

$\chi_{c1}(4140)$

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

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.

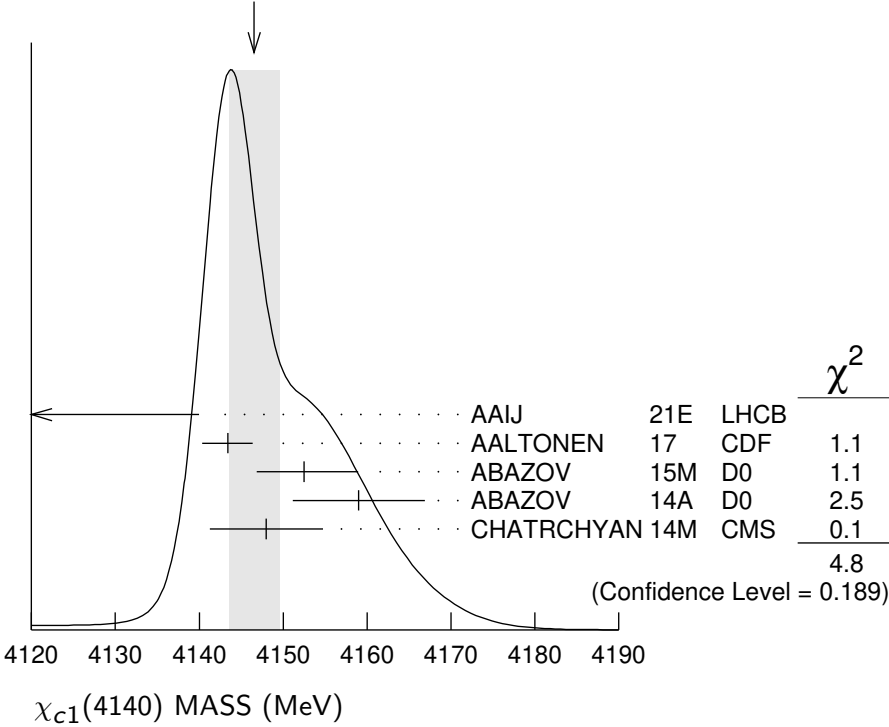
Seen by AALTONEN 09AH, ABAZOV 14A, CHATRCHYAN 14M, AAIJ 17C in $B^+ \rightarrow \chi_{c1} K^+$, $\chi_{c1} \rightarrow J/\psi \phi$, and by ABAZOV 15M separately in both prompt (4.7σ) and non-prompt (5.6σ) production in $p\bar{p} \rightarrow J/\psi \phi + \text{anything}$. Not seen by SHEN 10 in $\gamma\gamma \rightarrow J/\psi \phi$ 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$\pm$ 3.0 OUR AVERAGE		Error includes scale factor of 1.3. See the ideogram below.		
4118 $\pm$ 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 $\pm 1.7^{+6.2}_{-5.4}$	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. ● ● ●				
4146.5 $\pm 4.5^{+4.6}_{-2.8}$	4289	^{6,7} AAIJ	17C LHCb	$B^+ \rightarrow J/\psi \phi K^+$
4143.0 $\pm 2.9 \pm 1.2$	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⁷ Superseded by AAIJ 21E.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⁹ Superseded by AALTONEN 17.

WEIGHTED AVERAGE
4146.5±3.0 (Error scaled by 1.3)



$\chi_{c1}(4140)$ WIDTH

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
19 ± 7 - 5				OUR AVERAGE
162 ± 21 ± 24 - 49	24k	¹ AAIJ	21E LHCB	$B^+ \rightarrow J/\psi \phi K^+$
15.3 ± 10.4 - 6.1 ± 2.5	19	² AALTONEN	17 CDF	$B^+ \rightarrow J/\psi \phi K^+$
16.3 ± 5.6 ± 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 - 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 ± 8.3 - 5.0 ± 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 . 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	$pp \rightarrow B^+ X \text{ at } 7 \text{ TeV}$

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 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 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 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
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
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.)
