

$\chi_{c1}(4140)$

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

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 $^{+2.9}_{-3.0} \pm 0.6$	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	$B^+ \rightarrow J/\psi\phi K^+$

¹ From an amplitude analysis of the decay $B^+ \rightarrow J/\psi\phi K^+$ with a significance of 13σ .

² Statistical significance of more than 5σ .

³ Statistical significance of more than 6σ .

⁴ Statistical significance of 3.1σ .

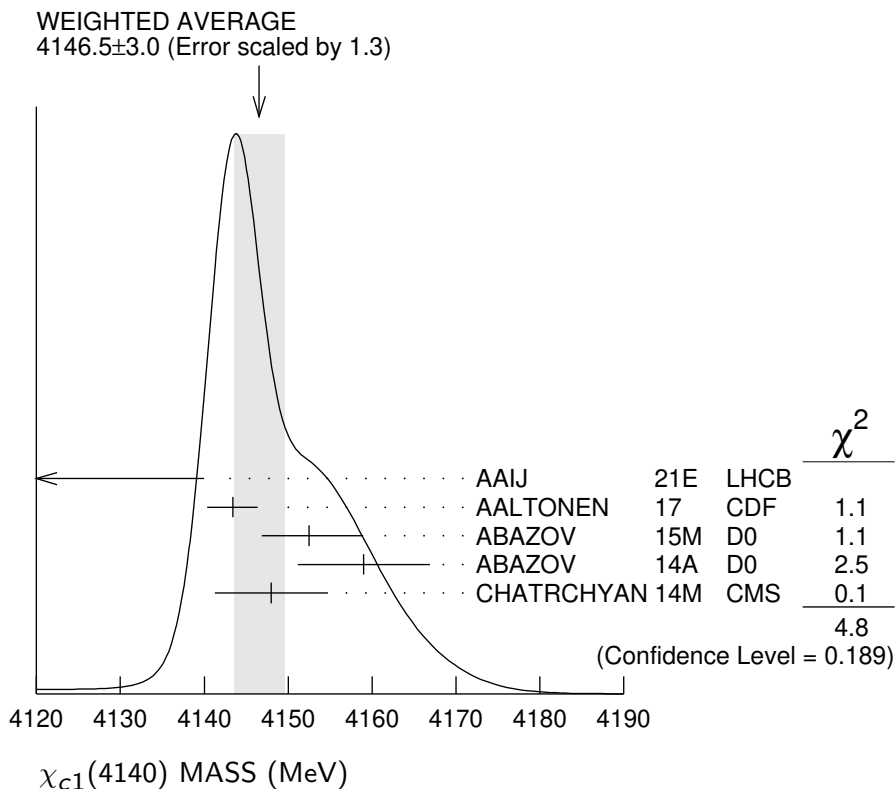
⁵ From a fit assuming an S -wave relativistic Breit-Wigner shape above a three-body phase-space non-resonant component with statistical significance of more than 5σ .

⁶ From an amplitude analysis of the decay $B^+ \rightarrow J/\psi\phi K^+$ with a significance of 8.4σ .

⁷ Superseded by AAIJ 21E.

⁸ Statistical significance of 3.8σ .

⁹ Superseded by AALTONEN 17.



$\chi_{c1}(4140)$ WIDTH

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
19 \pm 7 $\frac{7}{5}$ OUR AVERAGE				
162 \pm 21 $\frac{+24}{-49}$	24k	1 AAIJ	21E LHCb	$B^+ \rightarrow J/\psi \phi K^+$
15.3 \pm 10.4 $\frac{+10.4}{6.1} \pm 2.5$	19	2 AALTONEN	17 CDF	$B^+ \rightarrow J/\psi \phi K^+$
16.3 \pm 5.6 ± 11.4	616	3 ABAZOV	15M D0	$\rho \bar{p} \rightarrow J/\psi \phi + \text{anything}$
20 \pm 13 $\frac{+3}{-8}$	52	4 ABAZOV	14A D0	$B^+ \rightarrow J/\psi \phi K^+$
28 $\frac{+15}{-11} \pm 19$	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 $\frac{+21}{-14}$	4289	6,7 AAIJ	17C LHCb	$B^+ \rightarrow J/\psi \phi K^+$
11.7 $\frac{+8.3}{5.0} \pm 3.7$	14	8,9 AALTONEN	09AH CDF	$B^+ \rightarrow J/\psi \phi K^+$

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 5 σ .

³ Statistical significance of more than 6 σ .

⁴ Statistical significance of 3.1 σ .

⁵ 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 .

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 Statistical significance of 3.8 σ .

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	$pp \rightarrow B^+ X$ 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.)
