$Z_c(3900)$

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

was $X(3900)$

Properties incompatible with a $q\overline{q}$ structure (exotic state). See the review on non-$q\overline{q}$ states.

Charged $Z_c(3900)$ seen as a peak in the invariant mass distribution of the $J/\psi\pi^\pm$ system by BES III (ABLIKIM 13T) in $e^+e^- \to \pi^+\pi^- J/\psi$ at c.m. energy of 4.26 GeV and by radiative return from e^+e^- collisions at $\sqrt{s}$ from 9.46 to 10.86 GeV at Belle (LIU 13B). Partial wave analysis of ABLIKIM 17J determines $J^P = 1^+$ with more than $7\,\sigma$ significance. Neutral $Z_c(3900)$ seen in the $J/\psi\pi^0$ invariant mass distribution in $e^+e^- \to \pi^0\pi^0 J/\psi$ at c.m. energies of 4.23, 4.26, and 4.36 GeV by BES III (ABLIKIM 15U) and at 4.17 GeV by XIAO 13A. Peaks in $(D\overline{D}^*)^{0,\pm}$ reported by BES III (ABLIKIM 14A, ABLIKIM 15AB) are assumed to be related.

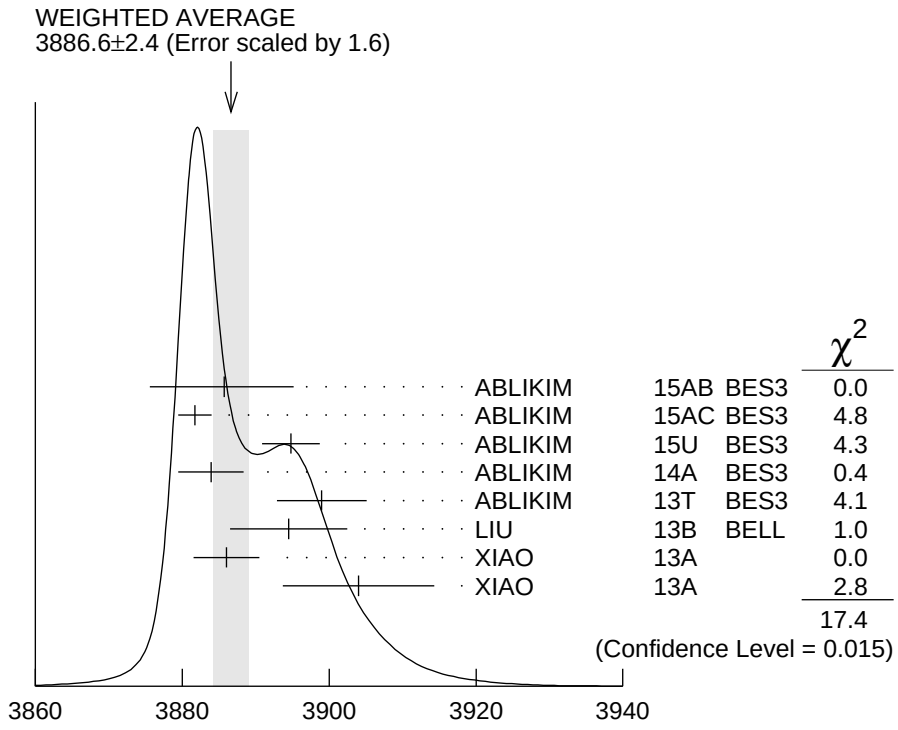
$Z_c(3900)$ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*CHG*	*COMMENT*
3886.6±2.4 OUR AVERAGE		Error includes scale factor of 1.6. See the ideogram below.				
$3885.7^{+4.3}_{-5.7}\pm 8.4$		[1] ABLIKIM	15AB	BES3	0	$e^+e^- \to \pi^0(D\overline{D}^*)^0$
3881.7±1.6± 1.6	1.2k	[1] ABLIKIM	15AC	BES3	±	$e^+e^- \to \pi^\pm(D\overline{D}^*)^\mp$
3894.8±2.3± 3.2	356	[1] ABLIKIM	15U	BES3	0	$e^+e^- \to \pi^0\pi^0 J/\psi$
3883.9±1.5± 4.2	1.2k	[1] ABLIKIM	14A	BES3	±	$e^+e^- \to \pi^\pm (D\overline{D}^*)^\mp$
3899.0±3.6± 4.9	307	[1] ABLIKIM	13T	BES3	±	$e^+e^- \to \pi^+\pi^- J/\psi$
3894.5±6.6± 4.5	159	[1] LIU	13B	BELL	±	$e^+e^- \to \gamma\pi^+\pi^- J/\psi$
3886 ±4 ± 2	81	[1,2] XIAO	13A		±	4.17 $e^+e^- \to \pi^+\pi^- J/\psi$
3904 ±9 ± 5	25	[1,2] XIAO	13A		0	4.17 $e^+e^- \to \pi^0\pi^0 J/\psi$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
3881.2±4.2±52.7	6k	[3] ABLIKIM	17J	BES3	±	$e^+e^- \to \pi^+\pi^- J/\psi$

[1] Neglecting interference between the $Z_c(3900)$ and non-resonant continuum.

