$\eta_c(2S)$

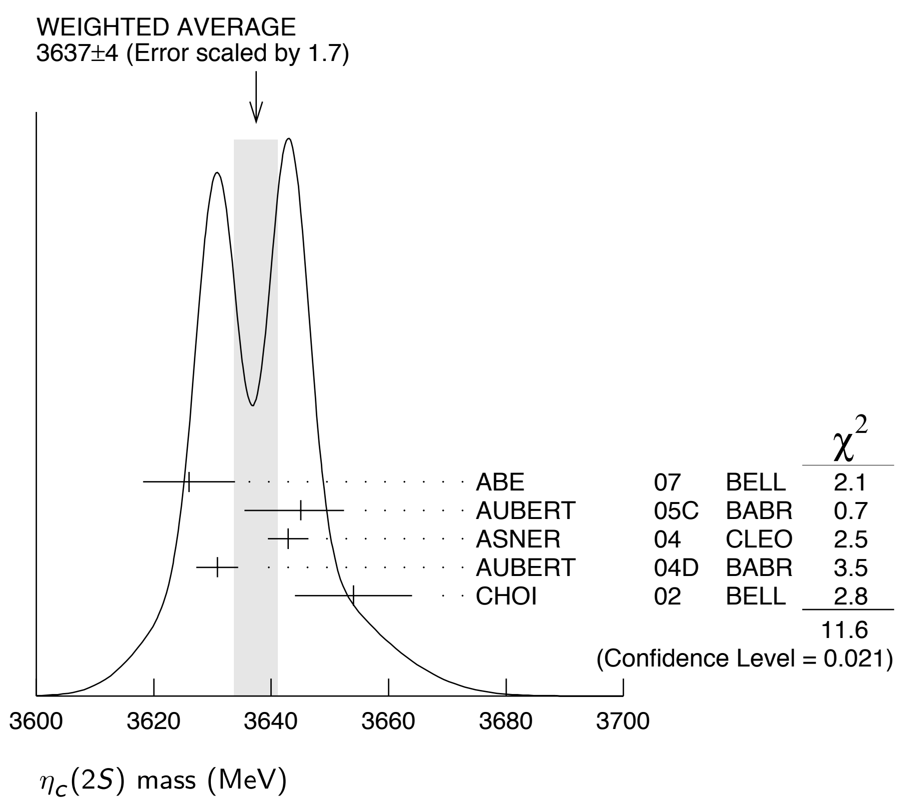
$I^G(J^{PC}) = 0^+(0^{-+})$

Quantum numbers are quark model predictions.

$\eta_c(2S)$ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
3637 ±4 OUR AVERAGE	Error includes scale factor of 1.7. See the ideogram below.				
3626 ±5 ±6	311	[1] ABE	07	BELL	$e^+e^- \to J/\psi(c\overline{c})$
$3645.0 \pm 5.5^{+4.9}_{-7.8}$	121 ± 27	AUBERT	05C	BABR	$e^+e^- \to J/\psi c\overline{c}$
3642.9±3.1±1.5	61	ASNER	04	CLEO	$\gamma\gamma \to \eta_c \to K^0_S K^\pm \pi^\mp$
3630.8±3.4±1.0	112 ± 24	AUBERT	04D	BABR	$\gamma\gamma \to \eta_c(2S) \to K\overline{K}\pi$
3654 ±6 ±8	39 ± 11	CHOI	02	BELL	$B \to K K_S K^- \pi^+$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3639 ±7	98 ± 52	[2] AUBERT	06E	BABR	$B^\pm \to K^\pm X_{c\overline{c}}$
3594 ±5		[3] EDWARDS	82C	CBAL	$e^+e^- \to \gamma X$

[1] From a fit of the J/ψ recoil mass spectrum. Supersedes ABE,K 02 and ABE 04G.
[2] From the fit of the kaon momentum spectrum. Systematic errors not evaluated.
[3] Assuming mass of $\psi(2S) = 3686$ MeV.



$\eta_c(2S)$ WIDTH

VALUE (MeV)	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
14 ± 7 OUR AVERAGE						
$6.3 \pm 12.4 \pm 4.0$		61	ASNER	04	CLEO	$\gamma\gamma \to \eta_c \to K^0_S K^\pm \pi^\mp$
$17.0 \pm 8.3 \pm 2.5$		112 ± 24	AUBERT	04D	BABR	$\gamma\gamma \to \eta_c(2S) \to K\overline{K}\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<23	90	98 ± 52	[4] AUBERT	06E	BABR	$B^\pm \to K^\pm X_{c\overline{c}}$
22 ± 14		121 ± 27	AUBERT	05C	BABR	$e^+e^- \to J/\psi c\overline{c}$
<55	90	39 ± 11	[5] CHOI	02	BELL	$B \to K K_S K^- \pi^+$
<8.0	95		[6] EDWARDS	82C	CBAL	$e^+e^- \to \gamma X$

[4] From the fit of the kaon momentum spectrum. Systematic errors not evaluated.
[5] For a mass value of 3654 ± 6 MeV
[6] For a mass value of 3594 ± 5 MeV

$\eta_c(2S)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Confidence level
Γ_1	hadrons	not seen	
Γ_2	$K\overline{K}\pi$	seen	
Γ_3	$2\pi^+ 2\pi^-$	not seen	
Γ_4	$K^+K^-\pi^+\pi^-$	not seen	
Γ_5	$2K^+ 2K^-$	not seen	
Γ_6	$p\overline{p}$	not seen	
Γ_7	$\gamma\gamma$	$<5 \times 10^{-4}$	90%

