$\chi_{c1}(1P)$

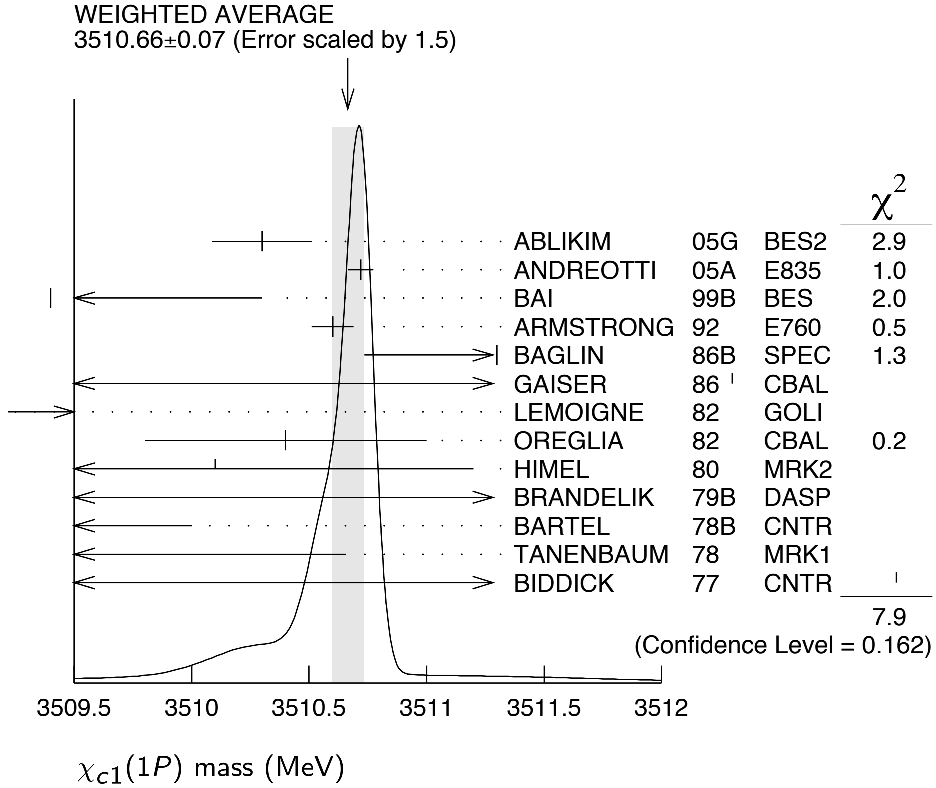
$I^G(J^{PC}) = 0^+(1^{++})$

See the Review on "$\psi(2S)$ and χ_c branching ratios" before the $\chi_{c0}(1P)$ Listings.

$\chi_{c1}(1P)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
3510.66 ± 0.07 OUR AVERAGE Error includes scale factor of 1.5. See the ideogram below.					
3510.30 ± 0.14 ± 0.16		ABLIKIM	05G	BES2	$\psi(2S) \to \gamma\chi_{c1}$
3510.719 ± 0.051 ± 0.019		ANDREOTTI	05A	E835	$p\overline{p} \to e^+e^-\gamma$
3509.4 ± 0.9		BAI	99B	BES	$\psi(2S) \to \gamma X$
3510.60 ± 0.087 ± 0.019	513	[1] ARMSTRONG	92	E760	$\overline{p}p \to e^+e^-\gamma$
3511.3 ± 0.4 ± 0.4	30	BAGLIN	86B	SPEC	$\overline{p}p \to e^+e^-X$
3512.3 ± 0.3 ± 4.0		[2] GAISER	86	CBAL	$\psi(2S) \to \gamma X$
3507.4 ± 1.7	91	[3] LEMOIGNE	82	GOLI	185 π^- Be $\to \gamma\mu^+\mu^-$ A
3510.4 ± 0.6		OREGLIA	82	CBAL	$e^+e^- \to J/\psi 2\gamma$
3510.1 ± 1.1	254	[4] HIMEL	80	MRK2	$e^+e^- \to J/\psi 2\gamma$
3509 ±11	21	BRANDELIK	79B	DASP	$e^+e^- \to J/\psi 2\gamma$
3507 ± 3		[4] BARTEL	78B	CNTR	$e^+e^- \to J/\psi 2\gamma$
3505.0 ± 4 ± 4		[4,5] TANENBAUM	78	MRK1	e^+e^-
3513 ± 7	367	[4] BIDDICK	77	CNTR	$\psi(2S) \to \gamma X$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3500 ±10	40	TANENBAUM	75	MRK1	Hadrons γ

[1] Recalculated by ANDREOTTI 05A, using the value of $\psi(2S)$ mass from AULCHENKO 03.
[2] Using mass of $\psi(2S)$ = 3686.0 MeV.
[3] $J/\psi(1S)$ mass constrained to 3097 MeV.
[4] Mass value shifted by us by amount appropriate for $\psi(2S)$ mass = 3686 MeV and $J/\psi(1S)$ mass = 3097 MeV.
[5] From a simultaneous fit to radiative and hadronic decay channels.



