

$\chi_{c1}(4140)$

$$I^G(J^{PC}) = 0^+(1^{++})$$

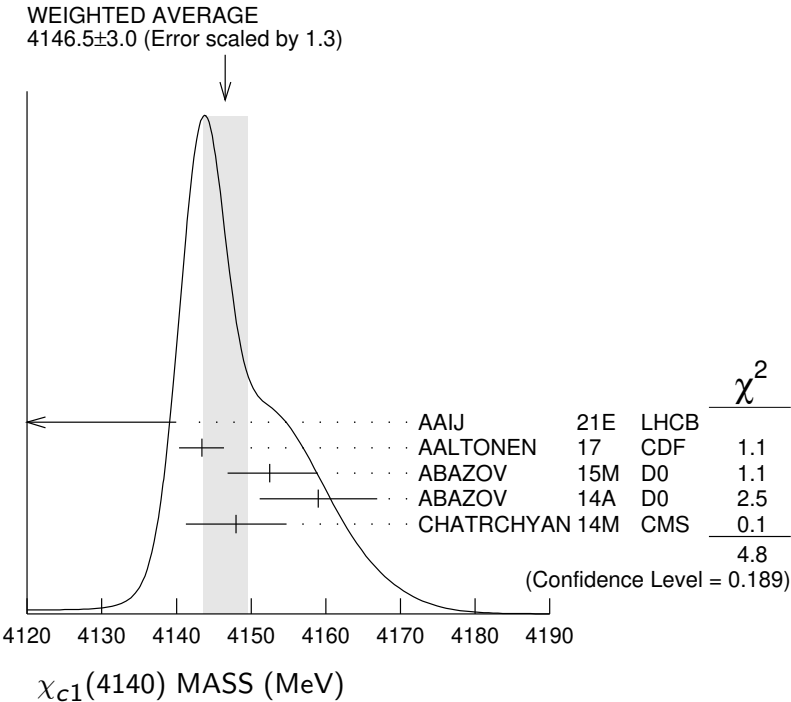
was $X(4140)$

This state shows properties different from a conventional $q\bar{q}$ state. A candidate for an exotic structure. See the review on non- $q\bar{q}$ states.

Seen by AALTONEN 09AH, ABAZOV 14A, CHATRCHYAN 14M, AAIJ 17C in $B^+ \rightarrow \chi_{c1} K^+$, $\chi_{c1} \rightarrow J/\psi \phi$, and by ABAZOV 15M separately in both prompt (4.7σ) and non-prompt (5.6σ) production in $p\bar{p} \rightarrow J/\psi \phi + \text{anything}$. Not seen by SHEN 10 in $\gamma\gamma \rightarrow J/\psi \phi$ and ABLIKIM 15 in $e^+e^- \rightarrow \gamma J/\psi \phi$ at $\sqrt{s} = 4.23, 4.26, 4.36$ GeV.

$\chi_{c1}(4140)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
4146.5± 3.0 OUR AVERAGE		Error includes scale factor of 1.3. See the ideogram below.		
4118 ±11 ⁺¹⁹ ₋₃₆	24k	1 AAIJ	21E LHCb	$B^+ \rightarrow J/\psi \phi K^+$
4143.4 ^{+2.9} _{-3.0} ± 0.6	19	2 AALTONEN	17 CDF	$B^+ \rightarrow J/\psi \phi K^+$
4152.5 ± 1.7 ^{+6.2} _{-5.4}	616	3 ABAZOV	15M D0	$p\bar{p} \rightarrow J/\psi \phi + \text{anything}$
4159.0 ± 4.3 ± 6.6	52	4 ABAZOV	14A D0	$B^+ \rightarrow J/\psi \phi K^+$
4148.0 ± 2.4 ± 6.3	0.3k	5 CHATRCHYAN 14M	CMS	$B^+ \rightarrow J/\psi \phi K^+$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
4146.5 ± 4.5 ^{+4.6} _{-2.8}	4289	6,7 AAIJ	17C LHCb	$B^+ \rightarrow J/\psi \phi K^+$
4143.0 ± 2.9 ± 1.2	14	8,9 AALTONEN	09AH CDF	$B^+ \rightarrow J/\psi \phi K^+$



