$\chi_{c0}(3915)$

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

was $X(3915)$

The $\chi_{c0}(3915)$ was originally seen by BELLE in its $\omega J/\psi$ decay mode and was produced in both B decays in CHOI 05 and $\gamma\gamma$ collisions in UEHARA 10. The J^{PC} was determined to be 0^{++} by BABAR in LEES 12AD but this assignment was questioned by ZHOU 15C. In AAIJ 20AI LHCb found the $D^+ D^-$ decay mode of the $\chi_{c0}(3915)$ using B decays and determined its J^{PC} to be 0^{++}. Based on their compatible mass, width, and J^{PC}, we assume the state decaying to $\omega J/\psi$ and the state decaying to $D^+ D^-$ are both the $\chi_{c0}(3915)$. See also the $\chi_{c2}(3930)$.

$\chi_{c0}(3915)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
3922.1± 1.8 OUR AVERAGE		Error includes scale factor of 1.5. See the ideogram below.			
3956 ± 5 ±10	360	[1] AAIJ	23AA	LHCB	$B^+ \rightarrow D_s^+ D_s^- K^+$
3923.8± 1.5± 0.4	1.2k	[2] AAIJ	20AI	LHCB	$B^+ \rightarrow D^+ D^- K^+$
3919.4± 2.2± 1.6	59 ± 10	LEES	12AD	BABR	$e^+ e^- \rightarrow e^+ e^- \omega J/\psi$
$3919.1^{+3.8}_{-3.4}\pm 2.0$		DEL-AMO-SA...	10B	BABR	$B \rightarrow \omega J/\psi K$
3915 ± 3 ± 2	49 ± 15	UEHARA	10	BELL	10.6 $e^+ e^- \rightarrow e^+ e^- \omega J/\psi$
3943 ±11 ±13	58 ± 11	[3] CHOI	05	BELL	$B \rightarrow \omega J/\psi K$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3922.4± 6.5± 2.0		[4] WANG	22A	BELL	$\gamma\gamma \rightarrow \gamma\psi(2S)$
3926.4± 2.2± 1.2		[5] ABLIKIM	19V	BES	$e^+ e^- \rightarrow \gamma\omega J/\psi$
$3914.6^{+3.8}_{-3.4}\pm 2.0$		[3] AUBERT	08W	BABR	Superseded by DEL-AMO-SANCHEZ 10B

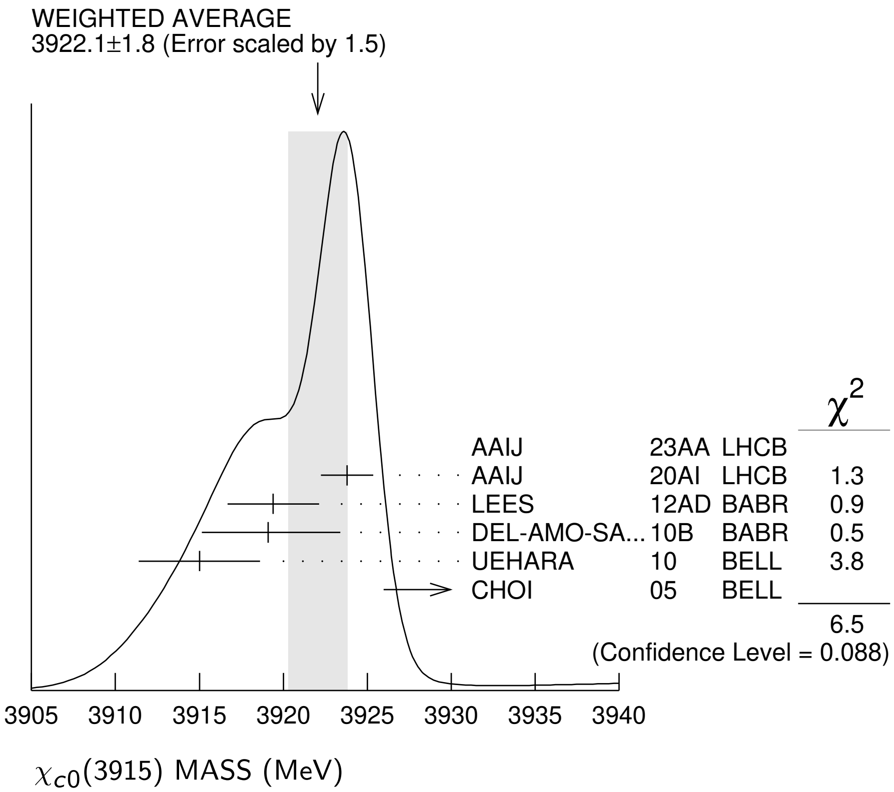
[1] $D_s^+ D_s^-$ near-threshold enhancement parameterized with a Flatte-like function .

