$J/\psi(1S)$ REFERENCES

ANTONELLI 93 PL B301 317 +Baldini+ (FENICE Collab.)
ARMSTRONG 93B PR D47 772 +Bettoni, Bharadwaj+ (FNAL E760 Collab.)
AUGUSTIN 92 PR D46 1951 +Cosme (DM2 Collab.)
BOLTON 92 PL B278 495 +Brown, Bunnell+ (Mark III Collab.)
BOLTON 92B PRL 69 1328 +Brown, Bunnell+ (Mark III Collab.)
COFFMAN 92 PRL 68 282 +DeJongh, Dubois, Hitlin+ (Mark III Collab.)
HSUEH 92 PR D45 R2181 +Palestini (FNAL, TORI)
BURCHELL 91 NP B21 132 (suppl) (Mark III Collab.)
AUGUSTIN 90 PR D42 10 +Cosme+ (DM2 Collab.)
BAI 90B PRL 65 1309 +Blaylock+ (Mark III Collab.)
BAI 90C PRL 65 2507 +Blaylock+ (Mark III Collab.)
BISELLO 90 PL B241 617 +Busetto+ (DM2 Collab.)
COFFMAN 90 PR D41 1410 +De Jongh+ (Mark III Collab.)
JOUSSET 90 PR D41 1389 +Ajaltouni+ (DM2 Collab.)
ALEXANDER 89 NP B320 45 +Bonvicini, Drell, Frey, Luth (LBL, MICH, SLAC)
AUGUSTIN 89 NP B320 1 +Cosme (DM2 Collab.)
BISELLO 89B PR D39 701 Busetto+ (DM2 Collab.)
AUGUSTIN 88 PRL 60 2238 +Calcaterra+ (DM2 Collab.)
COFFMAN 88 PR D38 2695 +Dubois, Eigen, Hauser+ (Mark III Collab.)
FALVARD 88 PR D38 2706 +Ajaltouni+ (CLER, FRAS, LALO, PADO)
AUGUSTIN 87 ZPHY C36 369 +Cosme+ (LALO, CLER, FRAS, PADO)
BAGLIN 87 NP B286 592 + (LAPP, CERN, GENO, LYON, OSLO, ROMA+)
BALTRUSAIT... 87 PR D35 2077 Baltrusaitis, Coffman, Dubois+ (Mark III Collab.)
BECKER 87 PRL 59 186 +Blaylock, Bolton, Brown+ (Mark III Collab.)
BISELLO 87 PL B192 239 +Ajaltouni, Baldini+ (PADO, CLER, FRAS, LALO)
HENRARD 87 NP B292 670 +Ajaltouni, et al (CLER, FRAS, LALO, PADO)
PALLIN 87 NP B292 653 +Ajaltouni+ (CLER, FRAS, LALO, PADO)
WISNIEWSKI 87 Hadron 87 Conf. (Mark III Collab.)
BALTRUSAIT... 86B PR D33 1222 Baltrusaitis, Coffman, Hauser+ (Mark III Collab.)
BALTRUSAIT... 86D PRL 56 107 Baltrusaitis (CIT, UCSC, ILL, SLAC, WASH)
BISELLO 86B PL B179 294 +Busetto, Castro, Limentani+ (DM2 Collab.)
GAISER 86 PR D34 711 +Bloom, Bulos, Godfrey+ (Crystal Ball Collab.)
BALTRUSAIT... 85C PRL 55 1723 Baltrusaitis+ (CIT, UCSC, ILL, SLAC, WASH)
BALTRUSAIT... 85D PR D32 566 Baltrusaitis, Coffman+ (CIT, UCSC, ILL, SLAC, WASH)
BALTRUSAIT... 84 PRL 52 2126 Baltrusaitis+ (CIT, UCSC, ILL, SLAC, WASH)
EATON 84 PR D29 804 +Goldhaber, Abrams, Alam, Boyarski+ (LBL, SLAC)
BLOOM 83 ARNS 33 143 +Peck (SLAC, CIT)
EDWARDS 83B PRL 51 859 +Partridge, Peck+ (CIT, HARV, PRIN, STAN, SLAC)
EINSWEILER 83 Brighton Conf. 348 (Mark III Collab.)
FRANKLIN 83 PRL 51 963 +Franklin, Feldman, Abrams, Alam+ (LBL, SLAC)
FRANKLIN 83B Thesis SLAC-0254 (STAN)
BURKE 82 PRL 49 632 +Trilling, Abrams, Alam, Blocker+ (LBL, SLAC)
EDWARDS 82B PR D25 3065 +Partridge, Peck+ (CIT, HARV, PRIN, STAN, SLAC)
EDWARDS 82D PRL 48 458 +Partridge, Peck+ (CIT, HARV, PRIN, STAN, SLAC)
Also 83 ARNS 33 143 Bloom, Peck (SLAC, CIT)
EDWARDS 82E PRL 49 259 +Partridge, Peck+ (CIT, HARV, PRIN, STAN, SLAC)
LEMOIGNE 82 PL 113B 509 +Barate, Astbury+ (SACL, LOIC, SHMP, IND)
BESCH 81 ZPHY C8 1 +Eisermann, Lohr, Kowalski+ (BONN, DESY, MANZ)
GIDAL 81 PL 107B 153 +Goldhaber, Guy, Millikan, Abrams+ (SLAC, LBL)
PARTRIDGE 80 PRL 44 712 +Peck+ (CIT, HARV, PRIN, SLAC, STAN)
SCHARRE 80 PL 97B 329 +Trilling, Abrams, Alam, Blocker+ (SLAC, LBL)
ZHOLENTZ 80 PL 96B 214 +Kurdadze, Lelchuk, Mishnev+ (NOVO)
Also 81 SJNP 34 814 Zholentz, Kurdadze, Lelchuk+ (NOVO)
Translated from YAF 34 1471.
BRANDELIK 79C ZPHY C1 233 +Cords+ (DASP Collab.)
SCHARRE 79B SLAC-PUB-2321 (SLAC, LBL)
Also 79 LBL-9502 Abrams, Alam, Blocker, Boyarski+ (SLAC, LBL)
ALEXANDER 78 PL 72B 493 +Criegee+ (DESY, HAMB, SIEG, WUPP)
BESCH 78 PL 78B 347 +Eisermann, Kowalski, Eyss+ (BONN, DESY, MANZ)
BRANDELIK 78B PL 74B 292 +Cords+ (DASP Collab.)
PERUZZI 78 PR D17 2901 +Piccolo, Alam, Boyarski, Goldhaber+ (SLAC, LBL)
BARTEL 77 PL 66B 489 +Duinker, Olsson, Heintze+ (DESY, HEIDP)
BURMESTER 77D PL 72B 135 +Criegee+ (DESY, HAMB, SIEG, WUPP)
FELDMAN 77 PRPL 33C 285 +Perl (LBL, SLAC)
VANNUCCI 77 PR D15 1814 +Abrams, Alam, Boyarski+ (SLAC, LBL)
BARTEL 76 PL 64B 483 +Duinker, Olsson, Steffen, Heintze+ (DESY, HEIDP)
BRAUNSCH... 76 PL 63B 487 Braunschweig+ (DASP Collab.)
JEAN-MARIE 76 PRL 36 291 +Abrams, Boyarski, Breidenbach+ (SLAC, LBL) IG
BALDINI-... 75 PL 58B 471 Baldini-Celio, Bozzo, Capon+ (FRAS, ROMA)
BEMPORAD 75 Stanford Symp. 113 (PISA, FRAS)
BOYARSKI 75 PRL 34 1357 +Breidenbach, Bulos, Feldman+ (SLAC, LBL) JPC
DASP 75 PL 56B 491 Braunschweig, Konigs+ (DASP Collab.)
ESPOSITO 75B LNC 14 73 +Bartoli, Bisello+ (FRAS, NAPL, PADO, ROMA)
FORD 75 PRL 34 604 +Beron, Hilger, Hofstadter+ (SLAC, PENN)
LIBERMAN 75 Stanford Symp. 55 (STAN)
WIIK 75 Stanford Symp. 69 (DESY)

