$\psi(4660)$

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

also known as $Y(4660)$; was $X(4660)$

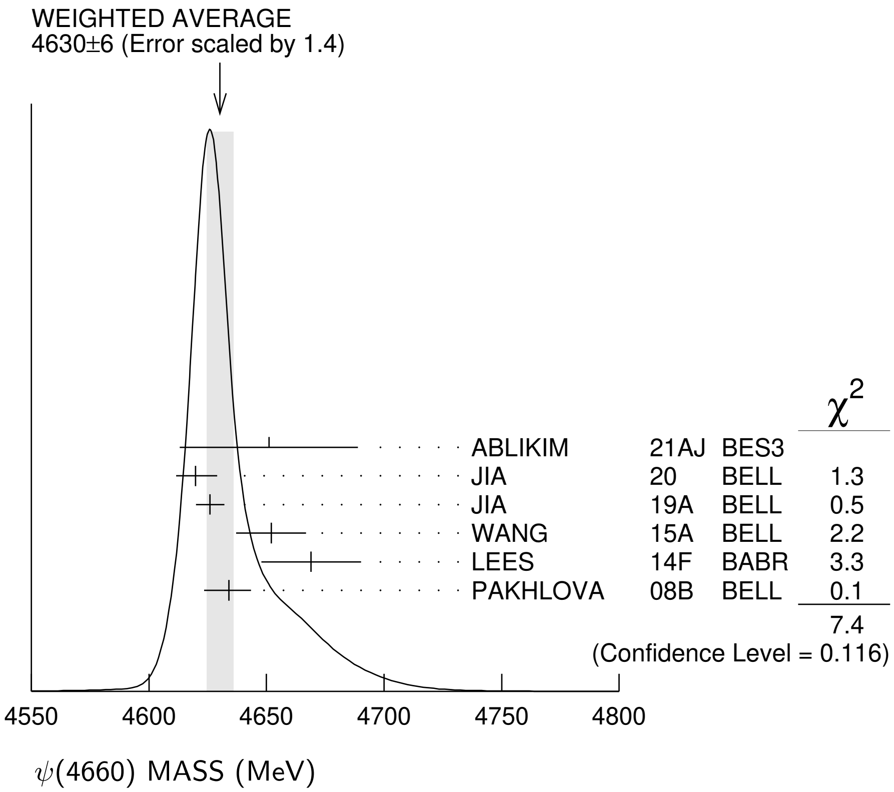
This state shows properties different from a conventional $q\overline{q}$ state. A candidate for an exotic structure. See the review on non-$q\overline{q}$ states.

Seen in radiative return from e^+e^- collisions at $\sqrt{s}$ = 9.54–10.58 GeV by WANG 07D. Also obtained in a combined fit of WANG 07D, AUBERT 07S, and LEES 14F. See also the review on "Spectroscopy of mesons containing two heavy quarks."

$\psi(4660)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
4630 ± 6 OUR AVERAGE		Error includes scale factor of 1.4. See the ideogram below.			
$4651.0 \pm 37.8 \pm 2.1$		[1] ABLIKIM	21AJ	BES3	$e^+e^- \to \pi^+\pi^-\psi(2S)$
$4619.8^{+8.9}_{-8.0} \pm 2.3$	66	[2] JIA	20	BELL	$e^+e^- \to \gamma D_s^+ D_{s2}^*(2573)^-$
$4625.9^{+6.2}_{-6.0} \pm 0.4$	89	[3] JIA	19A	BELL	$e^+e^- \to \gamma D_s^+ D_{s1}(2536)^-$
$4652 \pm 10 \pm 11$	279	[4] WANG	15A	BELL	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
$4669 \pm 21 \pm 3$	37	[5] LEES	14F	BABR	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
$4634^{+8}_{-7}{}^{+5}_{-8}$	142	[6] PAKHLOVA	08B	BELL	$e^+e^- \to \Lambda_c^+\Lambda_c^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$4647.9 \pm 8.6 \pm 0.8$		[7] ABLIKIM	22R	BES3	$e^+e^- \to \pi^+\pi^-\chi_{c1}\gamma$
$4652.5 \pm 3.4 \pm 1.1$		[8] DAI	17	RVUE	$e^+e^- \to \Lambda_c^+\Lambda_c^-$
$4645.2 \pm 9.5 \pm 6.0$		[9] ZHANG	17B	RVUE	$e^+e^- \to \pi^+\pi^-\psi(2S)$
$4646.4 \pm 9.7 \pm 4.8$		[10] ZHANG	17C	RVUE	$e^+e^- \to \pi^+\pi^- J/\psi$ or $\psi(2S)$
$4661^{+9}_{-8} \pm 6$	44	[11] LIU	08H	RVUE	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
$4664 \pm 11 \pm 5$	44	WANG	07D	BELL	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$

