

$\chi_{c0}(1P)$

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

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

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
3415.1 ± 0.8 OUR AVERAGE			
3416.5 ± 3.0	EISENSTEIN	01 CLE2	$e^+e^- \rightarrow e^+e^-\chi_{c0}$
3417.4 ^{+1.8} _{-1.9} ± 0.2	AMBROGIANI	99B E835	$\bar{p}p \rightarrow e^+e^-\gamma$
3414.1 ± 0.6 ± 0.8	BAI	99B BES	$\psi(2S) \rightarrow \gamma X$
3417.8 ± 0.4 ± 4	¹ GAISER	86 CBAL	$\psi(2S) \rightarrow \gamma X$
3422 ± 10	² BARTEL	78B CNTR	$e^+e^- \rightarrow J/\psi 2\gamma$
3416 ± 3 ± 4	² TANENBAUM	78 MRK1	e^+e^-
3415 ± 9	² BIDDICK	77 CNTR	$e^+e^- \rightarrow \gamma X$

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

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
16.2 ± 2.3 OUR FIT			
14.9^{+2.6}_{-2.3} OUR AVERAGE			
16.6 ^{+5.2} _{-3.7} ± 0.1	AMBROGIANI	99B E835	$\bar{p}p \rightarrow e^+e^-\gamma$
14.3 ± 2.0 ± 3.0	BAI	98I BES	$\psi(2S) \rightarrow \gamma\pi^+\pi^-$
13.5 ± 3.3 ± 4.2	GAISER	86 CBAL	$\psi(2S) \rightarrow \gamma X, \gamma\pi^0\pi^0$

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

Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Hadronic decays		
Γ_1 $2(\pi^+\pi^-)$	(2.44 ± 0.33) %	
Γ_2 $\pi^+\pi^-K^+K^-$	(1.8 ± 0.6) %	S=1.9
Γ_3 $\rho^0\pi^+\pi^-$	(1.6 ± 0.5) %	
Γ_4 $3(\pi^+\pi^-)$	(1.24 ± 0.22) %	
Γ_5 $K^+\bar{K}^*(892)^0\pi^- + c.c.$	(1.2 ± 0.4) %	
Γ_6 K^+K^-	(5.9 ± 0.9) × 10 ⁻³	
Γ_7 $\pi^+\pi^-$	(5.0 ± 0.7) × 10 ⁻³	
Γ_8 $K^+K^-K^+K^-$	(2.1 ± 0.5) × 10 ⁻³	
Γ_9 $K_S^0K_S^0$	(2.0 ± 0.6) × 10 ⁻³	

Γ_{10}	$\pi^+ \pi^- p \bar{p}$	$(1.8 \pm 0.9) \times 10^{-3}$	$S=1.6$
Γ_{11}	$\phi \phi$	$(9 \pm 5) \times 10^{-4}$	
Γ_{12}	$\rho \bar{\rho}$	$(2.2 \pm 0.5) \times 10^{-4}$	
Γ_{13}	$K_S^0 K^+ \pi^- + \text{c.c.}$	$< 7.1 \times 10^{-4}$	CL=90%
Γ_{14}	$\pi^0 \pi^0$		
Γ_{15}	$\eta \eta$		

Radiative decays

Γ_{16}	$\gamma J/\psi(1S)$	$(1.02 \pm 0.17) \%$
Γ_{17}	$\gamma \gamma$	$(1.9 \pm 0.4) \times 10^{-4}$

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

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

$\Gamma(p \bar{p}) \times \Gamma(\gamma J/\psi(1S)) / \Gamma_{\text{total}}$ $\Gamma_{12} \Gamma_{16} / \Gamma$

<u>VALUE (eV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
37 ± 10 OUR FIT			
48.7^{+11.3}_{-8.9} ± 2.4	³ AMBROGIANI 99B E835		$\bar{p} p \rightarrow \gamma J/\psi$

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

<u>VALUE (eV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
74 ± 14 OUR FIT			
75 ± 13 ± 8	EISENSTEIN 01 CLE2		$e^+ e^- \rightarrow e^+ e^- \chi_{c0}$

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

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

HADRONIC DECAYS

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

<u>VALUE</u>	<u>DOCUMENT ID</u>
0.0244 ± 0.0033 OUR FIT	

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

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.018 ± 0.006 OUR AVERAGE			Error includes scale factor of 1.9.
0.0147 ± 0.0007 ± 0.0038	⁴ BAI 99B BES		$\psi(2S) \rightarrow \gamma \chi_{c0}$
0.030 ± 0.007	⁵ TANENBAUM 78 MRK1		$\psi(2S) \rightarrow \gamma \chi_{c0}$

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

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.016 ± 0.005	⁵ TANENBAUM 78 MRK1		$\psi(2S) \rightarrow \gamma \chi_{c0}$