[2] Obtained from the full amplitude analysis. Parameterized with the relativistic Breit-Wigner line shape.

[3] $\omega J/\psi$ threshold enhancement fitted as an S-wave Breit-Wigner resonance.

[4] Not distinguished from the $\chi_{c2}(3930)$.

[5] Could also be $X(3940)$. Significance 3.1σ. Fit with additional resonance at 3963.7 ± 5.7 MeV, significance 3.4σ.



$\chi_{c0}(3915)$ WIDTH

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
20 ± 4 OUR AVERAGE		Error includes scale factor of 1.1.			
43 ±13 ± 8	360	[1] AAIJ	23AA	LHCB	$B^+ \rightarrow D_s^+ D_s^- K^+$
17.4± 5.1± 0.8	1.2k	[2] AAIJ	20AI	LHCB	$B^+ \rightarrow D^+ D^- K^+$
13 ± 6 ± 3	59	LEES	12AD	BABR	$e^+ e^- \rightarrow e^+ e^- \omega J/\psi$
31 $^{+10}_{-\ 8}$ ± 5		DEL-AMO-SA...	10B	BABR	$B \rightarrow \omega J/\psi K$
17 ±10 ± 3	49	UEHARA	10	BELL	10.6 $e^+ e^- \rightarrow e^+ e^- \omega J/\psi$
87 ±22 ±26	58	[3] CHOI	05	BELL	$B \rightarrow \omega J/\psi K$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
22 ±17 ± 4		[4] WANG	22A	BELL	$\gamma\gamma \rightarrow \gamma\psi(2S)$
3.8± 7.5± 2.6		[5] ABLIKIM	19V	BES	$e^+ e^- \rightarrow \gamma\omega J/\psi$
34 $^{+12}_{-\ 8}$ ± 5		[3] AUBERT	08W	BABR	Superseded by DEL-AMO-SANCHEZ 10B

[1] $D_s^+ D_s^-$ near-threshold enhancement parameterized with a Flatte-like function .

[2] Obtained from the full amplitude analysis. Parameterized with the relativistic Breit-Wigner line shape.

[3] $\omega J/\psi$ threshold enhancement fitted as an S-wave Breit-Wigner resonance.

[4] Not distinguished from the $\chi_{c2}(3930)$.

[5] Could also be $X(3940)$. Significance 3.1σ. Fit with additional resonance at 3963.7 ± 5.7 MeV, significance 3.4σ.

$\chi_{c0}(3915)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$\omega J/\psi$	seen
Γ_2	$\overline{D}^{*0} D^0$	not seen
Γ_3	$D^+ D^-$	seen
Γ_4	$D_s^+ D_s^-$	seen
Γ_5	$\pi^+ \pi^- \eta_c(1S)$	not seen
Γ_6	$\eta_c \eta$	not seen
Γ_7	$\eta_c \pi^0$	not seen
Γ_8	$K \overline{K}$	not seen
Γ_9	$\gamma\gamma$	seen
Γ_{10}	$\gamma \psi(2S)$	not seen
Γ_{11}	$\pi^0 \chi_{c1}$	not seen

