

$\chi_{c0}(1P)$ 

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

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

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
<b>3415.0 ± 0.8 OUR AVERAGE</b>			
3417.4 <sup>+1.8</sup> <sub>-1.9</sub> ± 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	<sup>1</sup> GAISER	86 CBAL	$\psi(2S) \rightarrow \gamma X$
3422 ± 10	<sup>2</sup> BARTEL	78B CNTR	$e^+e^- \rightarrow J/\psi 2\gamma$
3416 ± 3 ± 4	<sup>2</sup> TANENBAUM	78 MRK1	$e^+e^-$
3415 ± 9	<sup>2</sup> BIDDICK	77 CNTR	$e^+e^- \rightarrow \gamma X$

<sup>1</sup> Using mass of  $\psi(2S) = 3686.0$  MeV.  
<sup>2</sup> 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)	DOCUMENT ID	TECN	COMMENT
<b>14.9<sup>+2.6</sup><sub>-2.3</sub> OUR AVERAGE</b>			
16.6 <sup>+5.2</sup> <sub>-3.7</sub> ± 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 ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level
<b>Hadronic decays</b>		
$\Gamma_1$ $2(\pi^+\pi^-)$	(2.0 ± 0.9) %	S=2.7
$\Gamma_2$ $\pi^+\pi^- K^+ K^-$	(1.8 ± 0.6) %	S=1.9
$\Gamma_3$ $\rho^0\pi^+\pi^-$	(1.6 ± 0.5) %	
$\Gamma_4$ $3(\pi^+\pi^-)$	(1.24 ± 0.22) %	
$\Gamma_5$ $K^+\bar{K}^*(892)^0\pi^- + c.c.$	(1.2 ± 0.4) %	
$\Gamma_6$ $\pi^+\pi^-$	(5.0 ± 0.7) × 10 <sup>-3</sup>	
$\Gamma_7$ $K^+K^-$	(5.9 ± 0.9) × 10 <sup>-3</sup>	
$\Gamma_8$ $\pi^+\pi^- p\bar{p}$	(1.8 ± 0.9) × 10 <sup>-3</sup>	S=1.6
$\Gamma_9$ $K^+K^- K^+K^-$	(2.1 ± 0.5) × 10 <sup>-3</sup>	
$\Gamma_{10}$ $K_S^0 K_S^0$	(2.0 ± 0.6) × 10 <sup>-3</sup>	
$\Gamma_{11}$ $\phi\phi$	(9 ± 5) × 10 <sup>-4</sup>	
$\Gamma_{12}$ $\pi^0\pi^0$		
$\Gamma_{13}$ $\eta\eta$		
$\Gamma_{14}$ $K_S^0 K^+\pi^- + c.c.$	< 7.1 × 10 <sup>-4</sup>	CL=90%
$\Gamma_{15}$ $p\bar{p}$	(2.2 ± 1.3) × 10 <sup>-4</sup>	S=2.1

### Radiative decays

$\Gamma_{16}$	$\gamma J/\psi(1S)$	$(6.6 \pm 1.8) \times 10^{-3}$
$\Gamma_{17}$	$\gamma\gamma$	$(2.7 \pm 1.9) \times 10^{-4}$

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

$\Gamma(\gamma\gamma)$					$\Gamma_{17}$
VALUE (keV)	CL%	DOCUMENT ID	TECN	COMMENT	
<b>4.0±2.8</b>		LEE	85 CBAL	$\psi' \rightarrow$ photons	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
< 5.5	95	ACCIARRI	99T L3	$\gamma\gamma$	
< 6.2	95	CHEN	90B CLEO	$e^+e^- \rightarrow e^+e^-\chi_{c0}$	
<17	95	AIHARA	88D TPC	$e^+e^- \rightarrow e^+e^-X$	

