$\psi(4360)$

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

also known as $Y(4360)$; was $X(4360)$

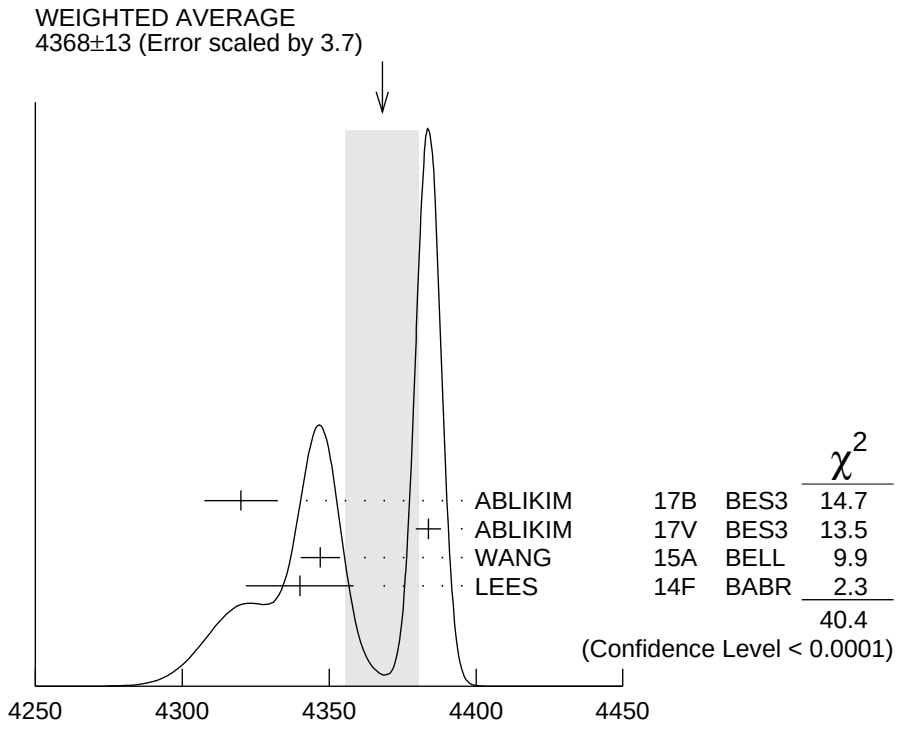
This state shows properties different from a conventional $q\overline{q}$ state. A candidate for an exotic structure. See the review on non-$q\overline{q}$ states.

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

$\psi(4360)$ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
4368 ±13 OUR AVERAGE					Error includes scale factor of 3.7. See the ideogram below.
4320.0±10.4±7.0		[1] ABLIKIM	17B	BES3	$e^+e^- \to \pi^+\pi^- J/\psi$
4383.8± 4.2±0.8		[2] ABLIKIM	17V	BES3	$e^+e^- \to \pi^+\pi^-\psi(2S)$
4347 ± 6 ±3	279	[3] WANG	15A	BELL	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
4340 ±16 ±9	37	[4] LEES	14F	BABR	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
4383.7± 2.9±6.2		[5] ZHANG	17B	RVUE	$e^+e^- \to \pi^+\pi^-\psi(2S)$
4386.4± 2.1±6.4		[6] ZHANG	17C	RVUE	$e^+e^- \to \pi^+\pi^- J/\psi$ or $\psi(2S)$
4355 $^{+\ 9}_{-10}$ ±9	74	[7] LIU	08H	RVUE	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
4324 ±24		[8] AUBERT	07S	BABR	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
4361 ± 9 ±9	47	[4] WANG	07D	BELL	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$

[1] From a three-resonance fit.
[2] From a fit to the cross section for $e^+e^- \to \pi^+\pi^-\psi(2S) \to 2(\pi^+\pi^-)\ell^+\ell^-$ obtained from 16 center-of-mass energies between 4.008 and 4.600 GeV and comprising 5.1 fb^{-1}.
[3] From a two-resonance fit. Supersedes WANG 07D.
[4] From a two-resonance fit.
[5] From a three-resonance fit.
[6] 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.
[7] From a combined fit of AUBERT 07S and WANG 07D data with two resonances.
[8] From a single-resonance fit. Systematic errors not estimated.