$\chi_{c1}(1P)$ WIDTH

VALUE (MeV)	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.89 ±0.05 OUR FIT						
0.88 ±0.05 OUR AVERAGE						
$1.39\ ^{+0.40}_{-0.38}\ ^{+0.26}_{-0.77}$			ABLIKIM	05G	BES2	$\psi(2S) \rightarrow \gamma\chi_{c1}$
0.876±0.045±0.026			ANDREOTTI	05A	E835	$p\overline{p} \rightarrow e^+e^-\gamma$
0.87 ±0.11 ±0.08		513	[6] ARMSTRONG	92	E760	$\overline{p}p \rightarrow e^+e^-\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<1.3	95		BAGLIN	86B	SPEC	$\overline{p}p \rightarrow e^+e^-X$
<3.8	90		GAISER	86	CBAL	$\psi(2S) \rightarrow \gamma X$

[6] Recalculated by ANDREOTTI 05A.

$\chi_{c1}(1P)$ DECAY MODES

Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level

Hadronic decays

Γ_{1}	$3(\pi^+\pi^-)$	$(5.8 \pm 1.4) \times 10^{-3}$	S=1.2
Γ_{2}	$2(\pi^+\pi^-)$	$(7.7 \pm 2.6) \times 10^{-3}$	
Γ_{3}	$\pi^+\pi^- K^+ K^-$	$(4.5 \pm 1.0) \times 10^{-3}$	
Γ_{4}	$\pi^+\pi^-\eta$	$(5.2 \pm 0.6) \times 10^{-3}$	
Γ_{5}	$\pi^+\pi^-\eta'$	$(2.5 \pm 0.5) \times 10^{-3}$	
Γ_{6}	$\rho^0\pi^+\pi^-$	$(3.9 \pm 3.5) \times 10^{-3}$	
Γ_{7}	$K^+ K^-\eta$	$(3.5 \pm 1.1) \times 10^{-4}$	
Γ_{8}	$K^0 K^+\pi^-$ + c.c.	$(7.7 \pm 0.7) \times 10^{-3}$	
Γ_{9}	$K^+ K^-\pi^0$	$(2.01 \pm 0.28) \times 10^{-3}$	
Γ_{10}	$\eta\pi^+\pi^-$	$(5.8 \pm 1.1) \times 10^{-3}$	
Γ_{11}	$a_0(980)^+\pi^-$ + c.c. $\rightarrow$ $\eta\pi^+\pi^-$	$(2.0 \pm 0.7) \times 10^{-3}$	
Γ_{12}	$f_2(1270)\eta$	$(3.0 \pm 0.9) \times 10^{-3}$	
Γ_{13}	$K^+\overline{K}^*(892)^0\pi^-$ + c.c.	$(3.2 \pm 2.1) \times 10^{-3}$	
Γ_{14}	$K^*(892)^0\overline{K}^*(892)^0$	$(1.6 \pm 0.4) \times 10^{-3}$	
Γ_{15}	$K^*(892)^0\overline{K}^0$ + c.c.	$(1.1 \pm 0.4) \times 10^{-3}$	
Γ_{16}	$K^*(892)^+ K^-$ + c.c.	$(1.6 \pm 0.7) \times 10^{-3}$	
Γ_{17}	$K^*_J(1430)^0\overline{K}^0$ + c.c. $\rightarrow$ $K^0_S K^+\pi^-$ + c.c.	$< 9 \times 10^{-4}$	CL=90%
Γ_{18}	$K^*_J(1430)^+ K^-$ + c.c. $\rightarrow$ $K^0_S K^+\pi^-$ + c.c.	$< 2.4 \times 10^{-3}$	CL=90%
Γ_{19}	$\pi^+\pi^- K^0_S K^0_S$	$(7.6 \pm 3.2) \times 10^{-4}$	
Γ_{20}	$K^+ K^- K^0_S K^0_S$	$< 5 \times 10^{-4}$	CL=90%
Γ_{21}	$K^+ K^- K^+ K^-$	$(5.8 \pm 1.2) \times 10^{-4}$	
Γ_{22}	$K^+ K^-\phi$	$(4.5 \pm 1.7) \times 10^{-4}$	
Γ_{23}	$p\overline{p}$	$(6.7 \pm 0.5) \times 10^{-5}$	
Γ_{24}	$p\overline{p}\pi^0$	$(1.2 \pm 0.5) \times 10^{-4}$	
Γ_{25}	$p\overline{p}\eta$	$< 1.6 \times 10^{-4}$	CL=90%
Γ_{26}	$\pi^+\pi^- p\overline{p}$	$(5.0 \pm 1.9) \times 10^{-4}$	
Γ_{27}	$K^0_S K^0_S p\overline{p}$	$< 4.5 \times 10^{-4}$	CL=90%
Γ_{28}	$\Lambda\overline{\Lambda}$	$(2.4 \pm 1.0) \times 10^{-4}$	
Γ_{29}	$\Lambda\overline{\Lambda}\pi^+\pi^-$	$< 1.5 \times 10^{-3}$	CL=90%
Γ_{30}	$K^+\overline{p}\Lambda$	$(3.4 \pm 1.0) \times 10^{-4}$	
Γ_{31}	$\Xi^-\overline{\Xi}^+$	$< 3.4 \times 10^{-4}$	CL=90%
Γ_{32}	$\pi^+\pi^-$ + $K^+ K^-$	$< 2.1 \times 10^{-3}$	
Γ_{33}	$K^0_S K^0_S$	$< 7 \times 10^{-5}$	CL=90%