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

#### HADRONIC DECAYS

$\Gamma(2(\pi^+\pi^-))/\Gamma_{total}$					$\Gamma_1/\Gamma$
VALUE		DOCUMENT ID	TECN	COMMENT	
<b>0.020 ±0.009 OUR AVERAGE</b>		Error includes scale factor of 2.7.			
0.0154±0.0005±0.0037		<sup>3</sup> BAI	99B BES	$\psi(2S) \rightarrow \gamma\chi_{c0}$	
0.037 ±0.007		<sup>4</sup> TANENBAUM	78 MRK1	$\psi(2S) \rightarrow \gamma\chi_{c0}$	

$\Gamma(\pi^+\pi^-K^+K^-)/\Gamma_{total}$					$\Gamma_2/\Gamma$
VALUE		DOCUMENT ID	TECN	COMMENT	
<b>0.018 ±0.006 OUR AVERAGE</b>		Error includes scale factor of 1.9.			
0.0147±0.0007±0.0038		<sup>3</sup> BAI	99B BES	$\psi(2S) \rightarrow \gamma\chi_{c0}$	
0.030 ±0.007		<sup>4</sup> TANENBAUM	78 MRK1	$\psi(2S) \rightarrow \gamma\chi_{c0}$	

$\Gamma(\rho^0\pi^+\pi^-)/\Gamma_{total}$					$\Gamma_3/\Gamma$
VALUE		DOCUMENT ID	TECN	COMMENT	
<b>0.016±0.005</b>		<sup>4</sup> TANENBAUM	78 MRK1	$\psi(2S) \rightarrow \gamma\chi_{c0}$	

$\Gamma(3(\pi^+\pi^-))/\Gamma_{total}$					$\Gamma_4/\Gamma$
VALUE		DOCUMENT ID	TECN	COMMENT	
<b>0.0124±0.0022 OUR AVERAGE</b>					
0.0117±0.0010±0.0023		<sup>3</sup> BAI	99B BES	$\psi(2S) \rightarrow \gamma\chi_{c0}$	
0.015 ±0.005		<sup>4</sup> TANENBAUM	78 MRK1	$\psi(2S) \rightarrow \gamma\chi_{c0}$	

$\Gamma(K^+\bar{K}^*(892)^0\pi^- + c.c.)/\Gamma_{total}$					$\Gamma_5/\Gamma$
VALUE		DOCUMENT ID	TECN	COMMENT	
<b>0.012±0.004</b>		<sup>4</sup> TANENBAUM	78 MRK1	$\psi(2S) \rightarrow \gamma\chi_{c0}$	

$\Gamma(\pi^+\pi^-)/\Gamma_{total}$					$\Gamma_6/\Gamma$
VALUE (units $10^{-3}$ )	EVTS	DOCUMENT ID	TECN	COMMENT	
<b>5.0 ±0.7 OUR AVERAGE</b>					
4.68±0.26±0.65	720±32	<sup>3</sup> BAI	98I BES	$\psi(2S) \rightarrow \gamma\chi_{c0}$	
7 ±3		<sup>4</sup> BRANDELIK	79B DASP	$\psi(2S) \rightarrow \gamma\chi_{c0}$	
8 ±3		<sup>4</sup> TANENBAUM	78 MRK1	$\psi(2S) \rightarrow \gamma\chi_{c0}$	

$\Gamma(K^+ K^-)/\Gamma_{\text{total}}$   $\Gamma_7/\Gamma$

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

$\Gamma(\pi^+ \pi^- \rho\bar{\rho})/\Gamma_{\text{total}}$   $\Gamma_8/\Gamma$

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

$\Gamma(K^+ K^- K^+ K^-)/\Gamma_{\text{total}}$   $\Gamma_9/\Gamma$

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

$\Gamma(K_S^0 K_S^0)/\Gamma_{\text{total}}$   $\Gamma_{10}/\Gamma$

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

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

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

$\Gamma(\pi^0 \pi^0)/\Gamma_{\text{total}}$   $\Gamma_{12}/\Gamma$

<u>VALUE (units <math>10^{-3}</math>)</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	<sup>3</sup> LEE	85 CBAL	$\psi' \rightarrow \text{photons}$