$\psi(4360)$ WIDTH

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
96 ± 7 OUR AVERAGE					
$101.4^{+25.3}_{-19.7}\pm10.2$		[1] ABLIKIM	17B	BES3	$e^+e^- \to \pi^+\pi^- J/\psi$
$84.2\pm12.5\pm 2.1$		[2] ABLIKIM	17V	BES3	$e^+e^- \to \pi^+\pi^-\psi(2S)$
$103 \pm 9 \pm 5$	279	[3] WANG	15A	BELL	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
$94 \pm32 \pm13$	37	[4] LEES	14F	BABR	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$94.2\pm 7.3\pm 2.0$		[5] ZHANG	17B	RVUE	$e^+e^- \to \pi^+\pi^-\psi(2S)$
$96.0\pm 6.7\pm 2.7$		[6] ZHANG	17C	RVUE	$e^+e^- \to \pi^+\pi^- J/\psi$ or $\psi(2S)$
$103 \ ^{+17}_{-15} \pm11$	74	[7] LIU	08H	RVUE	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
172 ± 33		[8] AUBERT	07S	BABR	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$
$74 \pm15 \pm10$	47	[4] WANG	07D	BELL	10.58 $e^+e^- \to \gamma\pi^+\pi^-\psi(2S)$

[1] From a three-resonance fit.
[2] From a fit to the cross section for $e^+e^- \to \pi^+\pi^-\psi(2S) \to 2(\pi^+\pi^-)\ell^+\ell^-$ obtained from 16 center-of-mass energies between 4.008 and 4.600 GeV and comprising 5.1 fb^{-1}.
[3] From a two-resonance fit. Supersedes WANG 07D.
[4] From a two-resonance fit.
[5] From a three-resonance fit.
[6] 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.
[7] From a combined fit of AUBERT 07S and WANG 07D data with two resonances.
[8] From a single-resonance fit. Systematic errors not estimated.

$\psi(4360)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	e^+e^-	
Γ_2	$J/\psi\pi^+\pi^-$	
Γ_3	$\psi(2S)\pi^+\pi^-$	seen
Γ_4	$\psi_2(3823)\pi^+\pi^-$	possibly seen
Γ_5	$J/\psi\eta$	
Γ_6	$D^0D^{*-}\pi^+$	
Γ_7	$\chi_{c1}\gamma$	
Γ_8	$\chi_{c2}\gamma$	

$\psi(4360)$ $\Gamma(i)\times\Gamma(e^+e^-)/\Gamma(\text{total})$

$\Gamma(\psi(2S)\pi^+\pi^-)\times\Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_3\Gamma_1/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
7.3 ± 2.8		[1] ABLIKIM	19K	BES3	$e^+e^-\to\pi^+\pi^-\psi(2S)$
11.0 ± 3.8		[2] ABLIKIM	19K	BES3	$e^+e^-\to\pi^+\pi^-\psi(2S)$
$9.2\pm0.6\pm0.6$	279	[3] WANG	15A	BELL	10.58 $e^+e^-\to\gamma\pi^+\pi^-\psi(2S)$
$10.9\pm0.6\pm0.7$	279	[4] WANG	15A	BELL	10.58 $e^+e^-\to\gamma\pi^+\pi^-\psi(2S)$
$6.0\pm1.0\pm0.5$	37	[1] LEES	14F	BABR	10.58 $e^+e^-\to\gamma\pi^+\pi^-\psi(2S)$
$7.2\pm1.0\pm0.6$	37	[2] LEES	14F	BABR	10.58 $e^+e^-\to\gamma\pi^+\pi^-\psi(2S)$
$11.1^{+1.3}_{-1.2}$	74	[5] LIU	08H	RVUE	10.58 $e^+e^-\to\gamma\pi^+\pi^-\psi(2S)$
12.3 ± 1.2	74	[6] LIU	08H	RVUE	10.58 $e^+e^-\to\gamma\pi^+\pi^-\psi(2S)$
$10.4\pm1.7\pm1.5$	47	[1] WANG	07D	BELL	10.58 $e^+e^-\to\gamma\pi^+\pi^-\psi(2S)$
$11.8\pm1.8\pm1.4$	47	[2] WANG	07D	BELL	10.58 $e^+e^-\to\gamma\pi^+\pi^-\psi(2S)$