Radiative decays

Γ_{34}	$\gamma J/\psi(1S)$	(35.9 ± 1.9) %	
Γ_{35}	$\gamma\gamma$		

$\chi_{c1}(1P)$ PARTIAL WIDTHS

$\chi_{c1}(1P)$ $\Gamma(i)\Gamma(\gamma J/\psi(1S))/\Gamma(\text{total})$

$\Gamma(p\overline{p}) \times \Gamma(\gamma J/\psi(1S))/\Gamma_{\text{total}}$ — $\Gamma_{23}\Gamma_{34}/\Gamma$

VALUE (eV)	DOCUMENT ID		TECN	COMMENT
21.3±0.9 OUR FIT				
21.4±0.9 OUR AVERAGE				
21.5±0.5±0.8	[7] ANDREOTTI	05A	E835	$p\overline{p} \to e^+e^-\gamma$
21.4±1.5±2.2	[7,8] ARMSTRONG	92	E760	$\overline{p}p \to e^+e^-\gamma$
$19.9^{+4.4}_{-4.0}$	[7] BAGLIN	86B	SPEC	$\overline{p}p \to e^+e^-X$

[7] Calculated by us using B($J/\psi(1S) \to e^+e^-$) = 0.0593 ± 0.0010.
[8] Recalculated by ANDREOTTI 05A.

$\chi_{c1}(1P)$ BRANCHING RATIOS

HADRONIC DECAYS

$\Gamma(3(\pi^+\pi^-))/\Gamma_{\text{total}}$ — Γ_1/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
5.8±1.4 OUR EVALUATION Error includes scale factor of 1.2. Treating systematic error as correlated.				
5.8±1.1 OUR AVERAGE				
5.4±0.7±0.9	[9] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c1}$
16.1±5.9±0.8	[9] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(2(\pi^+\pi^-))/\Gamma_{\text{total}}$ — Γ_2/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
7.7±2.6 OUR EVALUATION Treating systematic error as correlated.				
8 ±4 OUR AVERAGE Error includes scale factor of 1.5.				
4.6±2.1±2.6	[9] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c1}$
12.6±4.2±0.6	[9] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c1}$

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

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
4.5±1.0 OUR EVALUATION Treating systematic error as correlated.				
4.5±0.9 OUR AVERAGE				
4.2±0.4±0.9	[9] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c1}$
7.3±3.0±0.4	[9] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c1}$

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

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
5.2±0.5±0.2	[10] ATHAR	07	CLEO	$\psi(2S) \to \gamma h^+h^-h^0$

$\Gamma(\pi^+\pi^-\eta')/\Gamma_{\text{total}}$ — Γ_5/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
2.5±0.5±0.1	[11] ATHAR	07	CLEO	$\psi(2S) \to \gamma h^+h^-h^0$

$\Gamma(\rho^0\pi^+\pi^-)/\Gamma_{\text{total}}$ — Γ_6/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
39±35	[12] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(K^+K^-\eta)/\Gamma_{total}$ — Γ_7/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
0.35±0.11±0.02	[13] ATHAR	07	CLEO	$\psi(2S) \to \gamma h^+ h^- h^0$

$\Gamma(K^0 K^+\pi^- + \text{c.c.})/\Gamma_{total}$ — Γ_8/Γ

VALUE (units 10^{-3})	DOCUMENT ID
7.7±0.7 OUR FIT	

$\Gamma(K^+K^-\pi^0)/\Gamma_{total}$ — Γ_9/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
2.01±0.26±0.09	[14] ATHAR	07	CLEO	$\psi(2S) \to \gamma h^+ h^- h^0$

$\Gamma(\eta\pi^+\pi^-)/\Gamma_{total}$ — Γ_{10}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
5.8±1.0±0.3	222	[15] ABLIKIM	06R	BES2	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(a_0(980)^+\pi^- + \text{c.c.} \to \eta\pi^+\pi^-)/\Gamma_{total}$ — Γ_{11}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.0±0.7±0.1	58	[16] ABLIKIM	06R	BES2	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(f_2(1270)\eta)/\Gamma_{total}$ — Γ_{12}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
3.0±0.8±0.1	53	[17] ABLIKIM	06R	BES2	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(K^+\overline{K}^*(892)^0\pi^- + \text{c.c.})/\Gamma_{total}$ — Γ_{13}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
32±21	[12] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(K^*(892)^0\overline{K}^*(892)^0)/\Gamma_{total}$ — Γ_{14}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.6±0.4±0.1	28.4 ± 5.5	[18,19] ABLIKIM	04H	BES	$\psi(2S) \to \gamma K^+K^-\pi^+\pi^-$

