$\Gamma(\gamma\gamma)/\Gamma_{total}$ Γ_{13}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
4.0±2.0±1.1		[6] LEE	85	CBAL	$\psi' \to$ photons
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<15	90	[7] YAMADA	77	DASP	$e^+e^- \to 3\gamma$

[7] Calculated using B($\psi(2S) \to \gamma\chi_{c0}(1P)$) = 0.094; the errors do not contain the uncertainty in the $\psi(2S)$ decay.

$\chi_{c0}(1P)$ REFERENCES

CHEN	90B	PL B243 169	+McIlwain+	(CLEO Collab.)
AIHARA	88D	PRL 60 2355	+Alston-Garnjost+	(TPC Collab.)
GAISER	86	PR D34 711	+Bloom, Bulos, Godfrey+	(Crystal Ball Collab.)
LEE	85	SLAC 282		(SLAC)
BRANDELIK	79B	NP B160 426	+Cords+	(DASP Collab.)
HIMEL	79	Thesis SLAC-0223		(SLAC)
Also	82	Private Comm.	Trilling	(LBL, UCB)
BARTEL	78B	PL 79B 492	+Dittmann, Duinker, Olsson, O'Neill+	(DESY, HEIDP)
TANENBAUM	78	PR D17 1731	+Alam, Boyarski+	(SLAC, LBL)
Also	82	Private Comm.	Trilling	(LBL, UCB)
BIDDICK	77	PRL 38 1324	+Burnett+	(UCSD, UMD, PAVI, PRIN, SLAC, STAN)
FELDMAN	77	PRPL 33C 285	+Perl	(LBL, SLAC)
YAMADA	77	Hamburg Conf. 69		(DASP Collab.)
WIIK	75	Stanford Symp. 69		(DESY)

OTHER RELATED PAPERS

OREGLIA	82	PR D25 2259	+Partridge+	(SLAC, CIT, HARV, PRIN, STAN)
FELDMAN	75B	PRL 35 821	+Jean-Marie, Sadoulet, Vannucci+	(LBL, SLAC)
Also Erratum.	75C	PRL 35 1189	Feldman	
TANENBAUM	75	PRL 35 1323	+Whitaker, Abrams+	(LBL, SLAC)

$\chi_{c1}(1P)$ or $\chi_{c1}(3510)$

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

Observed in the radiative sequential decay $\psi(2S) \to \chi_{c1}(1P)\gamma$, $\chi_{c1}(1P) \to J/\psi(1S)\gamma$. Therefore, $C = +$. The lack of decays into $\pi^+\pi^-$ or K^+K^- is suggestive of J^P=abnormal. The decays into 4π and 6π imply $G = +$, thus $I = 0$. J=0,2 excluded by angular distribution in the $J/\psi(1S)\gamma$ decay. $J^P = 1^+$ preferred (FELDMAN 77, OREGLIA 82).

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

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
3510.53± 0.12 OUR AVERAGE					
3510.53± 0.04±0.12	513	ARMSTRONG	92	SPEC	$\overline{p}p \to e^+e^-\gamma$
3511.3 ± 0.4 ±0.4	30	BAGLIN	86B	SPEC	$\overline{p}p \to e^+e^-X$
3512.3 ± 0.3 ±4.0		[1] GAISER	86	CBAL	$\psi(2S) \to \gamma X$
3507.4 ± 1.7	91	[2] LEMOIGNE	82	GOLI	190 GeV π^- Be $\to \gamma 2\mu$
3510.4 ± 0.6		OREGLIA	82	CBAL	$e^+e^- \to J/\psi 2\gamma$
3510.1 ± 1.1	254	[3] HIMEL	80	MRK2	$e^+e^- \to J/\psi 2\gamma$
3509.0 ±11.0	21	BRANDELIK	79B	DASP	$e^+e^- \to J/\psi 2\gamma$
3507.0 ± 3.0		[3] BARTEL	78B	CNTR	$e^+e^- \to J/\psi 2\gamma$
3505.0 ± 4 ±4		[3,4] TANENBAUM	78	MRK1	e^+e^-
3513.0 ± 7.0	367	[3] BIDDICK	77	CNTR	$\psi(2S) \to \gamma X$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3510.0 ±20.0		BARTEL	76B	CNTR	$e^+e^- \to J/\psi 2\gamma$
3500 ±10	40	TANENBAUM	75	MRK1	Hadrons γ
3507.0 ± 7.0	7	WIIK	75	DASP	$e^+e^- \to J/\psi 2\gamma$

[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	SPEC	$\overline{p}p \to e^+e^-\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<1.3	95		BAGLIN	86B	SPEC	$\overline{p}p \to e^+e^-X$
<3.8	90		GAISER	86	CBAL	$\psi(2S) \to \gamma X$