$\eta_c(2S)$ PARTIAL WIDTHS

$\Gamma(\gamma\gamma)$ Γ_7

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.3 ± 0.6	[7] ASNER	04	CLEO	$\gamma\gamma \to \eta_c \to K^0_S K^\pm \pi^\mp$

[7] They measure $\Gamma(\eta_c(2S)\gamma\gamma)$ B$(\eta_c(2S) \to K\overline{K}\pi) = (0.18 \pm 0.05 \pm 0.02)$ $\Gamma(\eta_c(1S)\gamma\gamma)$ B$(\eta_c(1S) \to K\overline{K}\pi)$. The value for $\Gamma(\eta_c(2S) \to \gamma\gamma)$ is derived assuming that the branching fractions for $\eta_c(2S)$ and $\eta_c(1S)$ decays to $K_S K\pi$ are equal and using $\Gamma(\eta_c(1S) \to \gamma\gamma) = 7.4 \pm 0.4 \pm 2.3$ keV.

$\eta_c(2S)$ $\Gamma(i)\Gamma(\gamma\gamma)/\Gamma(\text{total})$

$\Gamma(2\pi^+2\pi^-) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ $\Gamma_3\Gamma_7/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID		TECN	COMMENT
<6.5	90	UEHARA	08	BELL	$\gamma\gamma \to \eta_c(2S) \to 2(\pi^+\pi^-)$

$\Gamma(K^+K^-\pi^+\pi^-) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ — $\Gamma_4\Gamma_7/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID		TECN	COMMENT
<5.0	90	UEHARA	08	BELL	$\gamma\gamma \to \eta_c(2S) \to K^+K^-\pi^+\pi^-$

$\Gamma(2K^+2K^-) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ — $\Gamma_5\Gamma_7/\Gamma$

VALUE (eV)	CL%	DOCUMENT ID		TECN	COMMENT
<2.9	90	UEHARA	08	BELL	$\gamma\gamma \to \eta_c(2S) \to 2(K^+K^-)$

$\eta_c(2S)$ $\Gamma(i)\Gamma(\gamma\gamma)/\Gamma^2(\text{total})$

$\Gamma(p\overline{p}) \times \Gamma(\gamma\gamma)/\Gamma^2_{\text{total}}$ — $\Gamma_6\Gamma_7/\Gamma^2$

VALUE (units 10^{-8})	CL%	DOCUMENT ID		TECN	COMMENT
< 5.6	90	[8,9,10] AMBROGIANI	01	E835	$\overline{p}p \to \gamma\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 8.0	90	[8,9,11] AMBROGIANI	01	E835	$\overline{p}p \to \gamma\gamma$
<12.0	90	[9,11] AMBROGIANI	01	E835	$\overline{p}p \to \gamma\gamma$

[8] Including the measurements of of ARMSTRONG 95F in the AMBROGIANI 01 analysis.
[9] For a total width Γ=5 MeV.
[10] For the resonance mass region 3589–3599 MeV/c^2.
[11] For the resonance mass region 3575–3660 MeV/c^2.

$\eta_c(2S)$ BRANCHING RATIOS

$\Gamma(\text{hadrons})/\Gamma_{\text{total}}$ — Γ_1/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
not seen	ABREU	98O	DLPH	$e^+e^- \to e^+e^- +$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •				
seen	[12] EDWARDS	82C	CBAL	$e^+e^- \to \gamma X$

[12] For a mass value of 3594 $\pm$ 5 MeV

$\Gamma(K\overline{K}\pi)/\Gamma_{\text{total}}$ — Γ_2/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
seen	39 $\pm$ 11	[13] CHOI	02	BELL	$B \to K K_S K^-\pi^+$

[13] For a mass value of 3654 $\pm$ 6 MeV

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

VALUE	DOCUMENT ID		TECN	COMMENT
not seen	UEHARA	08	BELL	$\gamma\gamma \to \eta_c(2S)$

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

VALUE	DOCUMENT ID		TECN	COMMENT
not seen	UEHARA	08	BELL	$\gamma\gamma \to \eta_c(2S)$

$\Gamma(2K^+2K^-)/\Gamma_{\text{total}}$ — Γ_5/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
not seen	UEHARA	08	BELL	$\gamma\gamma \to \eta_c(2S)$

VALUE	DOCUMENT ID	TECN	COMMENT
not seen	AMBROGIANI 01	E835	$\overline{p}p \rightarrow \gamma\gamma$

$\Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ — Γ_7/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.0005	90	[14] WICHT	08	BELL	$B^{\pm} \rightarrow K^{\pm}\gamma\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.01	90	LEE	85	CBAL	$\psi' \rightarrow$ photons

[14] WICHT 08 reports $[B(\eta_c(2S) \rightarrow \gamma\gamma)] \times [B(B^+ \rightarrow \eta_c(2S)K^+)] < 0.18 \times 10^{-6}$. We divide by our best value $B(B^+ \rightarrow \eta_c(2S)K^+) = 0.00034$.

$\eta_c(2S)$ REFERENCES

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WICHT	08	PL B662 323	J. Wicht *et al.*	(BELLE Collab.)
ABE	07	PRL 98 082001	K. Abe *et al.*	(BELLE Collab.)
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