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

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.0124 ± 0.0022 OUR AVERAGE			
0.0117 ± 0.0010 ± 0.0023	⁴ BAI 99B BES		$\psi(2S) \rightarrow \gamma \chi_{c0}$
0.015 ± 0.005	⁵ TANENBAUM 78 MRK1		$\psi(2S) \rightarrow \gamma \chi_{c0}$

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

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.012±0.004	⁵ TANENBAUM 78	MRK1	$\psi(2S) \rightarrow \gamma \chi_{c0}$

$\Gamma(K^+ K^-)/\Gamma_{\text{total}}$ Γ_6/Γ

<u>VALUE (units 10⁻³)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
5.9 ±0.9 OUR AVERAGE				
5.68±0.35±0.85	774±38	⁴ BAI	98I BES	$\psi(2S) \rightarrow \gamma \chi_{c0}$
6 ±3		⁵ BRANDELIK 79B	DASP	$\psi(2S) \rightarrow \gamma \chi_{c0}$
9 ±4		⁵ TANENBAUM 78	MRK1	$\psi(2S) \rightarrow \gamma \chi_{c0}$

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

<u>VALUE (units 10⁻³)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
5.0 ±0.7 OUR AVERAGE				
4.68±0.26±0.65	720±32	⁴ BAI	98I BES	$\psi(2S) \rightarrow \gamma \chi_{c0}$
7 ±3		⁵ BRANDELIK 79B	DASP	$\psi(2S) \rightarrow \gamma \chi_{c0}$
8 ±3		⁵ TANENBAUM 78	MRK1	$\psi(2S) \rightarrow \gamma \chi_{c0}$

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

<u>VALUE (units 10⁻³)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
2.14±0.26±0.40	⁴ BAI	99B BES	$\psi(2S) \rightarrow \gamma \chi_{c0}$

$\Gamma(K_S^0 K_S^0)/\Gamma_{\text{total}}$ Γ_9/Γ

<u>VALUE (units 10⁻³)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1.96±0.28±0.52	⁴ BAI	99B BES	$\psi(2S) \rightarrow \gamma \chi_{c0}$

$\Gamma(\pi^+ \pi^- \rho \bar{\rho})/\Gamma_{\text{total}}$ Γ_{10}/Γ

<u>VALUE (units 10⁻³)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1.8 ±0.9 OUR AVERAGE	Error includes scale factor of 1.6.		
1.57±0.21±0.54	⁴ BAI	99B BES	$\psi(2S) \rightarrow \gamma \chi_{c0}$
5 ±2	⁵ TANENBAUM 78	MRK1	$\psi(2S) \rightarrow \gamma \chi_{c0}$

$\Gamma(\phi\phi)/\Gamma_{\text{total}}$ Γ_{11}/Γ

<u>VALUE (units 10⁻³)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.92±0.34±0.38	⁴ BAI	99B BES	$\psi(2S) \rightarrow \gamma \chi_{c0}$

$\Gamma(\pi^0 \pi^0)/\Gamma_{\text{total}}$ Γ_{14}/Γ

<u>VALUE (units 10⁻³)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
••• We do not use the following data for averages, fits, limits, etc. •••			
3.1±0.4±0.5	⁴ LEE	85 CBAL	$\psi' \rightarrow \text{photons}$

$\Gamma(\eta\eta)/\Gamma_{\text{total}}$ Γ_{15}/Γ

<u>VALUE (units 10⁻³)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
••• We do not use the following data for averages, fits, limits, etc. •••			
2.5±0.8±0.8	⁴ LEE	85 CBAL	$\psi' \rightarrow \text{photons}$

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

VALUE (units 10^{-3})	CL%	DOCUMENT ID	TECN	COMMENT
<0.71	90	⁴ BAI	99B BES	$\psi(2S) \rightarrow \gamma \chi_{c0}$

$\Gamma(p\bar{p})/\Gamma_{\text{total}}$ Γ_{12}/Γ

VALUE (units 10^{-4})	DOCUMENT ID
--------------------------	-------------

2.2±0.5 OUR FIT

⁴ Calculated using $B(\psi(2S) \rightarrow \gamma \chi_{c0}(1P)) = 0.093 \pm 0.008$.

⁵ Calculated using $B(\psi(2S) \rightarrow \gamma \chi_{c0}(1P)) = 0.094$; the errors do not contain the uncertainty in the $\psi(2S)$ decay.

