^+e^- \rightarrow \pi^+\pi^-\chi_{c1(2)}\gamma$ 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 $\psi(2S) \rightarrow \chi_{c1(2)}\gamma$ and $\psi(3823) \rightarrow \chi_{c1(2)}\gamma$ together, with floating mass scale offset for $\psi(2S)$, $\psi(3823)$ mass floating (fixed to that above), and zero $\psi(3823)$ width.

 $\psi(3823)$ REFERENCES

ABLIKIM	15S	PRL 115 011803	M. Ablikim <i>et al.</i>	(BES III Collab.)
BHARDWAJ	13	PRL 111 032001	V. Bhardwaj <i>et al.</i>	(BELLE Collab.)