[1] From a three-resonance fit to the Born cross section in the range $\sqrt{s}$ = 4.008–4.698 GeV.
[2] Using $D_{s2}^*(2573)^- \to \overline{D}^0 K^-$ decays.
[3] From a fit of a Breit-Wigner convolved with a Gaussian.
[4] From a two-resonance fit. Supersedes WANG 07D.
[5] From a two-resonance fit.
[6] The $\pi^+\pi^-\psi(2S)$ and $\Lambda_c^+\Lambda_c^-$ states are not necessarily the same.
[7] From a fit to the $e^+e^- \to \pi^+\pi^-\psi(3823)$ cross section between 4.23 and 4.70 GeV with two coherent Breit-Wigner resonances. The data is also consistent with a single peak with mass 4417.5 ± 26.2 ± 3.5 MeV and width 245 ± 48 ± 13 MeV.
[8] The pole parameters are extracted from the speed plot.
[9] From a three-resonance fit.
[10] From a combined fit of BELLE, BABAR and BES3 $e^+e^- \to \pi^+\pi^- J/\psi$ and $e^+e^- \to \pi^+\pi^-\psi(2S)$ data.
[11] From a combined fit of AUBERT 07S and WANG 07D data with two resonances.



$\psi(4660)$ WIDTH

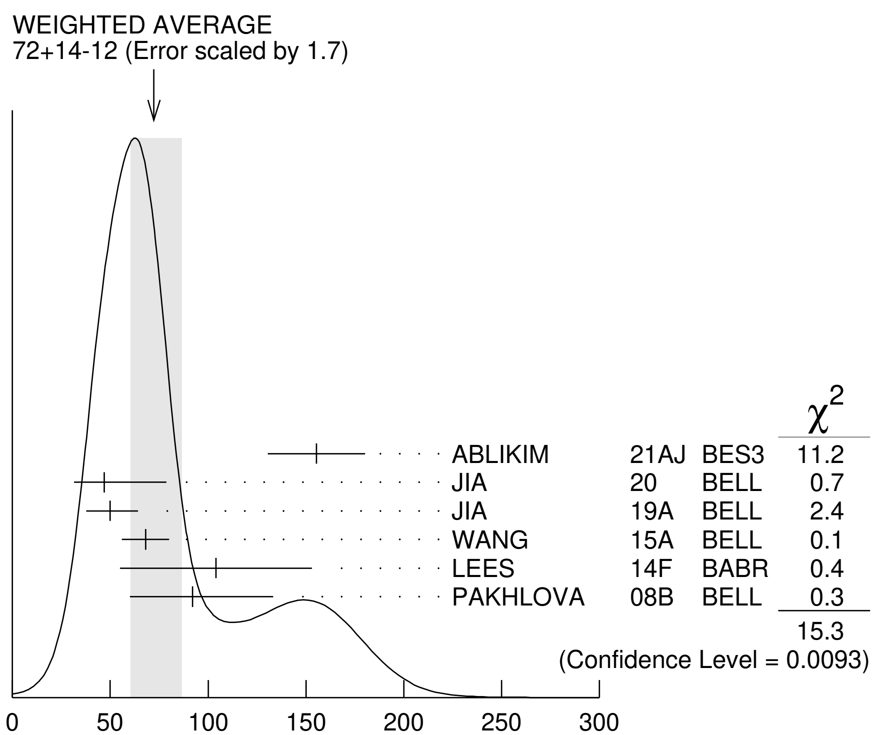
VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
72 $^{+14}_{-12}$ OUR AVERAGE		Error includes scale factor of 1.7. See the ideogram below.		
155.4±24.8± 0.8		[1] ABLIKIM	21AJ BES3	$e^+e^- \to \pi^+\pi^-\psi(2S)$
$47.0^{+31.3}_{-14.8}$± 4.6	66	[2] JIA	20 BELL	$e^+e^- \to \gamma D_s^+ D_{s2}^*(2573)^-$
$49.8^{+13.9}_{-11.5}$± 4.0	89	[3] JIA	19A BELL	$e^+e^- \to \gamma D_s^+ D_{s1}(2536)^-$
68 ±11 ± 5	279	[4] WANG	15A BELL	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
104 ±48 ±10	37	[5] LEES	14F BABR	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
92 $^{+40}_{-24}$ $^{+10}_{-21}$	142	[6] PAKHLOVA	08B BELL	$e^+e^- \to \Lambda_c^+\Lambda_c^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
33.1±18.6± 4.1		[7] ABLIKIM	22R BES3	$e^+e^- \to \pi^+\pi^-\chi_{c1}\gamma$
62.6± 5.6± 4.3		[8] DAI	17 RVUE	$e^+e^- \to \Lambda_c^+\Lambda_c^-$
113.8±18.1± 3.4		[9] ZHANG	17B RVUE	$e^+e^- \to \pi^+\pi^-\psi(2S)$
103.5±15.6± 4.0		[10] ZHANG	17C RVUE	$e^+e^- \to \pi^+\pi^- J/\psi$ or $\psi(2S)$
42 $^{+17}_{-12}$ ± 6	44	[11] LIU	08H RVUE	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
48 ±15 ± 3	44	WANG	07D BELL	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$