————— RADIATIVE DECAYS —————

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

VALUE (units 10^{-4})	DOCUMENT ID
--------------------------	-------------

102±17 OUR FIT

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

VALUE (units 10^{-4})	DOCUMENT ID
--------------------------	-------------

1.9±0.4 OUR FIT

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

VALUE (units 10^{-2})	DOCUMENT ID	TECN	COMMENT
--------------------------	-------------	------	---------

1.8 ±0.6 OUR FIT

1.45±0.74

⁶ AMBROGIANI 00B E835 $\bar{p}p \rightarrow \chi_{c2} \rightarrow \gamma\gamma, \gamma J/\psi$

⁶ Calculated by us using $B(J/\psi(1S) \rightarrow e^+e^-) = 0.0593 \pm 0.0010$.

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

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

VALUE (units 10^{-5})	DOCUMENT ID	TECN	COMMENT
--------------------------	-------------	------	---------

6.4±1.6 OUR FIT

4.6±1.9

⁷ BAI 98I BES $\psi(2S) \rightarrow \gamma \chi_{c0} \rightarrow \gamma p\bar{p}$

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

VALUE (units 10^{-2})	DOCUMENT ID	TECN	COMMENT
--------------------------	-------------	------	---------

0.089±0.015 OUR FIT

0.073±0.018 OUR AVERAGE

0.069±0.018

0.4 ±0.3

0.16 ±0.11

3.3 ±1.7

⁸ OREGLIA 82 CBAL $\psi(2S) \rightarrow \gamma \chi_{c0}$

⁹ BRANDELIK 79B DASP $\psi(2S) \rightarrow \gamma \chi_{c0}$

⁹ BARTEL 78B CNTR $\psi(2S) \rightarrow \gamma \chi_{c0}$

¹⁰ BIDDICK 77 CNTR $e^+e^- \rightarrow \gamma X$

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

VALUE (units 10^{-5})	DOCUMENT ID	TECN	COMMENT
1.6±0.4 OUR FIT			
3.7±1.8±1.0	LEE	85 CBAL	$\psi(2S) \rightarrow \gamma\chi_{c0}$

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

VALUE (units 10^{-3})	DOCUMENT ID	TECN	COMMENT
7.0±1.0 OUR FIT			
6.9±2.4 OUR AVERAGE	Error includes scale factor of 3.8.		
4.4±0.1±0.9	¹¹ BAI	99B BES	$\psi(2S) \rightarrow \gamma\chi_{c0}$
9.3±0.9	¹² TANENBAUM	78 MRK1	$\psi(2S) \rightarrow \gamma\chi_{c0}$

⁷ Calculated by us. The value for $B(\chi_{c0} \rightarrow p\bar{p})$ 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].

⁸ Recalculated by us using $B(J/\psi(1S) \rightarrow \ell^+\ell^-) = 0.1181 \pm 0.0020$.

⁹ Recalculated by us using $B(J/\psi(1S) \rightarrow \mu^+\mu^-) = 0.0588 \pm 0.0010$.

¹⁰ Assumes isotropic gamma distribution.

¹¹ 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].

¹² 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 $B(\psi(2S) \rightarrow J/\psi(1S)\pi^+\pi^-) \times B(J/\psi(1S) \rightarrow \ell^+\ell^-) = (4.6 \pm 0.7)\%$. Calculated by us using $B(J/\psi(1S) \rightarrow \ell^+\ell^-) = 0.1181 \pm 0.0020$.

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

EISENSTEIN	01	PRL 87 061801	B.I. Eisenstein <i>et al.</i>	(CLEO Collab.)
AMBROGIANI	00B	PR D62 052002	M. Ambrogiani <i>et al.</i>	(FNAL E835 Collab.)
AMBROGIANI	99B	PRL 83 2902	M. Ambrogiani <i>et al.</i>	(FNAL E835 Collab.)
BAI	99B	PR D60 072001	J.Z. Bai <i>et al.</i>	(BES Collab.)
BAI	98D	PR D58 092006	J.Z. Bai <i>et al.</i>	(BES Collab.)
BAI	98I	PRL 81 3091	J.Z. Bai <i>et al.</i>	(BES Collab.)
GAISER	86	PR D34 711	J. Gaiser <i>et al.</i>	(Crystal Ball Collab.)
LEE	85	SLAC 282	R.A. Lee	(SLAC)
OREGLIA	82	PR D25 2259	M.J. Oreglia <i>et al.</i>	(SLAC, CIT, HARV+)
BRANDELIK	79B	NP B160 426	R. Brandelik <i>et al.</i>	(DASP Collab.)
BARTEL	78B	PL 79B 492	W. Bartel <i>et al.</i>	(DESY, HEIDP)
TANENBAUM	78	PR D17 1731	W.M. Tanenbaum <i>et al.</i>	(SLAC, LBL)
Also	82	Private Comm.	G. Trilling	(LBL, UCB)
BIDDICK	77	PRL 38 1324	C.J. Biddick <i>et al.</i>	(UCSD, UMD, PAVI+)

OTHER RELATED PAPERS

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