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

	Mode	Fraction (Γ_i/Γ)
	Hadronic decays	
Γ_1	$3(\pi^+\pi^-)$	(2.2±0.8) %
Γ_2	$2(\pi^+\pi^-)$	(1.6±0.5) %
Γ_3	$\pi^+\pi^-K^+K^-$	(9 ±4) $\times 10^{-3}$
Γ_4	$\rho^0\pi^+\pi^-$	(3.9±3.5) $\times 10^{-3}$
Γ_5	$K^+\overline{K}^*(892)^0\pi^-$ + c.c.	(3.2±2.1) $\times 10^{-3}$
Γ_6	$\pi^+\pi^-p\overline{p}$	(1.4±0.9) $\times 10^{-3}$
Γ_7	$p\overline{p}$	(8.6±1.2) $\times 10^{-5}$
Γ_8	$\pi^+\pi^- + K^+K^-$	< 2.1 $\times 10^{-3}$
	Radiative decays	
Γ_9	$\gamma J/\psi(1S)$	(27.3±1.6) %
Γ_{10}	$\gamma\gamma$	

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

$\Gamma(p\overline{p})$ — Γ_7

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
74± 9 OUR AVERAGE					
76±10±5	513	[5] ARMSTRONG	92	SPEC	$\overline{p}p \to e^+e^-\gamma$
$69^{+16}_{-13}\pm4$		[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 ± 0.0011.

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

HADRONIC DECAYS

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.022±0.008	[7] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c1}$

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.016±0.005	[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
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	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(\pi^+\pi^-p\overline{p})/\Gamma_{total}$ — Γ_6/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
14±9	[7] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c1}$

$\Gamma(p\overline{p})/\Gamma_{\text{total}}$ Γ_7/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.86±0.12		513	[6] ARMSTRONG	92	SPEC	$\overline{p}p \to e^+e^-\gamma$
• • • 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	$\psi(2S) \to \gamma\chi_{c1}$

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

$\left[\Gamma(\pi^+\pi^-) + \Gamma(K^+K^-)\right]/\Gamma_{\text{total}}$ Γ_8/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	$\psi(2S) \to \gamma\chi_{c1}$

[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.

RADIATIVE DECAYS

$\Gamma(\gamma J/\psi(1S))/\Gamma_{\text{total}}$ Γ_9/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	[8] OREGLIA	82	CBAL	$\psi(2S) \to \gamma\chi_{c1}$
0.28 ±0.07		[8] HIMEL	80	MRK2	$\psi(2S) \to \gamma\chi_{c1}$
0.19 ±0.05		[8] BRANDELIK	79B	DASP	$\psi(2S) \to \gamma\chi_{c1}$
0.29 ±0.05		[8] BARTEL	78B	CNTR	$\psi(2S) \to \gamma\chi_{c1}$
0.28 ±0.09		[8] 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		[8] BIDDICK	77	CNTR	$\psi(2S) \to \gamma X$

$\Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ Γ_{10}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<$0.0015	90	[8] YAMADA	77	DASP	$e^+e^- \to 3\gamma$

[8] 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

ARMSTRONG	92	NP B373 35	+Bettoni+	(FNAL, FERR, GENO, UCI, NWES+)
Also	92B	PRL 68 1468	Armstrong, Bettoni+	(FNAL, FERR, GENO, UCI, NWES+)
BAGLIN	86B	PL B172 455		(LAPP, CERN, GENO, LYON, OSLO, ROMA+)
GAISER	86	PR D34 711	+Bloom, Bulos, Godfrey+	(Crystal Ball Collab.)
LEMOIGNE	82	PL 113B 509	+Barate, Astbury+	(SACL, LOIC, SHMP, IND)
OREGLIA	82	PR D25 2259	+Partridge+	(SLAC, CIT, HARV, PRIN, STAN)
Also	82B	Private Comm.	Oreglia	(EFI)
HIMEL	80	PRL 44 920	+Abrams, Alam, Blocker+	(LBL, SLAC)
Also	82	Private Comm.	Trilling	(LBL, UCB)
BRANDELIK	79B	NP B160 426	+Cords+	(DASP Collab.)
BARTEL	78B	PL 79B 492	+Dittmann, Duinker, Olsson, O'Neill+	(DESY, HEIDP)
TANENBAUM	78	PR D17 1731	+Alam, Boyarski+	(SLAC, LBL)
Also	82	Private Comm.	Trilling	(LBL, UCB)
BIDDICK	77	PRL 38 1324	+Burnett+	(UCSD, UMD, PAVI, PRIN, SLAC, STAN)
FELDMAN	77	PRPL 33C 285	+Perl	(LBL, SLAC)
YAMADA	77	Hamburg Conf. 69		(DASP Collab.)
BARTEL	76B	Tbilisi Conf. N75	+Duinker, Olsson, Heintze+	(DESY, HEIDP)
TANENBAUM	75	PRL 35 1323	+Whitaker, Abrams+	(LBL, SLAC)
WIIK	75	Stanford Symp. 69		(DESY)

OTHER RELATED PAPERS

BARATE	83	PL 121B 449	+Bareyre, Bonamy+	(SACL, LOIC, SHMP, IND)
BRAUNSCH...	75B	PL 57B 407	Braunschweig, Konigs+	(DASP Collab.)
FELDMAN	75	Stanford Symp. 39		(SLAC)
HEINTZE	75	Stanford Symp. 97		(HEIDP)
SIMPSON	75	PRL 35 699	+Beron, Ford, Hilger, Hofstadter+	(STAN, PENN)