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

$\Gamma(J/\psi\eta)\times\Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_5\Gamma_1/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<6.8	90	WANG	13B	BELL	$e^+e^-\to J/\psi\eta\gamma$

$\Gamma(\chi_{c1}\gamma)\times\Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_7\Gamma_1/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID		TECN	COMMENT
<0.57	90	[1] HAN	15	BELL	10.58 $e^+e^-\to\chi_{c1}\gamma$

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

$\Gamma(\chi_{c2}\gamma) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_8\Gamma_1/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID		TECN	COMMENT
<1.9	90	[1] HAN	15	BELL	10.58 $e^+e^- \to \chi_{c2}\gamma$

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

$\psi(4360)$ BRANCHING RATIOS

$\Gamma(D^0D^{*-}\pi^+)/\Gamma(\psi(2S)\pi^+\pi^-)$ Γ_6/Γ_3

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<8	90	PAKHLOVA	09	BELL	$e^+e^- \to \psi(4360) \to D^0D^{*-}\pi^+$

$\Gamma(\psi(2S)\pi^+\pi^-)/\Gamma_{\text{total}}$ Γ_3/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
seen	[1] ABLIKIM	17V	BES3	$e^+e^- \to \pi^+\pi^-\psi(2S)$

[1] From a fit to the cross section for $e^+e^- \to \pi^+\pi^-\psi(2S) \to 2(\pi^+\pi^-)\ell^+\ell^-$ obtained from 16 center-of-mass energies between 4.008 and 4.600 GeV and comprising 5.1 fb^{-1}.

$\Gamma(\psi(2S)\pi^+\pi^-)/\Gamma(J/\psi\pi^+\pi^-)$ Γ_3/Γ_2

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
(0.81 ± 0.12 ± 0.13) to (42 ± 15 ± 15)	[1] ZHANG	17C	RVUE	$e^+e^- \to \pi^+\pi^- J/\psi$ or $\psi(2S)$

[1] 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.

$\Gamma(\psi_2(3823)\pi^+\pi^-)/\Gamma_{\text{total}}$ Γ_4/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
possibly seen	19	[1] ABLIKIM	15S	BES3	$e^+e^- \to \pi^+\pi^-\chi_{c1}\gamma$

[1] From a fit of $e^+e^- \to \pi^+\pi^-\psi_2(3823)$, $\psi_2(3823) \to \chi_{c1}\gamma$ cross sections taken at $\sqrt{s}$ values of 4.23, 4.26, 4.36, 4.42, and 4.60 GeV to the $\psi(4360)$ line shape.

$\Gamma(D^0D^{*-}\pi^+)/\Gamma_{\text{total}} \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_6/\Gamma \times \Gamma_1/\Gamma$

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.72 × 10^{-6}	90	[1] PAKHLOVA	09	BELL	$e^+e^- \to \psi(4360) \to D^0D^{*-}\pi^+$

[1] Using $4355^{+9}_{-10} \pm 9$ MeV for the mass of $\psi(4360)$.

$\psi(4360)$ REFERENCES

ABLIKIM	19K	PR D99 019903 (errat.)	M. Ablikim *et al.*	(BES III Collab.)
ABLIKIM	17B	PRL 118 092001	M. Ablikim *et al.*	(BES III Collab.)
ABLIKIM	17V	PR D96 032004	M. Ablikim *et al.*	(BES III Collab.)
Also		PR D99 019903 (errat.)	M. Ablikim *et al.*	(BES III Collab.)
ZHANG	17B	PR D96 054008	J. Zhang, J. Zhang	
ZHANG	17C	EPJ C77 727	J. Zhang, L. Yuan	
ABLIKIM	15S	PRL 115 011803	M. Ablikim *et al.*	(BES III Collab.)
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	
AUBERT	07S	PRL 98 212001	B. Aubert *et al.*	(BABAR Collab.)
WANG	07D	PRL 99 142002	X.L. Wang *et al.*	(BELLE Collab.)