$\chi_{c1}(1P)$

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

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

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
3510.51± 0.12 OUR AVERAGE					
3509.4 ± 0.9		BAI	99B	BES	$\psi(2S) \rightarrow \gamma X$
3510.53± 0.04±0.12	513	ARMSTRONG	92	E760	$\overline{p}p \rightarrow e^+e^-\gamma$
3511.3 ± 0.4 ±0.4	30	BAGLIN	86B	SPEC	$\overline{p}p \rightarrow e^+e^- X$
3512.3 ± 0.3 ±4.0		[1] GAISER	86	CBAL	$\psi(2S) \rightarrow \gamma X$
3507.4 ± 1.7	91	[2] LEMOIGNE	82	GOLI	190 π^- Be $\rightarrow \gamma 2\mu$
3510.4 ± 0.6		OREGLIA	82	CBAL	$e^+e^- \rightarrow J/\psi 2\gamma$
3510.1 ± 1.1	254	[3] HIMEL	80	MRK2	$e^+e^- \rightarrow J/\psi 2\gamma$
3509 ±11	21	BRANDELIK	79B	DASP	$e^+e^- \rightarrow J/\psi 2\gamma$
3507 ± 3		[3] BARTEL	78B	CNTR	$e^+e^- \rightarrow J/\psi 2\gamma$
3505.0 ± 4 ±4		[3,4] TANENBAUM	78	MRK1	e^+e^-
3513 ± 7	367	[3] BIDDICK	77	CNTR	$\psi(2S) \rightarrow \gamma X$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3500 ±10	40	TANENBAUM	75	MRK1	Hadrons γ

[1] Using mass of $\psi(2S)$ = 3686.0 MeV.
[2] $J/\psi(1S)$ mass constrained to 3097 MeV.
[3] Mass value shifted by us by amount appropriate for $\psi(2S)$ mass = 3686 MeV and $J/\psi(1S)$ mass = 3097 MeV.
[4] From a simultaneous fit to radiative and hadronic decay channels.

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

VALUE (MeV)	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.88±0.11±0.08		513	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	$\psi(2S) \rightarrow \gamma X$

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

	Mode	Fraction (Γ_i/Γ)	Scale factor
	Hadronic decays		
Γ_1	$3(\pi^+\pi^-)$	$(6.3\pm1.4)\times10^{-3}$	
Γ_2	$2(\pi^+\pi^-)$	$(5.6\pm2.6)\times10^{-3}$	2.2
Γ_3	$\pi^+\pi^-K^+K^-$	$(4.9\pm1.2)\times10^{-3}$	1.1
Γ_4	$\rho^0\pi^+\pi^-$	$(3.9\pm3.5)\times10^{-3}$	
Γ_5	$K^+\overline{K}^*(892)^0\pi^-$ + c.c.	$(3.2\pm2.1)\times10^{-3}$	
Γ_6	$K^0_S K^+\pi^-$	$(2.5\pm0.8)\times10^{-3}$	
Γ_7	$\pi^+\pi^-p\overline{p}$	$(5.4\pm2.1)\times10^{-4}$	
Γ_8	$K^+K^-K^+K^-$	$(4.2\pm1.9)\times10^{-4}$	
Γ_9	$p\overline{p}$	$(8.2\pm1.3)\times10^{-5}$	1.2
Γ_{10}	$\pi^+\pi^- + K^+K^-$	$< 2.1 \times10^{-3}$	
	Radiative decays		
Γ_{11}	$\gamma J/\psi(1S)$	(27.3 ± 1.6) %	
Γ_{12}	$\gamma\gamma$		

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

$\Gamma(p\overline{p})$ — Γ_9

VALUE (eV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
74± 9 OUR AVERAGE					
$76\pm10\pm5$	513	[5] ARMSTRONG	92	E760	$\overline{p}p \to e^+e^-\gamma$
$69^{+16}_{-13}\pm4$		[5] BAGLIN	86B	SPEC	$\overline{p}p \to e^+e^-X$

[5] Restated by us using $B(\chi_{c1}(1P) \to J/\psi(1S)\gamma)B(J/\psi(1S) \to e^+e^-) = 0.0171 \pm 0.0011$.

