$\chi_{c0}(1P)$

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

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

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
3415.19± 0.34 OUR AVERAGE					
$3414.7\ ^{+\ 0.7}_{-\ 0.6}\ \pm 0.2$		[1] ANDREOTTI	03	E835	$\overline{p}p \to \chi_{c0} \to \pi^0\pi^0$
$3415.4 \pm 0.4 \pm 0.2$	392	[1] BAGNASCO	02	E835	$\overline{p}p \to \chi_{c0} \to J/\psi\gamma$
3416.5 ± 3.0		EISENSTEIN	01	CLE2	$e^+e^- \to e^+e^-\chi_{c0}$
$3417.4\ ^{+\ 1.8}_{-\ 1.9}\ \pm 0.2$		[1] AMBROGIANI	99B	E835	$\overline{p}p \to e^+e^-\gamma$
$3414.1 \pm 0.6 \pm 0.8$		BAI	99B	BES	$\psi(2S) \to \gamma X$
$3417.8 \pm 0.4 \pm 4$		[1] GAISER	86	CBAL	$\psi(2S) \to \gamma X$
3422 ± 10		[2] BARTEL	78B	CNTR	$e^+e^- \to J/\psi 2\gamma$
$3416 \pm 3 \pm 4$		[2] TANENBAUM	78	MRK1	e^+e^-
3415 ± 9		[2] BIDDICK	77	CNTR	$e^+e^- \to \gamma X$

[1] Using mass of $\psi(2S) = 3686.0$ MeV.

[2] Mass value shifted by us by amount appropriate for $\psi(2S)$ mass = 3686 MeV and $J/\psi(1S)$ mass = 3097 MeV.

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

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
10.1±0.8 OUR FIT					
10.2±0.9 OUR AVERAGE Error includes scale factor of 1.2.					
$8.6^{+1.7}_{-1.3}\pm 0.1$		ANDREOTTI	03	E835	$\overline{p}p \to \chi_{c0} \to \pi^0\pi^0$
$9.8 \pm 1.0 \pm 0.1$	392	BAGNASCO	02	E835	$\overline{p}p \to \chi_{c0} \to J/\psi\gamma$
$16.6^{+5.2}_{-3.7}\pm 0.1$		AMBROGIANI	99B	E835	$\overline{p}p \to e^+e^-\gamma$
$14.3 \pm 2.0 \pm 3.0$		BAI	98I	BES	$\psi(2S) \to \gamma\pi^+\pi^-$
$13.5 \pm 3.3 \pm 4.2$		GAISER	86	CBAL	$\psi(2S) \to \gamma X,\ \gamma\pi^0\pi^0$

$\chi_{c0}(1P)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Confidence level
	Hadronic decays		
Γ_1	$2(\pi^+\pi^-)$	(2.58 ± 0.31) %	
Γ_2	$\pi^+\pi^-K^+K^-$	$(2.1\ \pm0.5\ )$ %	
Γ_3	$\rho^0\pi^+\pi^-$	$(1.6\ \pm0.5\ )$ %	
Γ_4	$3(\pi^+\pi^-)$	(1.27 ± 0.22) %	
Γ_5	$K^+\overline{K}^*(892)^0\pi^- +$ c.c.	$(1.2\ \pm0.4\ )$ %	
Γ_6	K^+K^-	$(6.0\ \pm0.9\ )\times10^{-3}$	
Γ_7	$\pi\pi$	$(7.4\ \pm0.8\ )\times10^{-3}$	

Γ_8	$\eta\eta$	$(2.1 \pm 1.1) \times 10^{-3}$	
Γ_9	$K^+K^-K^+K^-$	$(2.3 \pm 0.5) \times 10^{-3}$	
Γ_{10}	$K^0_S K^0_S$	$(2.1 \pm 0.6) \times 10^{-3}$	
Γ_{11}	$\pi^+\pi^- p\overline{p}$	$(2.2 \pm 0.8) \times 10^{-3}$	
Γ_{12}	$\phi\phi$	$(1.0 \pm 0.6) \times 10^{-3}$	
Γ_{13}	$p\overline{p}$	$(2.24 \pm 0.27) \times 10^{-4}$	
Γ_{14}	$\Lambda\overline{\Lambda}$	$(4.7 \pm 1.6) \times 10^{-4}$	
Γ_{15}	$K^0_S K^+\pi^-$ + c.c.	$< 8 \times 10^{-4}$	90%