$\Gamma(K^*(892)^0\overline{K}^0 + \text{c.c.})/\Gamma_{total}$ — Γ_{15}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.09±0.40±0.05	22	[20] ABLIKIM	06R	BES2	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(K^*(892)^+K^- + \text{c.c.})/\Gamma_{total}$ — Γ_{16}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.6±0.7±0.1	27	[21] ABLIKIM	06R	BES2	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(K_J^*(1430)^0\overline{K}^0 + \text{c.c.} \to K_S^0 K^+\pi^- + \text{c.c.})/\Gamma_{total}$ — Γ_{17}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.9	90	[22] ABLIKIM	06R	BES2	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(K_J^*(1430)^+K^- + \text{c.c.} \to K_S^0 K^+\pi^- + \text{c.c.})/\Gamma_{total}$ — Γ_{18}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<2.4	90	[23] ABLIKIM	06R	BES2	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(\pi^+\pi^- K^0_S K^0_S)/\Gamma_{total}$ — Γ_{19}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
7.6±3.2±0.3	19.8 ± 7.7	[24] ABLIKIM	05O	BES2	$\psi(2S) \to \chi_{c1}\gamma$

$\Gamma(K^+K^- K^0_S K^0_S)/\Gamma_{total}$ — Γ_{20}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<5	90	3.2 ± 2.4	[25] ABLIKIM	05O	BES2	$\psi(2S) \to \chi_{c1}\gamma$

$\Gamma(K^+K^-K^+K^-)/\Gamma_{total}$ — Γ_{21}/Γ

VALUE (units 10^{-3})	DOCUMENT ID
0.58±0.12 OUR FIT	

$\Gamma(K^+K^-\phi)/\Gamma_{total}$ — Γ_{22}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.45±0.17±0.02	17	[26] ABLIKIM	06T	BES2	$\psi(2S) \to \gamma 2K^+ 2K^-$

$\Gamma(p\overline{p})/\Gamma_{total}$ — Γ_{23}/Γ

VALUE (units 10^{-4})	DOCUMENT ID
0.67±0.05 OUR FIT	

$\Gamma(p\overline{p}\pi^0)/\Gamma_{total}$ — Γ_{24}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
0.12±0.05±0.01	[27] ATHAR	07	CLEO	$\psi(2S) \to \gamma h^+ h^- h^0$

$\Gamma(p\overline{p}\eta)/\Gamma_{total}$ — Γ_{25}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.16	90	[28] ATHAR	07	CLEO	$\psi(2S) \to \gamma h^+ h^- h^0$

$\Gamma(\pi^+\pi^- p\overline{p})/\Gamma_{total}$ — Γ_{26}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
0.50±0.19 OUR EVALUATION	Treating systematic error as correlated.			
0.50±0.19 OUR AVERAGE				
0.46±0.12±0.15	[9] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c1}$
1.08±0.77±0.05	[9] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(K^0_S K^0_S p\overline{p})/\Gamma_{total}$ — Γ_{27}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<4.5	90	[29] ABLIKIM	06D	BES2	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(\Lambda\overline{\Lambda})/\Gamma_{total}$ — Γ_{28}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
2.4±0.9±0.5	$9.0^{+3.5}_{-3.1}$	[9] BAI	03E	BES	$\psi(2S) \to \gamma\chi_{c1} \to \gamma\Lambda\overline{\Lambda}$

$\Gamma(\Lambda\overline{\Lambda}\pi^+\pi^-)/\Gamma_{total}$ — Γ_{29}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<1.5	90	[29] ABLIKIM	06D	BES2	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(K^+ \overline{p} \Lambda)/\Gamma_{total}$ — Γ_{30}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
0.34±0.10±0.02	[30] ATHAR	07	CLEO	$\psi(2S) \to \gamma h^+ h^- h^0$

$\Gamma(\Xi^- \overline{\Xi}^+)/\Gamma_{total}$ — Γ_{31}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<3.4	90	[29] ABLIKIM	06D	BES2	$\psi(2S) \to \gamma \chi_{c1}$

$\left[\Gamma(\pi^+ \pi^-) + \Gamma(K^+ K^-)\right]/\Gamma_{total}$ — Γ_{32}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<21		[12] FELDMAN	77	MRK1	$\psi(2S) \to \gamma \chi_{c1}$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<38	90	[12] BRANDELIK	79B	DASP	$\psi(2S) \to \gamma \chi_{c1}$

$\Gamma(K^0_S K^0_S)/\Gamma_{total}$ — Γ_{33}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<0.7	90	[31] ABLIKIM	05O	BES2	$\psi(2S) \to \chi_{c1} \gamma$

[9] Rescaled by us using B($\psi(2S) \to \gamma \chi_{c1}$) = (8.8 ± 0.4)% and B($\psi(2S) \to J/\psi(1S) \pi^+ \pi^-$) = (32.3 ± 0.5)%.