$\chi_{c0}(3915)$ $\Gamma(i)\Gamma(\gamma\gamma)/\Gamma(\text{total})$

$\Gamma(\omega J/\psi) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ — $\Gamma_1\Gamma_9/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
54± 9 OUR AVERAGE					
52±10±3	59 ± 10	[1] LEES	12AD	BABR	$e^+ e^- \to e^+ e^- \omega J/\psi$
61±17±8	49 ± 15	[1] UEHARA	10	BELL	10.6 $e^+ e^- \to e^+ e^- \omega J/\psi$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
18± 5±2	49 ± 15	[2] UEHARA	10	BELL	10.6 $e^+ e^- \to e^+ e^- \omega J/\psi$

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

$\Gamma(\gamma\psi(2S)) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ — $\Gamma_{10}\Gamma_9/\Gamma$

VALUE (eV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
9.8±3.6±1.3	[1] WANG	22A	BELL	$\gamma\gamma \to \gamma\psi(2S)$

[1] Not distinguished from the $\chi_{c2}(3930)$.

$\Gamma(\pi^+\pi^-\eta_c(1S)) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ — $\Gamma_5\Gamma_9/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID		TECN	COMMENT
<16	90	LEES	12AE	BABR	$e^+ e^- \to e^+ e^- \pi^+ \pi^- \eta_c$

$\Gamma(K\overline{K}) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ — $\Gamma_8\Gamma_9/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID		TECN	COMMENT
<1.96	90	UEHARA	13	BELL	$\gamma\gamma \to K_S^0 K_S^0$

$\chi_{c0}(3915)$ BRANCHING RATIOS

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

VALUE	DOCUMENT ID		TECN	COMMENT
seen	[1] DEL-AMO-SA..	10B	BABR	$B \to \omega J/\psi K$
seen	[2] CHOI	05	BELL	$B \to \omega J/\psi K$

[1] DEL-AMO-SANCHEZ 10B reports $B(B^{\pm} \to \chi_{c0}(3915) K^{\pm}) \times B(\chi_{c0}(3915) \to J/\psi\omega) = (3.0^{+0.7}_{-0.6}{}^{+0.5}_{-0.3}) \times 10^{-5}$ and $B(B^0 \to \chi_{c0}(3915) K^0) \times B(\chi_{c0}(3915) \to J/\psi\omega) = (2.1 \pm 0.9 \pm 0.3) \times 10^{-5}$.

[2] CHOI 05 reports $B(B \to \chi_{c0}(3915) K) \times B(\chi_{c0}(3915) \to J/\psi\omega) = (7.1 \pm 1.3 \pm 3.1) \times 10^{-5}$.

$\Gamma(\omega J/\psi)/\Gamma(\overline{D}^{*0} D^0)$ — Γ_1/Γ_2

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
>0.71	90	[1] AUSHEV	10	BELL	$B \to \overline{D}^{*0} D^0 K$

[1] By combining the upper limit $B(B \to \chi_{c0}(3915) K) \times B(\chi_{c0}(3915) \to D^{*0} \overline{D}^0) < 0.67 \times 10^{-4}$ from AUSHEV 10 with the average of CHOI 05 and AUBERT 08W measurements $B(B \to \chi_{c0}(3915) K) \times B(\chi_{c0}(3915) \to \omega J/\psi) = (0.51 \pm 0.11) \times 10^{-4}$.

$\Gamma(D^+ D^-)/\Gamma_{total}$ — Γ_3/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
seen	AAIJ	20AI	LHCB	$B^+ \to D^+ D^- K^+$

$\Gamma(D^+ D^-)/\Gamma(D_s^+ D_s^-)$ — Γ_3/Γ_4

VALUE	DOCUMENT ID		TECN	COMMENT
0.29±0.09±0.10±0.08	[1] AAIJ	23AA	LHCB	$B^+ \to D_s^+ D_s^- K^+$

[1] Assuming that AAIJ 20AI reporting on $B^+ \to D^+ D^- K^+$ also refers to $\chi_{c0}(3915)$. The last uncertainty is due to the values of $B(D^+ \to K^- \pi^+ \pi^+)$ and $B(D_s^+ \to K^- K^+ \pi^+)$ from PDG 22.