Radiative decays

Γ_{16}	$\gamma J/\psi(1S)$	(1.18 ± 0.14) %	
Γ_{17}	$\gamma\gamma$	$(2.6 \pm 0.5) \times 10^{-4}$	

$\chi_{c0}(1P)$ PARTIAL WIDTHS

$\chi_{c0}(1P)$ Γ(i)$\Gamma(\gamma J/\psi(1S))/\Gamma$(total)

$\Gamma(p\overline{p}) \times \Gamma(\gamma J/\psi(1S))/\Gamma_{\text{total}}$ $\Gamma_{13}\Gamma_{16}/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
26.8± 2.9 OUR FIT					
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$26.6 \pm 2.6 \pm 1.4$	392	[3,4] BAGNASCO	02	E835	$\overline{p}p \to \chi_{c0} \to J/\psi\gamma$
$48.7^{+11.3}_{-8.9} \pm 2.4$		[3,4] AMBROGIANI	99B	E835	$\overline{p}p \to \gamma J/\psi$

$\Gamma(\gamma\gamma) \times \Gamma(2(\pi^+\pi^-))/\Gamma_{\text{total}}$ $\Gamma_{17}\Gamma_1/\Gamma$

VALUE (eV)	DOCUMENT ID		TECN	COMMENT
67±14 OUR FIT				
75±13±8	EISENSTEIN	01	CLE2	$e^+e^- \to e^+e^-\chi_{c0}$

[3] Calculated by us using $B(J/\psi(1S) \to e^+e^-) = 0.0593 \pm 0.0010$.

[4] Values in $(\Gamma(p\overline{p}) \times \Gamma(\gamma J/\psi(1S))/\Gamma_{\text{total}})$ and $(\Gamma(p\overline{p}) \times \Gamma(\gamma J/\psi(1S))/\Gamma^2_{\text{total}})$ are not independent. The latter is used in the fit since it is less correlated to the total width.

$\chi_{c0}(1P)$ BRANCHING RATIOS

HADRONIC DECAYS

$\Gamma(2(\pi^+\pi^-))/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE	DOCUMENT ID
0.0258±0.0031 OUR FIT	

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

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
21 ±5 OUR EVALUATION Treating systematic error as correlated.				
21 ±6 OUR AVERAGE Error includes scale factor of 1.9.				
$15.6 \pm 0.7 \pm 3.9$	[5] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c0}$
$27.4 \pm 3.7 \pm 2.7$	[5] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$

$\Gamma(\rho^0\pi^+\pi^-)/\Gamma_{total}$ Γ_3/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.016±0.005	[6] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$

$\Gamma(3(\pi^+\pi^-))/\Gamma_{total}$ Γ_4/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
12.7±2.2 OUR EVALUATION	Treating systematic error as correlated.			
12.7±2.0 OUR AVERAGE				
12.4±1.1±2.3	[5] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c0}$
13.3±3.0±1.3	[5] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.012±0.004	[6] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$

$\Gamma(K^+K^-)/\Gamma_{total}$ Γ_6/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
6.0±0.4±0.8	774±38	[5] BAI	98I	BES	$\psi(2S) \to \gamma\chi_{c0}$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
6 ±3		[6] BRANDELIK	79B	DASP	$\psi(2S) \to \gamma\chi_{c0}$
9 ±4		[6] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$

$\Gamma(K^0_S K^0_S)/\Gamma_{total}$ Γ_{10}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
2.08±0.30±0.54	[5] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c0}$

$\Gamma(\pi\pi)/\Gamma_{total}$ Γ_7/Γ

VALUE (units 10^{-3})	DOCUMENT ID
7.4±0.8 OUR FIT	

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

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
2.27±0.28±0.40	[5] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c0}$

$\Gamma(\pi^+\pi^- p\overline{p})/\Gamma_{total}$ Γ_{11}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
2.2 ±0.8 OUR EVALUATION	Treating systematic error as correlated.			
2.2 ±1.1 OUR AVERAGE	Error includes scale factor of 1.9.			
1.66±0.22±0.58	[5] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c0}$
4.4 ±1.2 ±0.4	[5] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$