[10] ATHAR 07 reports $(5.0 \pm 0.3 \pm 0.5) \times 10^{-3}$ for B($\psi(2S) \to \gamma \chi_{c1}(1P)$) = 0.0907 ± 0.0011 ± 0.0054. We rescale to our best value B($\psi(2S) \to \gamma \chi_{c1}(1P)$) = $(8.8 \pm 0.4) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[11] ATHAR 07 reports $(2.4 \pm 0.4 \pm 0.3) \times 10^{-3}$ for B($\psi(2S) \to \gamma \chi_{c1}(1P)$) = 0.0907 ± 0.0011 ± 0.0054. We rescale to our best value B($\psi(2S) \to \gamma \chi_{c1}(1P)$) = $(8.8 \pm 0.4) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[12] Estimated using B($\psi(2S) \to \gamma \chi_{c1}(1P)$) = 0.087. The errors do not contain the uncertainty in the $\psi(2S)$ decay.

[13] ATHAR 07 reports $(0.34 \pm 0.10 \pm 0.04) \times 10^{-3}$ for B($\psi(2S) \to \gamma \chi_{c1}(1P)$) = 0.0907 ± 0.0011 ± 0.0054. We rescale to our best value B($\psi(2S) \to \gamma \chi_{c1}(1P)$) = $(8.8 \pm 0.4) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[14] ATHAR 07 reports $(1.95 \pm 0.16 \pm 0.23) \times 10^{-3}$ for B($\psi(2S) \to \gamma \chi_{c1}(1P)$) = 0.0907 ± 0.0011 ± 0.0054. We rescale to our best value B($\psi(2S) \to \gamma \chi_{c1}(1P)$) = $(8.8 \pm 0.4) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[15] ABLIKIM 06R reports $(5.9 \pm 0.7 \pm 0.8) \times 10^{-3}$ for B($\psi(2S) \to \gamma \chi_{c1}(1P)$) = $(8.7 \pm 0.4) \times 10^{-2}$. We rescale to our best value B($\psi(2S) \to \gamma \chi_{c1}(1P)$) = $(8.8 \pm 0.4) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[16] ABLIKIM 06R reports $(2.0 \pm 0.5 \pm 0.5) \times 10^{-3}$ for B($\psi(2S) \to \gamma \chi_{c1}(1P)$) = $(8.7 \pm 0.4) \times 10^{-2}$. We rescale to our best value B($\psi(2S) \to \gamma \chi_{c1}(1P)$) = $(8.8 \pm 0.4) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[17] ABLIKIM 06R reports $(3.0 \pm 0.7 \pm 0.5) \times 10^{-3}$ for B($\psi(2S) \to \gamma \chi_{c1}(1P)$) = $(8.7 \pm 0.4) \times 10^{-2}$. We rescale to our best value B($\psi(2S) \to \gamma \chi_{c1}(1P)$) = $(8.8 \pm 0.4) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[18] ABLIKIM 04H reports [B($\chi_{c1}(1P) \rightarrow K^*(892)^0 \overline{K}^*(892)^0$) × B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$)] = (1.40 ± 0.27 ± 0.22) × 10^{-4}. We divide by our best value B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = (8.8 ± 0.4) × 10^{-2}. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[19] Assumes B($K^*(892)^0 \rightarrow K^-\pi^+$) = 2/3.

[20] ABLIKIM 06R reports (1.1 ± 0.4 ± 0.1) × 10^{-3} for B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = (8.7 ± 0.4)×$10^{-2}$. We rescale to our best value B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = (8.8±0.4)×$10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[21] ABLIKIM 06R reports (1.6 ± 0.7 ± 0.2) × 10^{-3} for B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = (8.7 ± 0.4)×$10^{-2}$. We rescale to our best value B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = (8.8±0.4)×$10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[22] ABLIKIM 06R reports < 0.9 × 10^{-3} for B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = (8.7 ± 0.4) × 10^{-2}. We rescale to our best value B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = 0.088.

[23] ABLIKIM 06R reports < 2.4 × 10^{-3} for B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = (8.7 ± 0.4) × 10^{-2}. We rescale to our best value B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = 0.088.

[24] ABLIKIM 05O reports [B($\chi_{c1}(1P) \rightarrow \pi^+\pi^- K^0_S K^0_S$) × B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$)] = (0.67 ± 0.26 ± 0.11) × 10^{-4}. We divide by our best value B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = (8.8 ± 0.4) × 10^{-2}. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[25] ABLIKIM 05O reports [B($\chi_{c1}(1P) \rightarrow K^+ K^- K^0_S K^0_S$) × B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$)] = < 4.2 × 10^{-5}. We divide by our best value B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = 0.088.