$\Gamma(\eta\eta)/\Gamma_{\text{total}}$   $\Gamma_{13}/\Gamma$

<u>VALUE (units <math>10^{-3}</math>)</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	<sup>3</sup> LEE	85 CBAL	$\psi' \rightarrow \text{photons}$

$\Gamma(K_S^0 K^+ \pi^- + \text{c.c.})/\Gamma_{\text{total}}$   $\Gamma_{14}/\Gamma$

<u>VALUE (units <math>10^{-3}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>&lt;0.71</b>	90	<sup>3</sup> BAI	99B BES	$\psi(2S) \rightarrow \gamma \chi_{c0}$

$\Gamma(\rho\rho)/\Gamma_{\text{total}}$   $\Gamma_{15}/\Gamma$

<u>VALUE (units <math>10^{-3}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.22 ± 0.13 OUR AVERAGE</b>		Error includes scale factor of 2.1.		
0.48 +0.09 +0.21 -0.08 -0.11		<sup>5</sup> AMBROGIANI	99B E835	$\bar{p}p \rightarrow e^+ e^- \gamma$
0.159 ± 0.043 ± 0.053		<sup>3</sup> BAI	98I BES	$\psi(2S) \rightarrow \gamma \chi_{c0}$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<0.9	90	<sup>4</sup> BRANDELIK	79B DASP	$\psi(2S) \rightarrow \gamma \chi_{c0}$

<sup>3</sup> Calculated using  $B(\psi(2S) \rightarrow \gamma\chi_{c0}(1P)) = 0.093 \pm 0.008$ .

<sup>4</sup> Calculated using  $B(\psi(2S) \rightarrow \gamma\chi_{c0}(1P)) = 0.094$ ; the errors do not contain the uncertainty in the  $\psi(2S)$  decay.

<sup>5</sup> Estimated using  $B(\chi_{c0} \rightarrow \gamma J/\psi) = (6.0 \pm 1.8) \times 10^{-3}$  and  $B(J/\psi \rightarrow e^+e^-) = (6.02 \pm 0.19) \times 10^{-2}$ .

## RADIATIVE DECAYS

$\Gamma(\gamma J/\psi(1S))/\Gamma_{\text{total}}$				$\Gamma_{16}/\Gamma$
VALUE (units $10^{-4}$ )	DOCUMENT ID	TECN	COMMENT	
<b>66 ± 18 OUR AVERAGE</b>				
60 ± 18	GAISER	86	CBAL	$\psi(2S) \rightarrow \gamma\chi_{c0}$
320 ± 210	<sup>6</sup> BRANDELIK	79B	DASP	$\psi(2S) \rightarrow \gamma\chi_{c0}$
150 ± 100	<sup>6</sup> BARTEL	78B	CNTR	$\psi(2S) \rightarrow \gamma\chi_{c0}$
210 ± 210	<sup>6</sup> TANENBAUM	78	MRK1	$\psi(2S) \rightarrow \gamma\chi_{c0}$

$\Gamma(\gamma\gamma)/\Gamma_{\text{total}}$				$\Gamma_{17}/\Gamma$
VALUE (units $10^{-4}$ )	DOCUMENT ID	TECN	COMMENT	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
4.0 ± 2.0 ± 1.1	<sup>3</sup> LEE	85	CBAL	$\psi' \rightarrow \text{photons}$
<sup>6</sup> Calculated using $B(\psi(2S) \rightarrow \gamma\chi_{c0}(1P)) = 0.094$ ; the errors do not contain the uncertainty in the $\psi(2S)$ decay.				

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

ACCIARRI	99T	PL B461 155	M. Acciarri <i>et al.</i>	(L3 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	98I	PRL 81 3091	J.Z. Bai <i>et al.</i>	(BES 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.)
GAISER	86	PR D34 711	J. Gaiser <i>et al.</i>	(Crystal Ball Collab.)
LEE	85	SLAC 282	R.A. Lee	(SLAC)
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

OREGLIA	82	PR D25 2259	M.J. Oreglia <i>et al.</i>	(SLAC, CIT, HARV+)
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)