$\psi_2(3823)$

$I^G(J^{PC}) = 0^-(2^{--})$
I, J, P need confirmation.

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

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 $\psi_2(1^3D_2)$ $c\overline{c}$ state.

$\psi_2(3823)$ 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 $\psi_2(3823) \to \chi_{c1}\gamma$ together, with floating mass scale offset for $\psi(2S)$, floating $\psi_2(3823)$ mass, and zero $\psi_2(3823)$ width, resulting in a significance of 5.9σ 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 4.0σ including systematics. Corrected for the measured $\psi(2S)$ mass using $B \to \psi(2S)K \to (\gamma\chi_{c1})K$ decays.

$\psi_2(3823)$ 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 4.0σ including systematics.

$\psi_2(3823)$ DECAY MODES

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

$\psi_2(3823)$ BRANCHING RATIOS

$\Gamma(\chi_{c1}\gamma)/\Gamma_{total}$ Γ_1/Γ

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

[1] Reported $B(B^\pm \to \psi_2(3823)K^\pm) \times B(\psi_2(3823) \to \gamma\chi_{c1}) = (9.7 \pm 2.8 \pm 1.1) \times 10^{-6}$ 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	$e^+e^- \to \pi^+\pi^-\chi_{c2}\gamma$
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 $\psi_2(3823) \to \chi_{c2}\gamma$ together, with floating mass scale offset for $\psi(2S)$, $\psi_2(3823)$ mass floating (fixed to that above), and zero $\psi_2(3823)$ width.

[2] Reported $B(B^\pm \to \psi_2(3823)K^\pm) \times B(\psi_2(3823) \to \gamma\chi_{c2}) < 3.6 \times 10^{-6}$ 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	$B^+ \to \chi_{c1/c2}\gamma K^+$

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

<0.42	90	[1] ABLIKIM	15S	BES3	$e^+e^- \to \pi^+\pi^-\chi_{c1}\gamma$

[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 $\psi_2(3823) \to \chi_{c1(2)}\gamma$ together, with floating mass scale offset for $\psi(2S)$, $\psi_2(3823)$ mass floating (fixed to that above), and zero $\psi_2(3823)$ width.

$\psi_2(3823)$ REFERENCES

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