[2] For $M^2(\pi^+\pi^-) < 0.65$ GeV^2. Obtained by analyzing CLEO-c data but not authored by the CLEO Collaboration.

[3] Pole mass obtained from a fit to a Flatte-like formula.



$Z_c(3900)$ WIDTH

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*CHG*	*COMMENT*
28.2± 2.6 OUR AVERAGE						
51.8± 4.6±36.0	6 k	[1] ABLIKIM	17J	BES3	±	$e^+e^- \to \pi^+\pi^- J/\psi$
$35\ ^{+11}_{-12}\ \pm 15$		[2] ABLIKIM	15AB	BES3	0	$e^+e^- \to \pi^0(D\overline{D}^*)^0$
26.6± 2.0± 2.1	1248	[2] ABLIKIM	15AC	BES3	±	$e^+e^- \to \pi^\pm(D\overline{D}^*)^\mp$
29.6± 8.2± 8.2	356	[2] ABLIKIM	15U	BES3	0	$e^+e^- \to \pi^0\pi^0 J/\psi$
24.8± 3.3±11.0	1212	[2] ABLIKIM	14A	BES3	±	$e^+e^- \to \pi^\pm (D\overline{D}^*)^\mp$
46 ±10 ±20	307	[2] ABLIKIM	13T	BES3	±	$e^+e^- \to \pi^+\pi^- J/\psi$
63 ±24 ±26	159	[2] LIU	13B	BELL	±	$e^+e^- \to \gamma\pi^+\pi^- J/\psi$
37 ± 4 ± 8	81	[2,3] XIAO	13A		±	4.17 $e^+e^- \to \pi^+\pi^- J/\psi$

[1] Pole width obtained from a fit to a Flatte-like formula.
[2] Neglecting interference between the $Z_c(3900)$ and non-resonant continuum.
[3] For $M^2(\pi^+\pi^-) < 0.65$ GeV^2. Obtained by analyzing CLEO-c data but not authored by the CLEO Collaboration.

$Z_c(3900)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$J/\psi\pi$	seen
Γ_2	$h_c\pi^\pm$	not seen
Γ_3	$\eta_c\pi^+\pi^-$	not seen

Γ_4	$(D\overline{D}^*)^\pm$	seen
Γ_5	$D^0 D^{*-}$ + c.c.	seen
Γ_6	$D^- D^{*0}$ + c.c.	seen
Γ_7	$\omega\pi^\pm$	not seen
Γ_8	$J/\psi\eta$	not seen
Γ_9	$D^+ D^{*-}$ + c.c	seen
Γ_{10}	$D^0\overline{D}^{*0}$ + c.c	seen

$Z_c(3900)$ BRANCHING RATIOS

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

VALUE	CL%	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
seen		356	ABLIKIM	15U	BES3	0	$e^+e^- \to \pi^0\pi^0 J/\psi$
seen		307	ABLIKIM	13T	BES3	$\pm$	$e^+e^- \to \pi^+\pi^- J/\psi$
seen		25	[1] XIAO	13A		0	4.17 $e^+e^- \to \pi^0\pi^0 J/\psi$

• • • We do not use the following data for averages, fits, limits, etc. • • •

not seen	90		[2] ADOLPH	15D	COMP	$\pm$	$\gamma N \to J/\psi\pi^\pm N$

[1] Obtained by analyzing CLEO-c data but not authored by the CLEO Collaboration.

[2] ADOLPH 15D measure $B(Z_c(3900)^\pm \to J/\psi\pi^\pm)\ \sigma(\gamma N \to Z_c(3900)^\pm N)/\sigma(\gamma N \to J/\psi N) < 3.7\times10^{-3}$ at 90% CL.

$\Gamma(h_c\pi^\pm)/\Gamma_{\text{total}}$ Γ_2/Γ

VALUE	DOCUMENT ID		TECN	CHG	COMMENT
not seen	ABLIKIM	13X	BES3	$\pm$	$e^+e^- \to h_c\pi^+\pi^-$

$\Gamma(\eta_c\pi^+\pi^-)/\Gamma_{\text{total}}$ Γ_3/Γ

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

[1] VINOKUROVA 15 reports $B(B^+ \to K^+ Z_c(3900)^0) \times B(X \to \eta_c\pi^+\pi^-) < 4.7\times10^{-5}$ at 90% CL.

$\Gamma((D\overline{D}^*)^\pm)/\Gamma(J/\psi\pi)$ Γ_4/Γ_1

VALUE	DOCUMENT ID		TECN	CHG	COMMENT
6.2±1.1±2.7	[1] ABLIKIM	14A	BES3	$\pm$	$e^+e^- \to \pi^\pm (D\overline{D}^*)^\mp$

[1] Assuming the same origin of the $(D\overline{D}^*)^\pm$ and $\pi^\pm J/\psi$ decay modes.