¹From an amplitude analysis of the decay $B^+ \rightarrow J/\psi \phi K^+$ with a significance of 13σ .
²Statistical significance of more than 5σ .
³Statistical significance of more than 6σ .
⁴Statistical significance of 3.1σ .
⁵From a fit assuming an S -wave relativistic Breit-Wigner shape above a three-body phase-space non-resonant component with statistical significance of more than 5σ .
⁶From an amplitude analysis of the decay $B^+ \rightarrow J/\psi \phi K^+$ with a significance of 8.4σ .
⁷Superseded by AAIJ 21E.
⁸Statistical significance of 3.8σ .
⁹Superseded by AALTONEN 17.

$\chi_{c1}(4140)$ WIDTH

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
19^{+7}_{-5} OUR AVERAGE				
162 $\pm 21^{+24}_{-49}$	24k	¹ AAIJ	21E LHCb	$B^+ \rightarrow J/\psi \phi K^+$
15.3 $\pm 10.4^{+6.1}_{-2.5}$	19	² AALTONEN	17 CDF	$B^+ \rightarrow J/\psi \phi K^+$
16.3 $\pm 5.6 \pm 11.4$	616	³ ABAZOV	15M D0	$p\bar{p} \rightarrow J/\psi \phi + \text{anything}$
20 $\pm 13^{+3}_{-8}$	52	⁴ ABAZOV	14A D0	$B^+ \rightarrow J/\psi \phi K^+$
28 $\pm 15^{+11}_{-19}$	0.3k	⁵ CHATRCHYAN	14M CMS	$B^+ \rightarrow J/\psi \phi K^+$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
83 $\pm 21^{+21}_{-14}$	4289	^{6,7} AAIJ	17C LHCb	$B^+ \rightarrow J/\psi \phi K^+$
11.7 $\pm 8.3^{+5.0}_{-3.7}$	14	^{8,9} AALTONEN	09AH CDF	$B^+ \rightarrow J/\psi \phi K^+$

¹From an amplitude analysis of the decay $B^+ \rightarrow J/\psi \phi K^+$ with a significance of 13σ .
²Statistical significance of more than 5σ .
³Statistical significance of more than 6σ .
⁴Statistical significance of 3.1σ .
⁵From a fit assuming an S -wave relativistic Breit-Wigner shape above a three-body phase-space non-resonant component with statistical significance of more than 5σ .
⁶From an amplitude analysis of the decay $B^+ \rightarrow J/\psi \phi K^+$ with a significance of 8.4σ .
⁷Superseded by AAIJ 21E.
⁸Statistical significance of 3.8σ .
⁹Superseded by AALTONEN 17.

$\chi_{c1}(4140)$ DECAY MODES

Mode	Fraction (Γ_i/Γ)
Γ_1 $J/\psi \phi$	seen
Γ_2 $\gamma\gamma$	not seen

$\chi_{c1}(4140) \Gamma(i) \Gamma(\gamma\gamma) / \Gamma(\text{total})$ $\Gamma(\gamma\gamma) \times \Gamma(J/\psi\phi) / \Gamma_{\text{total}}$ $\Gamma_2 \Gamma_1 / \Gamma$

VALUE (eV)	CL%	DOCUMENT ID	TECN	COMMENT
<41	90	¹ SHEN	10	BELL 10.6 $e^+e^- \rightarrow e^+e^- J/\psi\phi$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
< 6	90	² SHEN	10	BELL 10.6 $e^+e^- \rightarrow e^+e^- J/\psi\phi$
¹ For $J^P = 0^+$.				
² For $J^P = 2^+$.				

