

$\chi_{c1}(4140)$

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

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.

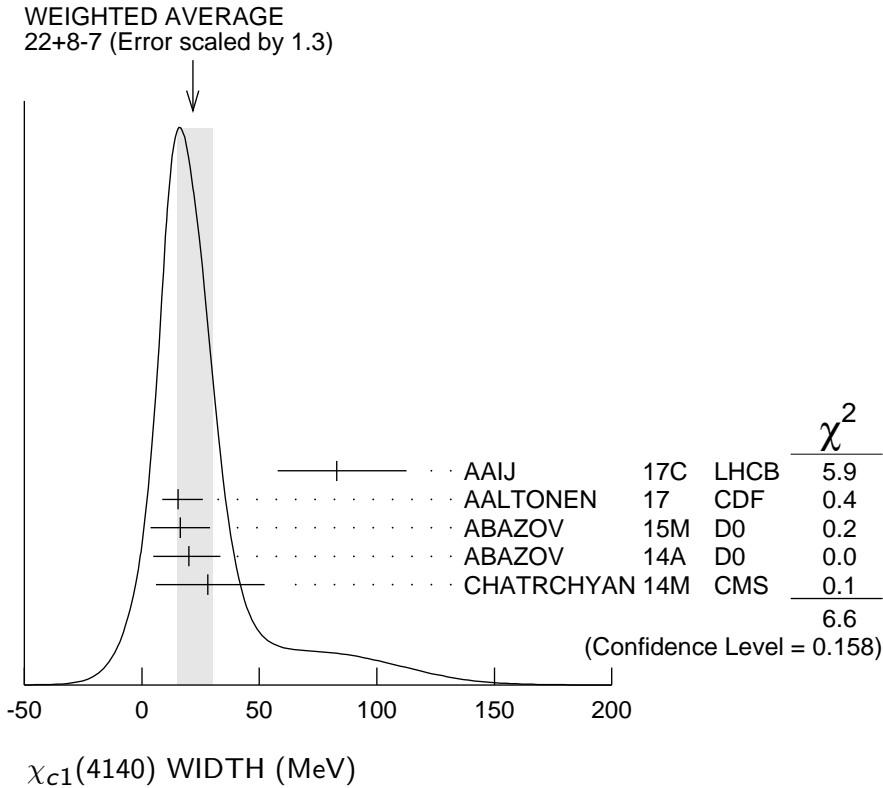
 $\chi_{c1}(4140)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
4146.8 ± 2.4 OUR AVERAGE		Error includes scale factor of 1.1.		
$4146.5 \pm 4.5^{+4.6}_{-2.8}$	4289	¹ AAIJ	17C LHCb	$B^+ \rightarrow J/\psi\phi K^+$
$4143.4^{+2.9}_{-3.0} \pm 0.6$	19	² AALTONEN	17 CDF	$B^+ \rightarrow J/\psi\phi K^+$
$4152.5 \pm 1.7^{+6.2}_{-5.4}$	616	³ ABAZOV	15M D0	$p\bar{p} \rightarrow J/\psi\phi + \text{anything}$
$4159.0 \pm 4.3 \pm 6.6$	52	⁴ ABAZOV	14A D0	$B^+ \rightarrow J/\psi\phi K^+$
$4148.0 \pm 2.4 \pm 6.3$	0.3k	⁵ CHATRCHYAN 14M	CMS	$B^+ \rightarrow J/\psi\phi K^+$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
$4143.0 \pm 2.9 \pm 1.2$	14	^{6,7} 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 8.4σ .				
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 Statistical significance of 3.8σ .				
⁷ Superseded by AALTONEN 17.				

 $\chi_{c1}(4140)$ WIDTH

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
22^{+8}_{-7} OUR AVERAGE		Error includes scale factor of 1.3. See the ideogram below.		
$83 \pm 21^{+21}_{-14}$	4289	¹ AAIJ	17C LHCb	$B^+ \rightarrow J/\psi\phi K^+$
$15.3^{+10.4}_{-6.1} \pm 2.5$	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	$B^+ \rightarrow J/\psi\phi K^+$
$28^{+15}_{-11} \pm 19$	0.3k	⁵ CHATRCHYAN 14M	CMS	$B^+ \rightarrow J/\psi\phi K^+$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
$11.7^{+8.3}_{-5.0} \pm 3.7$	14	^{6,7} 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 8.4σ .
- 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 Statistical significance of 3.8σ .
- ⁷ 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	4289	¹ AAIJ	17C 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. • • •					
not seen		⁶ ABLIKIM	15 BES3	$e^+e^- \rightarrow \gamma\phi J/\psi$	
not seen		⁷ 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 8.4σ .

² Statistical significance of more than 6σ .

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 3.1σ 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 5σ .

⁵ Statistical significance of 3.8σ .

⁶ Reported $\sigma(e^+e^- \rightarrow \gamma\chi_{c1}(4140)) \cdot B(\chi_{c1}(4140) \rightarrow J/\psi\phi) < 0.35, 0.28,$ and 0.33 pb at 4.23, 4.26, and 4.36 GeV, respectively, at 90% CL.

⁷ 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	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>	(BES III 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.)