$\chi_{c1}(4140)$

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

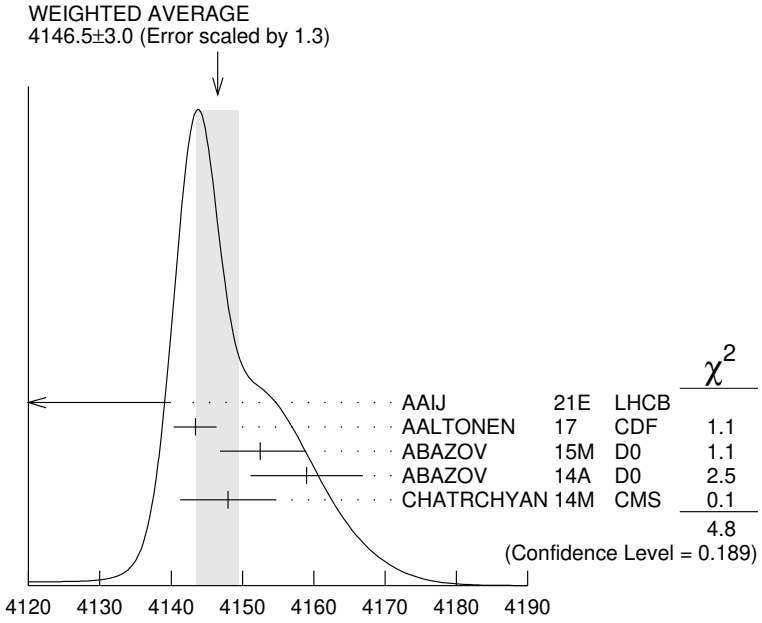
was $X(4140)$

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

Seen by AALTONEN 09AH, ABAZOV 14A, CHATRCHYAN 14M, AAIJ 17C in $B^+ \to \chi_{c1} K^+$, $\chi_{c1} \to J/\psi\phi$, and by ABAZOV 15M separately in both prompt (4.7 σ) and non-prompt (5.6 σ) production in $p\overline{p} \to J/\psi\phi +$ anything. Not seen by SHEN 10 in $\gamma\gamma \to J/\psi\phi$ and ABLIKIM 15 in $e^+e^- \to \gamma J/\psi\phi$ 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.			
$4118 \pm 11 \ ^{+19}_{-36}$	24k	[1] AAIJ	21E	LHCB	$B^+ \to J/\psi\phi K^+$
$4143.4^{+\ 2.9}_{-\ 3.0} \pm 0.6$	19	[2] AALTONEN	17	CDF	$B^+ \to J/\psi\phi K^+$
$4152.5 \pm 1.7^{+\ 6.2}_{-\ 5.4}$	616	[3] ABAZOV	15M	D0	$p\overline{p} \to J/\psi\phi +$ anything
$4159.0 \pm 4.3 \pm 6.6$	52	[4] ABAZOV	14A	D0	$B^+ \to J/\psi\phi K^+$
$4148.0 \pm 2.4 \pm 6.3$	0.3k	[5] CHATRCHYAN	14M	CMS	$B^+ \to J/\psi\phi K^+$
• • • 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	$B^+ \to J/\psi\phi K^+$
$4143.0 \pm 2.9 \pm 1.2$	14	[8,9] AALTONEN	09AH	CDF	$B^+ \to J/\psi\phi K^+$



[1] From an amplitude analysis of the decay $B^+ \to J/\psi\phi K^+$ 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 $B^+ \to J/\psi\phi K^+$ with a significance of 8.4 σ.
[7] Superseded by AAIJ 21E.
[8] Statistical significance of 3.8 σ.
[9] Superseded by AALTONEN 17.

$\chi_{c1}(4140)$ WIDTH

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

[1] From an amplitude analysis of the decay $B^+ \to J/\psi\phi K^+$ 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 $B^+ \to J/\psi\phi K^+$ 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

$\chi_{c1}(4140)$ Γ(i)Γ(γγ)/Γ(total)

$\Gamma(\gamma\gamma) \times \Gamma(J/\psi\phi)/\Gamma_{total}$ $\Gamma_2\Gamma_1/\Gamma$

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

[1] For $J^P = 0^+$.
[2] For $J^P = 2^+$.

$\chi_{c1}(4140)$ BRANCHING RATIOS

$\Gamma(J/\psi\phi)/\Gamma_{total}$ Γ_1/Γ

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

[1] From an amplitude analysis of the decay $B^+ \to J/\psi\phi K^+$ with a significance of 13 σ.
[2] Statistical significance of more than 6 σ.
[3] ABAZOV 14A reports $B(B^+ \to \chi_{c1}(4140)K^+ \to J/\psi\phi K^+)/B(B^+ \to J/\psi\phi K^+) = (19 \pm 7 \pm 4)\%$ with 3.1 σ signficance.
[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 $B^+ \to J/\psi\phi K^+$ with a significance of 8.4 σ.
[7] Superseded by AAIJ 21E.
[8] Reported $\sigma(e^+e^- \to \gamma\chi_{c1}(4140))\cdot B(\chi_{c1}(4140) \to J/\psi\phi) < 0.35$, 0.28, and 0.33 pb at 4.23, 4.26, and 4.36 GeV, respectively, at 90% CL.
[9] Reported $B(B^+ \to \chi_{c1}(4140)K^+)\cdot B(\chi_{c1}(4140) \to J/\psi\phi)/B(B^+ \to J/\psi\phi K^+) < 0.07$ at 90% CL.

$\Gamma(\gamma\gamma)/\Gamma_{total}$ Γ_2/Γ

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

$\chi_{c1}(4140)$ REFERENCES

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