[26] ABLIKIM 06T reports (0.46 ± 0.16 ± 0.06) × 10^{-3} for B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = (8.7 ± 0.4) × 10^{-2}. We rescale to our best value B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = (8.8 ± 0.4) × 10^{-2}. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[27] ATHAR 07 reports (0.12 ± 0.05 ± 0.01) × 10^{-3} for B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = 0.0907 ± 0.0011 ± 0.0054. We rescale to our best value B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = (8.8 ± 0.4) × 10^{-2}. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[28] ATHAR 07 reports < 0.16 × 10^{-3} for B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = 0.0907 ± 0.0011 ± 0.0054. We rescale to our best value B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = 0.088.

[29] Using B($\psi(2S) \rightarrow \chi_{c1}\gamma$) (9.1 ± 0.6)%.

[30] ATHAR 07 reports (0.33 ± 0.09 ± 0.04) × 10^{-3} for B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = 0.0907 ± 0.0011 ± 0.0054. We rescale to our best value B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = (8.8 ± 0.4) × 10^{-2}. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[31] ABLIKIM 05O reports [B($\chi_{c1}(1P) \rightarrow K^0_S K^0_S$) × B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$)] = < 0.6 × 10^{-5}. We divide by our best value B($\psi(2S) \rightarrow \gamma\chi_{c1}(1P)$) = 0.088.

RADIATIVE DECAYS

$\Gamma(\gamma J/\psi(1S))/\Gamma_{total}$ — Γ_{34}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.359±0.019 OUR FIT				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.379±0.008±0.021	[32] ADAM	05A	CLEO	$e^+e^- \rightarrow \psi(2S) \rightarrow \gamma\chi_{c1}$

$\Gamma(\gamma\gamma)/\Gamma_{total}$ — Γ_{35}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.0015	90	[33] YAMADA	77	DASP	$e^+e^- \to 3\gamma$

[32] Uses B($\psi(2S) \to \gamma\chi_{c1} \to \gamma\gamma J/\psi$) from ADAM 05A and B($\psi(2S) \to \gamma\chi_{c1}$) from ATHAR 04.

[33] Estimated using B($\psi(2S) \to \gamma\chi_{c1}(1P)$) = 0.087. The errors do not contain the uncertainty in the $\psi(2S)$ decay.

$\chi_{c1}(1P)$ CROSS-PARTICLE BRANCHING RATIOS

$B(\chi_{c1}(1P) \to p\overline{p}) \times \frac{\Gamma(\psi(2S) \to \gamma\chi_{c1}(1P))}{\Gamma(\psi(2S) \to J/\psi(1S)\pi^+\pi^-)}$

VALUE (units 10^{-5})	DOCUMENT ID		TECN	COMMENT
1.81±0.20 OUR FIT				
1.1 ±1.0	[34] BAI	98I	BES	$\psi(2S) \to \gamma\chi_{c1} \to \gamma\overline{p}p$

$B(\chi_{c1}(1P) \to \gamma J/\psi(1S)) \times B(\psi(2S) \to \gamma\chi_{c1}(1P))$

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
3.14±0.08 OUR FIT					
2.70±0.13 OUR AVERAGE					
2.81±0.05±0.23	13k	BAI	04I	BES2	$\psi(2S) \to J/\psi\gamma\gamma$
2.56±0.12±0.20		GAISER	86	CBAL	$\psi(2S) \to \gamma X$
2.78±0.30		[35] OREGLIA	82	CBAL	$\psi(2S) \to \gamma\chi_{c1}$
2.2 ±0.5		[36] BRANDELIK	79B	DASP	$\psi(2S) \to \gamma\chi_{c1}$
2.9 ±0.5		[36] BARTEL	78B	CNTR	$\psi(2S) \to \gamma\chi_{c1}$
5.0 ±1.5		[37] BIDDICK	77	CNTR	$e^+e^- \to \gamma X$
2.8 ±0.9		[35] WHITAKER	76	MRK1	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3.44±0.06±0.13	3.7k	[38] ADAM	05A	CLEO	$\psi(2S) \to J/\psi\gamma\gamma$

$B(\chi_{c1}(1P) \to \gamma J/\psi) \times \frac{\Gamma(\psi(2S) \to \gamma\chi_{c1}(1P))}{\Gamma(\psi(2S) \to J/\psi(1S) anything)}$

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
5.51±0.09 OUR FIT					
5.77±0.10±0.12	3.7k	ADAM	05A	CLEO	$\psi(2S) \to J/\psi\gamma\gamma$

$B(\chi_{c1}(1P) \to \gamma J/\psi(1S)) \times \frac{\Gamma(\psi(2S) \to \gamma\chi_{c1}(1P))}{\Gamma(\psi(2S) \to J/\psi(1S)\pi^+\pi^-)}$

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
9.70±0.34 OUR FIT					
9.5 ±1.8 OUR AVERAGE					
12.6 ±0.3 ±3.8	3k	[39] ABLIKIM	04B	BES	$\psi(2S) \to J/\psi X$
8.5 ±2.1		[40] HIMEL	80	MRK2	$\psi(2S) \to \gamma\chi_{c1}$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
10.24±0.17±0.23	3.7k	[38] ADAM	05A	CLEO	$\psi(2S) \to J/\psi\gamma\gamma$