[1] From a three-resonance fit to the Born cross section in the range $\sqrt{s}$ = 4.008–4.698 GeV.

[2] Using $D_{s2}^*(2573)^- \to \overline{D}^0 K^-$ decays.

[3] From a fit of a Breit-Wigner convolved with a Gaussian.

[4] From a two-resonance fit. Supersedes WANG 07D.
[5] From a two-resonance fit.
[6] The $\pi^+ \pi^- \psi(2S)$ and $\Lambda_c^+ \Lambda_c^-$ states are not necessarily the same.
[7] From a fit to the $e^+ e^- \to \pi^+ \pi^- \psi(3823)$ cross section between 4.23 and 4.70 GeV with two coherent Breit-Wigner resonances. The data is also consistent with a single peak with mass 4417.5 ± 26.2 ± 3.5 MeV and width 245 ± 48 ± 13 MeV.
[8] The pole parameters are extracted from the speed plot.
[9] From a three-resonance fit.
[10] From a combined fit of BELLE, BABAR and BES3 $e^+ e^- \to \pi^+ \pi^- J/\psi$ and $e^+ e^- \to \pi^+ \pi^- \psi(2S)$ data.
[11] From a combined fit of AUBERT 07S and WANG 07D data with two resonances.



$\psi(4660)$ WIDTH (MeV)

ψ(4660) DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$e^+ e^-$	not seen
Γ_2	$\psi(2S) \pi^+ \pi^-$	seen
Γ_3	$J/\psi \eta$	not seen
Γ_4	$D^0 D^{*-} \pi^+$	not seen
Γ_5	$\psi_2(3823) \pi^+ \pi^-$	seen
Γ_6	$\chi_{c1} \gamma$	not seen
Γ_7	$\chi_{c2} \gamma$	not seen

Γ_8	$\Lambda_c^+ \Lambda_c^-$	seen
Γ_9	$D_s^+ D_{s1}(2536)^-$	seen
Γ_{10}	$D_s^+ D_{s2}^*(2573)^-$	
Γ_{11}	$\omega \pi^0$	not seen
Γ_{12}	$\omega \eta$	not seen