 $\chi_{c1}(4140)$ BRANCHING RATIOS $\Gamma(J/\psi\phi) / \Gamma_{\text{total}}$ Γ_1 / Γ

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
seen	24k	¹ AAIJ	21E	LHCB $B^+ \rightarrow J/\psi\phi K^+$
seen	616	² ABAZOV	15M	D0 $p\bar{p} \rightarrow J/\psi\phi + \text{anything}$
seen	52	³ ABAZOV	14A	D0 $B^+ \rightarrow J/\psi\phi K^+$
seen	0.3k	⁴ CHATRCHYAN	14M	CMS $B^+ \rightarrow J/\psi\phi K^+$
seen	14	⁵ AALTONEN	09AH	CDF $B^+ \rightarrow J/\psi\phi K^+$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
seen	4289	^{6,7} AAIJ	17C	LHCB $B^+ \rightarrow J/\psi\phi K^+$
not seen		⁸ ABLIKIM	15	BES3 $e^+e^- \rightarrow \gamma\phi J/\psi$
not seen		⁹ AAIJ	12AA	LHCB $p\bar{p} \rightarrow B^+ X$ at 7 TeV

¹ From an amplitude analysis of the decay $B^+ \rightarrow J/\psi\phi K^+$ with a significance of 13 σ .² Statistical significance of more than 6 σ .³ ABAZOV 14A reports $B(B^+ \rightarrow \chi_{c1}(4140) K^+ \rightarrow J/\psi\phi K^+) / B(B^+ \rightarrow J/\psi\phi K^+) = (19 \pm 7 \pm 4)\%$ with 3.1 σ significance.⁴ From a fit assuming an S-wave relativistic Breit-Wigner shape above a three-body phase-space non-resonant component with statistical significance of more than 5 σ .⁵ Statistical significance of 3.8 σ .⁶ From an amplitude analysis of the decay $B^+ \rightarrow J/\psi\phi K^+$ with a significance of 8.4 σ .⁷ Superseded by AAIJ 21E.⁸ Reported $\sigma(e^+e^- \rightarrow \gamma\chi_{c1}(4140)) \cdot B(\chi_{c1}(4140) \rightarrow J/\psi\phi) < 0.35, 0.28, \text{ and } 0.33$ pb at 4.23, 4.26, and 4.36 GeV, respectively, at 90% CL.⁹ Reported $B(B^+ \rightarrow \chi_{c1}(4140) K^+) \cdot B(\chi_{c1}(4140) \rightarrow J/\psi\phi) / B(B^+ \rightarrow J/\psi\phi K^+) < 0.07$ at 90% CL. $\Gamma(\gamma\gamma) / \Gamma_{\text{total}}$ Γ_2 / Γ

VALUE	DOCUMENT ID	TECN	COMMENT
not seen	SHEN	10	BELL 10.6 $e^+e^- \rightarrow e^+e^- J/\psi\phi$

 $\chi_{c1}(4140)$ REFERENCES

AAIJ	21E	PRL 127 082001	R. Aaij <i>et al.</i>	(LHCb Collab.)
AAIJ	17C	PRL 118 022003	R. Aaij <i>et al.</i>	(LHCb Collab.) JP
Also		PR D95 012002	R. Aaij <i>et al.</i>	(LHCb Collab.)
AALTONEN	17	MPL A32 1750139	T. Altonen <i>et al.</i>	(CDF Collab.)
ABAZOV	15M	PRL 115 232001	V.M. Abazov <i>et al.</i>	(D0 Collab.)
ABLIKIM	15	PR D91 032002	M. Ablikim <i>et al.</i>	(BESIII Collab.)
ABAZOV	14A	PR D89 012004	V.M. Abazov <i>et al.</i>	(D0 Collab.)
CHATRCHYAN	14M	PL B734 261	S. Chatrchyan <i>et al.</i>	(CMS Collab.)
AAIJ	12AA	PR D85 091103	R. Aaij <i>et al.</i>	(LHCb Collab.)
SHEN	10	PRL 104 112004	C.P. Shen <i>et al.</i>	(BELLE Collab.)
AALTONEN	09AH	PRL 102 242002	T. Aaltonen <i>et al.</i>	(CDF Collab.)