$\Gamma(D^0 D^{*-}+\text{c.c.})/\Gamma_{\text{total}}$ Γ_5/Γ

VALUE	DOCUMENT ID		TECN	CHG	COMMENT
seen	ABLIKIM	15AC	BES3	$\pm$	$e^+e^- \to \pi^+ D^0 D^{*-}$ + c.c.
seen	ABLIKIM	14A	BES3	$\pm$	$e^+e^- \to \pi^+ D^0 D^{*-}$ + c.c.

$\Gamma(D^- D^{*0}+\text{c.c.})/\Gamma_{\text{total}}$ Γ_6/Γ

VALUE	DOCUMENT ID		TECN	CHG	COMMENT
seen	ABLIKIM	15AC	BES3	$\pm$	$e^+e^- \to \pi^+ D^- D^{*0}$ + c.c.
seen	ABLIKIM	14A	BES3	$\pm$	$e^+e^- \to \pi^+ D^- D^{*0}$ + c.c.

$\Gamma(\omega\pi^{\pm})/\Gamma_{\text{total}}$ Γ_7/Γ

VALUE	DOCUMENT ID		TECN	CHG	COMMENT
not seen	ABLIKIM	15R	BES3	$\pm$	$e^+e^- \to \omega\pi^+\pi^-$

$\Gamma(J/\psi\eta)/\Gamma_{\text{total}}$ Γ_8/Γ

VALUE	DOCUMENT ID		TECN	CHG	COMMENT
not seen	ABLIKIM	15Q	BES3	0	4.0–4.6 $e^+e^- \to J/\psi\eta\pi^0$

$\Gamma(J/\psi\eta)/\Gamma(J/\psi\pi)$ Γ_8/Γ_1

VALUE	CL%	DOCUMENT ID		TECN	CHG	COMMENT
<0.15	90	ABLIKIM	15Q	BES3	0	4.226 $e^+e^- \to J/\psi\eta\pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<0.65	90	ABLIKIM	15Q	BES3	0	4.257 $e^+e^- \to J/\psi\eta\pi^0$

$\Gamma(D^+D^{*-}+\text{c.c})/\Gamma_{\text{total}}$ Γ_9/Γ

VALUE	DOCUMENT ID		TECN	CHG	COMMENT
seen	ABLIKIM	15AB	BES3	0	$e^+e^- \to \pi^0(D\overline{D}^*)^0$

$\Gamma(D^0\overline{D}^{*0}+\text{c.c})/\Gamma_{\text{total}}$ Γ_{10}/Γ

VALUE	DOCUMENT ID		TECN	CHG	COMMENT
seen	ABLIKIM	15AB	BES3	0	$e^+e^- \to \pi^0(D\overline{D}^*)^0$

$\Gamma(D^+D^{*-}+\text{c.c})/\Gamma(D^0\overline{D}^{*0}+\text{c.c})$ Γ_9/Γ_{10}

VALUE	DOCUMENT ID		TECN	CHG	COMMENT
0.96±0.18±0.12	ABLIKIM	15AB	BES3	0	$e^+e^- \to \pi^0(D\overline{D}^*)^0$

$Z_c(3900)$ REFERENCES

ABLIKIM	17J	PRL 119 072001	M. Ablikim *et al.*	(BES III Collab.)
ABLIKIM	15AB	PRL 115 222002	M. Ablikim *et al.*	(BES III Collab.)
ABLIKIM	15AC	PR D92 092006	M. Ablikim *et al.*	(BES III Collab.) JP
ABLIKIM	15Q	PR D92 012008	M. Ablikim *et al.*	(BES III Collab.)
ABLIKIM	15R	PR D92 032009	M. Ablikim *et al.*	(BES III Collab.)
ABLIKIM	15U	PRL 115 112003	M. Ablikim *et al.*	(BES III Collab.)
ADOLPH	15D	PL B742 330	C. Adolph *et al.*	(COMPASS Collab.)
VINOKUROVA	15	JHEP 1506 132	A. Vinokurova *et al.*	(BELLE Collab.)
Also		JHEP 1702 088 (errat.)	A. Vinokurava *et al.*	(BELLE Collab.)
ABLIKIM	14A	PRL 112 022001	M. Ablikim *et al.*	(BES III Collab.) JP
ABLIKIM	13T	PRL 110 252001	M. Ablikim *et al.*	(BES III Collab.)
ABLIKIM	13X	PRL 111 242001	M. Ablikim *et al.*	(BES III Collab.)
LIU	13B	PRL 110 252002	Z.Q. Liu *et al.*	(BELLE Collab.)
XIAO	13A	PL B727 366	T. Xiao *et al.*	(NWES)