$\psi(4660)$ $\Gamma(i) \times \Gamma(e^+ e^-)/\Gamma(\text{total})$

$\Gamma(\psi(2S)\pi^+\pi^-) \times \Gamma(e^+e^-)/\Gamma_{total}$ — $\Gamma_2\Gamma_1/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
4.7 ± 3.8		[1] ABLIKIM	21AJ	BES3	$e^+e^- \to \pi^+\pi^-\psi(2S)$
11.2 ± 3.2		[2] ABLIKIM	21AJ	BES3	$e^+e^- \to \pi^+\pi^-\psi(2S)$
4.7 ± 4.2		[3] ABLIKIM	21AJ	BES3	$e^+e^- \to \pi^+\pi^-\psi(2S)$
11.3 ± 3.3		[4] ABLIKIM	21AJ	BES3	$e^+e^- \to \pi^+\pi^-\psi(2S)$
$2.0\pm0.3\pm0.2$	279	[5] WANG	15A	BELL	$10.58\ e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
$8.1\pm1.1\pm1.0$	279	[6] WANG	15A	BELL	$10.58\ e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
$2.7\pm1.3\pm0.5$	37	[7] LEES	14F	BABR	$10.58\ e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
$7.5\pm1.7\pm0.7$	37	[8] LEES	14F	BABR	$10.58\ e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
$2.2^{+0.7}_{-0.6}$	44	[9] LIU	08H	RVUE	$10.58\ e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
5.9 ± 1.6	44	[10] LIU	08H	RVUE	$10.58\ e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
$3.0\pm0.9\pm0.3$	44	[7] WANG	07D	BELL	$10.58\ e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
$7.6\pm1.8\pm0.8$	44	[8] WANG	07D	BELL	$10.58\ e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$

[1] Solution I of four equivalent solutions in a fit using three interfering resonances.
[2] Solution II of four equivalent solutions in a fit using three interfering resonances.
[3] Solution III of four equivalent solutions in a fit using three interfering resonances.
[4] Solution IV of four equivalent solutions in a fit using three interfering resonances.
[5] Solution I of two equivalent solutions from a fit using two interfering resonances. Supersedes WANG 07D.
[6] Solution II of two equivalent solutions from a fit using two interfering resonances. Supersedes WANG 07D.
[7] Solution I of two equivalent solutions in a fit using two interfering resonances.
[8] Solution II of two equivalent solutions in a fit using two interfering resonances.
[9] Solution I in a combined fit of AUBERT 07S and WANG 07D data with two resonances.
[10] Solution II in a combined fit of AUBERT 07S and WANG 07D data with two resonances.

$\Gamma(\psi_2(3823)\pi^+\pi^-)/\Gamma_{total}$ — Γ_5/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
seen	[1] ABLIKIM	22R	BES3	$e^+e^- \to \pi^+\pi^-\chi_{c1}\gamma$

[1] From a fit to the $e^+e^- \to \pi^+\pi^-\psi(3823)$ cross section between 4.23 and 4.70 GeV with two coherent Breit-Wigner resonances.

$\Gamma(J/\psi\eta) \times \Gamma(e^+e^-)/\Gamma_{total}$ — $\Gamma_3\Gamma_1/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.94	90	WANG	13B	BELL	$e^+e^- \to J/\psi\eta\gamma$

$\Gamma(\chi_{c1}\gamma) \times \Gamma(e^+e^-)/\Gamma_{total}$ — $\Gamma_6\Gamma_1/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID		TECN	COMMENT
<0.45	90	[1] HAN	15	BELL	10.58 $e^+e^- \rightarrow \chi_{c1}\gamma$

[1] Using $B(\eta \rightarrow \gamma\gamma) = (39.41 \pm 0.21)\%$.

$\Gamma(\chi_{c2}\gamma) \times \Gamma(e^+e^-)/\Gamma_{total}$ — $\Gamma_7\Gamma_1/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID		TECN	COMMENT
<2.1	90	[1] HAN	15	BELL	10.58 $e^+e^- \rightarrow \chi_{c2}\gamma$

[1] Using $B(\eta \rightarrow \gamma\gamma) = (39.41 \pm 0.21)\%$.

$\Gamma(D_s^+ D_{s1}(2536)^-) \times \Gamma(e^+e^-)/\Gamma_{total}$ — $\Gamma_9\Gamma_1/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
$14.3^{+2.8}_{-2.6} \pm 1.5$	89	[1] JIA	19A	BELL	$e^+e^- \rightarrow \gamma D_s^+ D_{s1}(2536)^-$

[1] Assuming $B(D_{s1}(2536)^- \rightarrow \overline{D}^{*0} K^-) = 1$.