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

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
1.0±0.4±0.4	[5] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c0}$

$\Gamma(\eta\eta)/\Gamma_{\text{total}}$ Γ_8/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
2.1±0.9±0.6	12.7 ± 5.3	[5] BAI	03C	BES	$\psi(2S) \to \gamma\eta\eta \to 5\gamma$

• • • We do not use the following data for averages, fits, limits, etc. • • •

$2.5\pm0.8\pm0.8$	[7] LEE	85	CBAL	$\psi' \to$ photons

$\Gamma(\eta\eta)/\Gamma(\pi\pi)$ Γ_8/Γ_7

VALUE	DOCUMENT ID		TECN	COMMENT

• • • We do not use the following data for averages, fits, limits, etc. • • •

$0.24\pm0.10\pm0.08$	[8] BAI	03C	BES	$\psi(2S) \to 5\gamma$

$\Gamma(K^0_S K^+\pi^- + \text{c.c.})/\Gamma_{\text{total}}$ Γ_{15}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
<0.8	90	[5] BAI	99B	BES	$\psi(2S) \to \gamma\chi_{c0}$

$\Gamma(p\overline{p})/\Gamma_{\text{total}}$ Γ_{13}/Γ

VALUE (units 10^{-4})	DOCUMENT ID
2.24±0.27 OUR FIT	

$\Gamma(\Lambda\overline{\Lambda})/\Gamma_{\text{total}}$ Γ_{14}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
4.7±1.3±1.0	$15.2^{+4.2}_{-4.0}$	[5] BAI	03E	BES	$\psi(2S) \to \gamma\chi_{c0} \to \gamma\Lambda\overline{\Lambda}$

$\Gamma(p\overline{p}) \times \Gamma(\pi\pi)/\Gamma^2_{\text{total}}$ $\Gamma_{13}\Gamma_7/\Gamma^2$

VALUE (units 10^{-7})	DOCUMENT ID		TECN	COMMENT
16.7±1.9 OUR FIT				
15.3±2.4±0.8	[9] ANDREOTTI	03	E835	$\overline{p}p \to \chi_{c0} \to \pi^0\pi^0$

[5] Rescaled by us using B($\psi(2S) \to \gamma\chi_{c0}$)= (8.6 ± 0.7)% and B($\psi(2S) \to J/\psi(1S)\pi^+\pi^-$) = 0.317 ± 0.011.

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

[7] Calculated using B($\psi(2S) \to \gamma\chi_{c0}(1P)$) = 0.093 ± 0.008.

[8] We have multiplied $\pi^0\pi^0$ measurement by 3 to obtain $\pi\pi$.

[9] We have multiplied B($p\overline{p}$)·B($\pi^0\pi^0$) measurement by 3 to obtain B($p\overline{p}$)·B($\pi\pi$).

RADIATIVE DECAYS

$\Gamma(\gamma J/\psi(1S))/\Gamma_{\text{total}}$ Γ_{16}/Γ

VALUE (units 10^{-4})	DOCUMENT ID
118±14 OUR FIT	

$\Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ Γ_{17}/Γ

VALUE (units 10^{-4})	DOCUMENT ID
2.6±0.5 OUR FIT	

$\Gamma(\gamma\gamma)/\Gamma(\gamma J/\psi(1S))$ Γ_{17}/Γ_{16}

VALUE (units 10^{-2})	DOCUMENT ID		TECN	COMMENT
2.2 ±0.6 OUR FIT				
1.45±0.74	[10] AMBROGIANI	00B	E835	$\overline{p}p \to \chi_{c2} \to \gamma\gamma, \gamma J/\psi$

$\Gamma(p\overline{p}) \times \Gamma(\gamma J/\psi(1S))/\Gamma^2_{\text{total}}$ $\Gamma_{13}\Gamma_{16}/\Gamma^2$