$B(\chi_{c1}(1P) \to K^0 K^+ \pi^- + c.c.) \times B(\psi(2S) \to \gamma \chi_{c1}(1P))$

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
6.7±0.5 OUR FIT				
7.3±0.5±0.5	[41] ATHAR	07	CLEO	$\psi(2S) \to \gamma K^0_S K^+ \pi^-$

$B(\chi_{c1}(1P) \to K^0 K^+ \pi^- + c.c.) \times \frac{\Gamma(\psi(2S) \to \gamma \chi_{c1}(1P))}{\Gamma(\psi(2S) \to J/\psi(1S) \pi^+ \pi^-)}$

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
20.7±1.7 OUR FIT				
13.2±2.4±3.2	[42] BAI	99B	BES	$\psi(2S) \to \gamma K^0_S K^+ \pi^-$

$B(\chi_{c1}(1P) \to K^+ K^- K^+ K^-) \times B(\psi(2S) \to \gamma \chi_{c1}(1P))$

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
0.51±0.10 OUR FIT					
0.61±0.11±0.08	54	[43] ABLIKIM	06T	BES2	$\psi(2S) \to \gamma K^+ K^+ K^- K^-$

$B(\chi_{c1}(1P) \to K^+ K^- K^+ K^-) \times \frac{\Gamma(\psi(2S) \to \gamma \chi_{c1}(1P))}{\Gamma(\psi(2S) \to J/\psi(1S) \pi^+ \pi^-)}$

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
1.57±0.32 OUR FIT				
1.13±0.40±0.29	[44] BAI	99B	BES	$\psi(2S) \to \gamma K^+ K^+ K^- K^-$

$B(\chi_{c1}(1P) \to p\overline{p}) \times B(\psi(2S) \to \gamma \chi_{c1}(1P))$

VALUE (units 10^{-6})	EVTS	DOCUMENT ID		TECN	COMMENT
5.8±0.6 OUR FIT					
$\mathbf{4.8^{+1.4}_{-1.3}\pm0.6}$	$18.2^{+5.5}_{-4.9}$	BAI	04F	BES	$\psi(2S) \to \gamma \chi_{c1}(1P) \to \gamma \overline{p} p$

[34] Calculated by us. The value for $B(\chi_{c1} \to p\overline{p})$ reported in BAI 98I is derived using $B(\psi(2S) \to \gamma \chi_{c1}) = (8.7 \pm 0.8)\%$ and $B(\psi(2S) \to J/\psi(1S)\pi^+\pi^-) = (32.4 \pm 2.6)\%$ [BAI 98D].

[35] Recalculated by us using $B(J/\psi(1S) \to \ell^+\ell^-) = 0.1181 \pm 0.0020$.

[36] Recalculated by us using $B(J/\psi(1S) \to \mu^+\mu^-) = 0.0588 \pm 0.0010$.

[37] Assumes isotropic gamma distribution.

[38] Not independent from other values reported by ADAM 05A.

[39] From a fit to the J/ψ recoil mass spectra.

[40] The value for $B(\psi(2S) \to \gamma \chi_{c1}) \times B(\chi_{c1} \to \gamma J/\psi(1S))$ quoted in HIMEL 80 is derived using $B(\psi(2S) \to J/\psi(1S)\pi^+\pi^-) = (33 \pm 3)\%$ and $B(J/\psi(1S) \to \ell^+\ell^-) = 0.138 \pm 0.018$. Calculated by us using $B(J/\psi(1S) \to \ell^+\ell^-) = 0.1181 \pm 0.0020$.

[41] Calculated by us. The value of $B(\chi_{c1} \to K^0 K^+ \pi^- + c.c.)$ reported by ATHAR 07 was derived using $B(\psi(2S) \to \gamma \chi_{c1}(1P)) = (9.07 \pm 0.11 \pm 0.54)\%$.

[42] Calculated by us. The value of $B(\chi_{c1} \to K^0_S K^+ \pi^-)$ reported by BAI 99B was derived using $B(\psi(2S) \to \gamma \chi_{c1}(1P)) = (8.7 \pm 0.8)\%$ and $B(\psi(2S) \to J/\psi \pi^+\pi^-) = (32.4 \pm 2.6)\%$ [BAI 98D].

[43] Calculated by us. The value of B($\chi_{c1} \rightarrow 2K^+ 2K^-$) reported by ABLIKIM 06T was derived using B($\psi(2S) \rightarrow \gamma \chi_{c1}(1P)$) = (8.7 ± 0.8)%.

[44] Calculated by us. The value of B($\chi_{c1} \rightarrow 2K^+ 2K^-$) reported by BAI 99B was derived using B($\psi(2S) \rightarrow \gamma \chi_{c1}(1P)$) = (8.7 ± 0.8)% and B($\psi(2S) \rightarrow J/\psi \pi^+ \pi^-$) = (32.4 ± 2.6)% [BAI 98D].