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

HADRONIC DECAYS

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

VALUE (units 10^{-3})	*DOCUMENT ID*		*TECN*	*COMMENT*
6.3±1.4 OUR AVERAGE				
$5.8\pm0.7\pm1.2$	[6] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c1}$
22 ± 8	[7] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c1}$

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

VALUE (units 10^{-3})	*DOCUMENT ID*		*TECN*	*COMMENT*
5.6±2.6 OUR AVERAGE Error includes scale factor of 2.2.				
$4.9\pm0.4\pm1.2$	[6] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c1}$
16 ± 5	[7] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c1}$

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

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
49±12 OUR AVERAGE Error includes scale factor of 1.1.				
45± 4±11	[6] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c1}$
90±40	[7] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(\rho^0\pi^+\pi^-)/\Gamma_{total}$ — Γ_4/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
39±35	[7] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(K^+\overline{K}^*(892)^0\pi^- + \text{c.c.})/\Gamma_{total}$ — Γ_5/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
32±21	[7] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c1}$

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

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
2.46±0.44±0.65	[6] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(\pi^+\pi^- p\overline{p})/\Gamma_{total}$ — Γ_7/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
5.4±2.1 OUR AVERAGE				
4.9±1.3±1.7	[6] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c1}$
14 ±9	[7] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(K^+K^-K^+K^-)/\Gamma_{total}$ — Γ_8/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
0.42±0.15±0.12	[6] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(p\overline{p})/\Gamma_{total}$ — Γ_9/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.82±0.13 OUR AVERAGE Error includes scale factor of 1.2.						
0.42±0.22±0.28		4.2 ± 2.2	[6] BAI	98I	BES	$\psi(2S) \to \gamma\chi_{c1}$
0.86±0.12		513	[8] ARMSTRONG	92	E760	$\overline{p}p \to e^+e^-\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
> 0.54	95		BAGLIN	86B	SPEC	$\overline{p}p \to e^+e^-X$
<12.0	90		[7] BRANDELIK	79B	DASP	$\psi(2S) \to \gamma\chi_{c1}$

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

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<21		[7] FELDMAN	77	MRK1	$\psi(2S) \to \gamma\chi_{c1}$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<38	90	[7] BRANDELIK	79B	DASP	$\psi(2S) \to \gamma\chi_{c1}$

[6] Using $B(\psi(2S) \to \gamma\chi_{c1}(1P)) = 0.087 \pm 0.008$.

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

[8] Restated by us using $B(\chi_{c1}(1P) \to J/\psi(1S)\gamma)B(J/\psi(1S) \to e^+e^-) = 0.0171 \pm 0.0011$.

RADIATIVE DECAYS

$\Gamma(\gamma J/\psi(1S))/\Gamma_{total}$ Γ_{11}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.273±0.016 OUR AVERAGE					
0.284±0.021		GAISER	86	CBAL	$\psi(2S) \to \gamma X$
0.274±0.046	943	[9] OREGLIA	82	CBAL	$\psi(2S) \to \gamma \chi_{c1}$
0.28 ±0.07		[9] HIMEL	80	MRK2	$\psi(2S) \to \gamma \chi_{c1}$
0.19 ±0.05		[9] BRANDELIK	79B	DASP	$\psi(2S) \to \gamma \chi_{c1}$
0.29 ±0.05		[9] BARTEL	78B	CNTR	$\psi(2S) \to \gamma \chi_{c1}$
0.28 ±0.09		[9] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma \chi_{c1}$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.57 ±0.17		[9] BIDDICK	77	CNTR	$\psi(2S) \to \gamma X$

$\Gamma(\gamma\gamma)/\Gamma_{total}$ Γ_{12}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.0015	90	[9] YAMADA	77	DASP	$e^+ e^- \to 3\gamma$

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

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

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ARMSTRONG	92	NP B373 35	T.A. Armstrong *et al.*	(FNAL, FERR, GENO+)
Also	92B	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+)
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