$\Gamma(\eta_c \eta)/\Gamma_{total}$ — Γ_6/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
not seen	90	[1] VINOKUROVA	15	BELL	$B^+ \to K^+ \eta_c \eta$

[1] VINOKUROVA 15 reports $B(B^+ \to K^+ \chi_{c0}(3915)) \times B(\chi_{c0}(3915) \to \eta_c \eta) < 4.7 \times 10^{-5}$ at 90% CL.

$\Gamma(\eta_c \pi^0)/\Gamma_{total}$ — Γ_7/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
not seen	90	[1] VINOKUROVA	15	BELL	$B^+ \to K^+ \eta_c \pi^0$

[1] VINOKUROVA 15 reports $B(B^+ \to K^+ \chi_{c0}(3915)^0) \times B(\chi_{c0}(3915) \to \eta_c \pi^0) < 1.7 \times 10^{-5}$ at 90% CL.

$\Gamma(\gamma\gamma)/\Gamma_{total}$ — Γ_9/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
seen	59 ± 10	LEES	12AD	BABR	$e^+ e^- \to e^+ e^- \omega J/\psi$
seen		UEHARA	10	BELL	10.6 $e^+ e^- \to e^+ e^- \omega J/\psi$

$\Gamma(\pi^0 \chi_{c1})/\Gamma_{\text{total}}$ Γ_{11}/Γ

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
not seen	42 ± 14	[1] BHARDWAJ	19	BELL	$B^{\pm} \to \chi_{c1} \pi^0 K^{\pm}$

[1] BHARDWAJ 19 reports $B(B^+ \to K^+ \chi_{c0}(3915)) \times B(\chi_{c0}(3915) \to \chi_{c1} \pi^0) < 3.8 \times 10^{-5}$ at 90% CL. A signal significance 2.3 standard deviations.

$\chi_{c0}(3915)$ REFERENCES

AAIJ	23AA	PRL 131 071901	R. Aaij *et al.*	(LHCb Collab.)
PDG	22	PTEP 2022 083C01	R.L. Workman *et al.*	(PDG Collab.)
WANG	22A	PR D105 112011	X.L. Wang *et al.*	(BELLE Collab.)
AAIJ	20AI	PR D102 112003	R. Aaij *et al.*	(LHCb Collab.) JPC
ABLIKIM	19V	PRL 122 232002	M. Ablikim *et al.*	(BESIII Collab.)
BHARDWAJ	19	PR D99 111101	V. Bhardwaj *et al.*	(BELLE Collab.)
VINOKUROVA	15	JHEP 1506 132	A. Vinokurova *et al.*	(BELLE Collab.)
Also		JHEP 1702 088 (errat.)	A. Vinokurava *et al.*	(BELLE Collab.)
ZHOU	15C	PRL 115 022001	Z.-Y. Zhou, Z. Xiao, H.-Q. Zhou	(BEIJT, NANJ)
UEHARA	13	PTEP 2013 123C01	S. Uehara *et al.*	(BELLE Collab.)
LEES	12AD	PR D86 072002	J.P. Lees *et al.*	(BABAR Collab.)
LEES	12AE	PR D86 092005	J.P. Lees *et al.*	(BABAR Collab.)
AUSHEV	10	PR D81 031103	T. Aushev *et al.*	(BELLE Collab.)
DEL-AMO-SA...	10B	PR D82 011101	P. del Amo Sanchez *et al.*	(BABAR Collab.)
UEHARA	10	PRL 104 092001	S. Uehara *et al.*	(BELLE Collab.)
AUBERT	08W	PRL 101 082001	B. Aubert *et al.*	(BABAR Collab.)
CHOI	05	PRL 94 182002	S.-K. Choi *et al.*	(BELLE Collab.)