VALUE (units 10^{-7})	EVTS	DOCUMENT ID		TECN	COMMENT
26.5±2.0 OUR FIT					
27.5±2.1 OUR AVERAGE					
27.2±1.9±1.3	392	[10,11] BAGNASCO	02	E835	$\overline{p}p \to \chi_{c0} \to J/\psi\gamma$
$29.3^{+5.7}_{-4.7}\pm1.5$	89	[10,11] AMBROGIANI	99B		$\overline{p}p \to \chi_{c0} \to J/\psi\gamma$

[10] Calculated by us using $B(J/\psi(1S) \to e^+e^-) = 0.0593 \pm 0.0010$.
[11] Values in $(\Gamma(p\overline{p}) \times \Gamma(\gamma J/\psi(1S))/\Gamma_{\text{total}})$ and $(\Gamma(p\overline{p}) \times \Gamma(\gamma J/\psi(1S))/\Gamma^2_{\text{total}})$ are not independent. The latter is used in the fit since it is less correlated to the total width.

$\chi_{c0}(1P)$ CROSS-PARTICLE BRANCHING RATIOS

$B(\chi_{c0}(1P) \to p\overline{p}) \times \dfrac{\Gamma(\psi(2S) \to \gamma\chi_{c0}(1P))}{\Gamma(\psi(2S) \to J/\psi(1S)\pi^+\pi^-)}$

VALUE (units 10^{-5})	DOCUMENT ID		TECN	COMMENT
6.1±1.1 OUR FIT				
4.6±1.9	[12] BAI	98I	BES	$\psi(2S) \to \gamma\chi_{c0} \to \gamma\overline{p}p$

$B(\chi_{c0}(1P) \to \gamma J/\psi(1S)) \times B(\psi(2S) \to \gamma\chi_{c0}(1P))$

VALUE (units 10^{-2})	DOCUMENT ID		TECN	COMMENT
0.101±0.012 OUR FIT				
0.073±0.018 OUR AVERAGE				
0.069±0.018	[13] OREGLIA	82	CBAL	$\psi(2S) \to \gamma\chi_{c0}$
0.4 ±0.3	[14] BRANDELIK	79B	DASP	$\psi(2S) \to \gamma\chi_{c0}$
0.16 ±0.11	[14] BARTEL	78B	CNTR	$\psi(2S) \to \gamma\chi_{c0}$
3.3 ±1.7	[15] BIDDICK	77	CNTR	$e^+e^- \to \gamma X$

$B(\chi_{c0}(1P) \to \gamma\gamma) \times B(\psi(2S) \to \gamma\chi_{c0}(1P))$

VALUE (units 10^{-5})	DOCUMENT ID		TECN	COMMENT
2.2±0.5 OUR FIT				
3.7±1.8±1.0	LEE	85	CBAL	$\psi(2S) \to \gamma\chi_{c0}$

$$\mathbf{B(\chi_{c0}(1P) \rightarrow\ \pi\pi) \times \frac{\Gamma(\psi(2S)\ \rightarrow\gamma\chi_{c0}(1P))}{\Gamma(\psi(2S)\ \rightarrow J/\psi(1S)\pi^+\pi^-)}}$$

VALUE (units 10^{-4})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
20.1±2.1 OUR FIT					
20.7±1.7 OUR AVERAGE					
23.9±2.7±4.1	96.9± 11.1	[16] BAI	03C	BES	$\psi(2S) \rightarrow\ \gamma\chi_{c0} \rightarrow \gamma\pi^0\pi^0$
20.2±1.1±1.5	720± 32	[17] BAI	98I	BES	$\psi(2S) \rightarrow\ \gamma\chi_{c0} \rightarrow \gamma\pi^+\pi^-$

$$\mathbf{B(\chi_{c0}(1P) \rightarrow\ 2(\pi^+\pi^-)) \times \frac{\Gamma(\psi(2S)\ \rightarrow\gamma\chi_{c0}(1P))}{\Gamma(\psi(2S)\ \rightarrow J/\psi(1S)\pi^+\pi^-)}}$$

VALUE (units 10^{-3})	*DOCUMENT ID*		*TECN*	*COMMENT*
7.0±0.8 OUR FIT				
6.9±2.4 OUR AVERAGE Error includes scale factor of 3.8.				
4.4±0.1±0.9	[18] BAI	99B	BES	$\psi(2S) \rightarrow\ \gamma\chi_{c0}$
9.3±0.9	[19] TANENBAUM	78	MRK1	$\psi(2S) \rightarrow\ \gamma\chi_{c0}$

[12] Calculated by us. The value for $B(\chi_{c0} \rightarrow\ p\overline{p})$ reported in BAI 98I is derived using $B(\psi(2S) \rightarrow\ \gamma\chi_{c0}) = (9.3 \pm 0.8)\%$ and $B(\psi(2S) \rightarrow\ J/\psi(1S)\pi^+\pi^-) = (32.4 \pm 2.6)\%$ [BAI 98D].

