

$\chi_{c1}(4140)$

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

was $X(4140)$

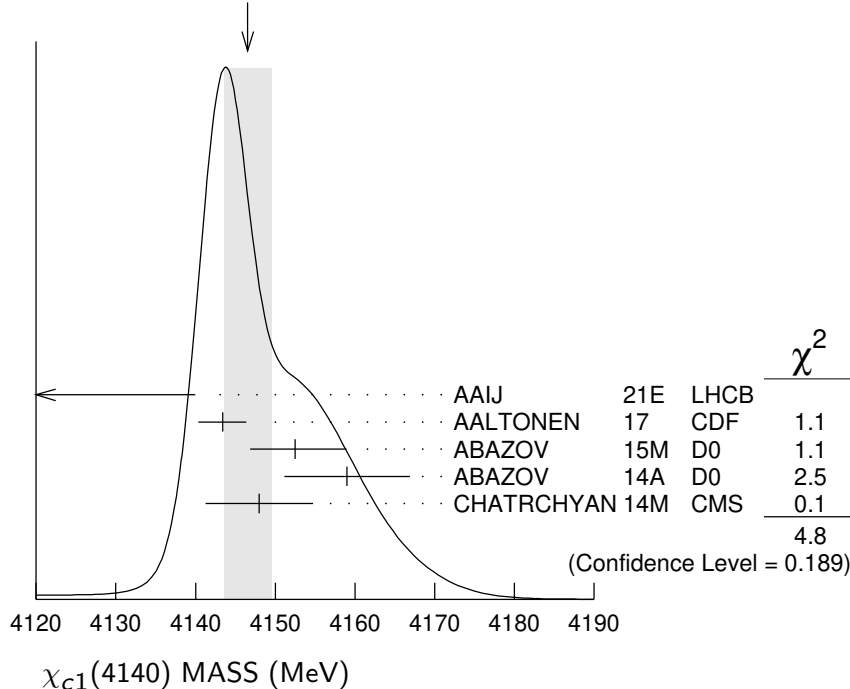
This state shows properties different from a conventional $q\bar{q}$ state. A candidate for an exotic structure. See the review on non- $q\bar{q}$ states.

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 $\sqrt{s} = 4.23, 4.26, 4.36 \text{ GeV}$.

$\chi_{c1}(4140)$ 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	$B^+ \rightarrow J/\psi \phi K^+$

WEIGHTED AVERAGE
4146.5±3.0 (Error scaled by 1.3)



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⁷ Superseded by AAIJ 21E.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⁹ Superseded by AALTONEN 17.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
$19 \pm \frac{7}{5}$				OUR AVERAGE
162 ± 21 $^{+24}_{-49}$	24k	¹ AAIJ	21E LHCB	$B^+ \rightarrow J/\psi\phi K^+$
15.3 ± 2.5 $^{+10.4}_{-6.1}$	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 ± 13 $^{+3}_{-8}$	52	⁴ ABAZOV	14A D0	$B^+ \rightarrow J/\psi\phi K^+$
28 ± 15 $^{+15}_{-11}$ ± 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 ± 21 $^{+21}_{-14}$	4289	^{6,7} AAIJ	17C LHCB	$B^+ \rightarrow J/\psi\phi K^+$
11.7 ± 3.7 $^{+8.3}_{-5.0}$	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.

$\chi_{c1}(4140)$ 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.)