$\Gamma(D_s^+ D_{s2}^*(2573)^-) \times \Gamma(e^+e^-)/\Gamma_{total}$ — $\Gamma_{10}\Gamma_1/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
$14.7^{+5.9}_{-4.5} \pm 3.6$	66	[1] JIA	20	BELL	$e^+e^- \rightarrow \gamma D_s^+ D_{s2}^*(2573)^-$

[1] Assuming $B(D_{s2}^*(2573)^- \rightarrow \overline{D}^0 K^-) = 1$.

$\psi(4660)$ BRANCHING RATIOS

$\Gamma(D^0 D^{*-}\pi^+)/\Gamma(\psi(2S)\pi^+\pi^-)$ — Γ_4/Γ_2

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<10	90	PAKHLOVA	09	BELL	$e^+e^- \rightarrow D^0 D^{*-}\pi^+$

$\Gamma(D^0 D^{*-}\pi^+)/\Gamma_{total} \times \Gamma(e^+e^-)/\Gamma_{total}$ — $\Gamma_4/\Gamma \times \Gamma_1/\Gamma$

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<0.37 \times 10^{-6}$	90	[1] PAKHLOVA	09	BELL	$e^+e^- \rightarrow D^0 D^{*-}\pi^+$

[1] Using $4664 \pm 11 \pm 5$ MeV for the mass of $\psi(4660)$.

$\Gamma(\Lambda_c^+\Lambda_c^-)/\Gamma_{total} \times \Gamma(e^+e^-)/\Gamma_{total}$ — $\Gamma_8/\Gamma \times \Gamma_1/\Gamma$

VALUE (units 10^{-6})	EVTS	DOCUMENT ID		TECN	COMMENT
$0.68^{+0.16}_{-0.15}{}^{+0.29}_{-0.30}$	142	[1] PAKHLOVA	08B	BELL	$e^+e^- \rightarrow \Lambda_c^+\Lambda_c^-$

[1] The $\pi^+\pi^-\psi(2S)$ and $\Lambda_c^+\Lambda_c^-$ states are not necessarily the same.

$\Gamma(\omega\pi^0)/\Gamma_{total}$ — Γ_{11}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
not seen	ABLIKIM	22K	BES3	$e^+e^- \rightarrow \omega\pi^0$

$\Gamma(\omega\eta)/\Gamma_{total}$ — Γ_{12}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
not seen	ABLIKIM	22K	BES3	$e^+e^- \rightarrow \omega\eta$

$\psi(4660)$ REFERENCES

ABLIKIM	22K	JHEP 2207 064	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	22R	PRL 129 102003	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	21AJ	PR D104 052012	M. Ablikim *et al.*	(BESIII Collab.)
JIA	20	PR D101 091101	S. Jia *et al.*	(BELLE Collab.)
JIA	19A	PR D100 111103	S. Jia *et al.*	(BELLE Collab.)
DAI	17	PR D96 116001	L.-Y. Dai, J. Haidenbauer, U.-G. Meissner	(JULI+)
ZHANG	17B	PR D96 054008	J. Zhang, J. Zhang	
ZHANG	17C	EPJ C77 727	J. Zhang, L. Yuan	
HAN	15	PR D92 012011	Y.L. Han *et al.*	(BELLE Collab.)
WANG	15A	PR D91 112007	X.L. Wang *et al.*	(BELLE Collab.)
LEES	14F	PR D89 111103	J.P. Lees *et al.*	(BABAR Collab.)
WANG	13B	PR D87 051101	X.L. Wang *et al.*	(BELLE Collab.)
PAKHLOVA	09	PR D80 091101	G. Pakhlova *et al.*	(BELLE Collab.)
LIU	08H	PR D78 014032	Z.Q. Liu, X.S. Qin, C.Z. Yuan	
PAKHLOVA	08B	PRL 101 172001	C. Pakhlova *et al.*	(BELLE Collab.)
AUBERT	07S	PRL 98 212001	B. Aubert *et al.*	(BABAR Collab.)
WANG	07D	PRL 99 142002	X.L. Wang *et al.*	(BELLE Collab.)