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

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

[15] Assumes isotropic gamma distribution.

[16] We have multiplied $\pi^0\pi^0$ measurement by 3 to obtain $\pi\pi$.

[17] Calculated by us. The value for $B(\chi_{c0} \rightarrow\ \pi^+\pi^-)$ reported in BAI 98I is derived using $B(\psi' \rightarrow\ \gamma\chi_{c0})$= $(9.3 \pm 0.8)\%$ and $B(\psi' \rightarrow\ J/\psi\pi^+\pi^-) = (32.4 \pm 2.6)\%$ [BAI 98D]. We have multiplied $\pi^+\pi^-$ measurement by 3/2 to obtain $\pi\pi$.

[18] Calculated by us. The value for $B(\chi_{c0} \rightarrow\ 2\pi^+2\pi^-)$ reported in BAI 99B is derived using $B(\psi(2S) \rightarrow\ \gamma\chi_{c0}) = (9.3 \pm 0.8)\%$ and $B(\psi(2S) \rightarrow\ J/\psi(1S)\pi^+\pi^-) = (32.4 \pm 2.6)\%$ [BAI 98D].

[19] The value $B(\psi(1S) \rightarrow\ \gamma\chi_{c0})\times B(\chi_{c0} \rightarrow\ 2\pi^+2\pi^-)$ reported in TANENBAUM 78 is derived using $B(\psi(2S) \rightarrow\ J/\psi(1S)\pi^+\pi^-)\times B(J/\psi(1S) \rightarrow\ \ell^+\ell^-)$ =(4.6 ± 0.7)%. Calculated by us using $B(J/\psi(1S) \rightarrow\ \ell^+\ell^-) = 0.1181 \pm 0.0020$.

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

ANDREOTTI	03	PRL 91 091801	M. Andreotti *et al.*	(FNAL E835 Collab.)
BAI	03C	PR D67 032004	J.Z. Bai *et al.*	(BES Collab.)
BAI	03E	PR D67 112001	J.Z. Bai *et al.*	(BES Collab.)
BAGNASCO	02	PL B533 237	S. Bagnasco *et al.*	(FNAL E835 Collab.)
EISENSTEIN	01	PRL 87 061801	B.I. Eisenstein *et al.*	(CLEO Collab.)
AMBROGIANI	00B	PR D62 052002	M. Ambrogiani *et al.*	(FNAL E835 Collab.)
AMBROGIANI	99B	PRL 83 2902	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.)
GAISER	86	PR D34 711	J. Gaiser *et al.*	(Crystal Ball Collab.)
LEE	85	SLAC 282	R.A. Lee	(SLAC)
OREGLIA	82	PR D25 2259	M.J. Oreglia *et al.*	(SLAC, CIT, HARV+)
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	82	Private Comm.	G. Trilling	(LBL, UCB)
BIDDICK	77	PRL 38 1324	C.J. Biddick *et al.*	(UCSD, UMD, PAVI+)

OTHER RELATED PAPERS

BARBERIS	00G	PL B485 357	D. Barberis *et al.*	(Omega Expt.)
ACCIARRI	99T	PL B461 155	M. Acciarri *et al.*	(L3 Collab.)
CHEN	90B	PL B243 169	W.Y. Chen *et al.*	(CLEO Collab.)
AIHARA	88D	PRL 60 2355	H. Aihara *et al.*	(TPC Collab.)
FELDMAN	75B	PRL 35 821	G.J. Feldman *et al.*	(LBL, SLAC)
Also	75C	PRL 35 1189	G.J. Feldman	
Erratum.				
TANENBAUM	75	PRL 35 1323	W.M. Tanenbaum *et al.*	(LBL, SLAC)