MULTIPOLE AMPLITUDES IN $\chi_{c1}(1P) \rightarrow \gamma J/\psi(1S)$

$a_2 = M2/\sqrt{E1^2 + M2^2}$ Magnetic quadrupole fractional transition amplitude

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$-0.002^{+0.008}_{-0.017}$ **OUR AVERAGE**					
$0.002 \pm 0.032 \pm 0.004$	2090	AMBROGIANI	02	E835	$p\overline{p} \rightarrow \chi_{c1} \rightarrow J/\psi \gamma$
$-0.002^{+0.008}_{-0.020}$	921	OREGLIA	82	CBAL	$\psi(2S) \rightarrow \chi_{c1} \gamma \rightarrow J/\psi \gamma \gamma$

$\chi_{c1}(1P)$ REFERENCES

ATHAR	07	PR D75 032002	S.B. Athar et al.	(CLEO Collab.)
ABLIKIM	06D	PR D73 052006	M. Ablikim et al.	(BES Collab.)
ABLIKIM	06R	PR D74 072001	M. Ablikim et al.	(BES Collab.)
ABLIKIM	06T	PL B642 197	M. Ablikim et al.	(BES Collab.)
ABLIKIM	05G	PR D71 092002	M. Ablikim et al.	(BES Collab.)
ABLIKIM	05O	PL B630 21	M. Ablikim et al.	(BES Collab.)
ADAM	05A	PRL 94 232002	N.E. Adam et al.	(CLEO Collab.)
ANDREOTTI	05A	NP B717 34	M. Andreotti et al.	(FNAL E835 Collab.)
ABLIKIM	04B	PR D70 012003	M. Ablikim et al.	(BES Collab.)
ABLIKIM	04H	PR D70 092003	M. Ablikim et al.	(BES Collab.)
ATHAR	04	PR D70 112002	S.B. Athar et al.	(CLEO Collab.)
BAI	04F	PR D69 092001	J.Z. Bai et al.	(BES Collab.)
BAI	04I	PR D70 012006	J.Z. Bai et al.	(BES Collab.)
AULCHENKO	03	PL B573 63	V.M. Aulchenko et al.	(KEDR Collab.)
BAI	03E	PR D67 112001	J.Z. Bai et al.	(BES Collab.)
AMBROGIANI	02	PR D65 052002	M. Ambrogiani et al.	(FNAL E835 Collab.)
BAI	99B	PR D60 072001	J.Z. Bai et al.	(BES Collab.)
BAI	98D	PR D58 092006	J.Z. Bai et al.	(BES Collab.)
BAI	98I	PRL 81 3091	J.Z. Bai et al.	(BES Collab.)
ARMSTRONG	92	NP B373 35	T.A. Armstrong et al.	(FNAL, FERR, GENO+)
Also		PRL 68 1468	T.A. Armstrong et al.	(FNAL, FERR, GENO+)
BAGLIN	86B	PL B172 455	C. Baglin	(LAPP, CERN, GENO, LYON, OSLO+)
GAISER	86	PR D34 711	J. Gaiser et al.	(Crystal Ball Collab.)
LEMOIGNE	82	PL 113B 509	Y. Lemoigne et al.	(SACL, LOIC, SHMP+)
OREGLIA	82	PR D25 2259	M.J. Oreglia et al.	(SLAC, CIT, HARV+)
Also		Private Comm.	M.J. Oreglia	(EFI)
HIMEL	80	PRL 44 920	T. Himel et al.	(LBL, SLAC)
Also		Private Comm.	G. Trilling	(LBL, UCB)
BRANDELIK	79B	NP B160 426	R. Brandelik et al.	(DASP Collab.)
BARTEL	78B	PL 79B 492	W. Bartel et al.	(DESY, HEIDP)
TANENBAUM	78	PR D17 1731	W.M. Tanenbaum et al.	(SLAC, LBL)
Also		Private Comm.	G. Trilling	(LBL, UCB)
BIDDICK	77	PRL 38 1324	C.J. Biddick et al.	(UCSD, UMD, PAVI+)
FELDMAN	77	PRPL 33C 285	G.J. Feldman, M.L. Perl	(LBL, SLAC)
YAMADA	77	Hamburg Conf. 69	S. Yamada	(DASP Collab.)
WHITAKER	76	PRL 37 1596	J.S. Whitaker et al.	(SLAC, LBL)
TANENBAUM	75	PRL 35 1323	W.M. Tanenbaum et al.	(LBL, SLAC)

OTHER RELATED PAPERS

BARBERIS	00G	PL B485 357	D. Barberis et al.	(Omega Expt.)
BARATE	83	PL 121B 449	R. Barate et al.	(SACL, LOIC, SHMP, IND)
BRAUNSCH...	75B	PL 57B 407	W. Braunschweig et al.	(DASP Collab.)
SIMPSON	75	PRL 35 699	J.W. Simpson et al.	(STAN, PENN)