OTHER RELATED PAPERS

BAGLIN 85 SLAC Summer Inst. 609 (LAPP, CERN, GENO, LYON, OSLO, ROMA+)
LEE 85 SLAC 282 (SLAC)
BARATE 83 PL 121B 449 +Bareyre, Bonamy+ (SACL, LOIC, SHMP, IND)
ABRAMS 74 PRL 33 1453 +Briggs, Augustin, Boyarski+ (LBL, SLAC)
ASH 74 LNC 11 705 +Zorn, Bartoli+ (FRAS, UMD, NAPL, PADO, ROMA)
AUBERT 74 PRL 33 1404 +Becker, Biggs, Burger, Chen, Everhart (MIT, BNL)
AUGUSTIN 74 PRL 33 1406 +Boyarski, Abrams, Briggs+ (SLAC, LBL)
BACCI 74 PRL 33 1408 +Bartoli, Barbarino, Barbiellini+ (FRAS)
Also 74B PRL 33 1649 Bacci
BALDINI-... 74 LNC 11 711 Baldini-Celio, Bacci+ (FRAS, ROMA)
BARBIELLINI 74 LNC 11 718 +Bemporad+ (FRAS, NAPL, PISA, ROMA)
BRAUNSCH... 74 PL 53B 393 Braunschweig+ (DASP Collab.)
CHRISTENS... 70 PRL 25 1523 Christenson, Hicks, Lederman+ (COLU, BNL, CERN)

$\chi_{c0}(1P)$ or $\chi_{c0}(3415)$

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

Observed in the radiative decay $\psi(2S) \to \chi_{c0}(1P)\gamma$. Therefore $C = +$. The observed decay into $\pi^+\pi^-$ or K^+K^- implies $G = +$, $J^P = 0^+, 2^+, \ldots$ The angular distribution is consistent with $J = 0$. J^P abnormal excluded by $\pi^+\pi^-$ and K^+K^- decays. $J^P = 0^+$ preferred (FELDMAN 77).

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

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
3415.1± 1.0 OUR AVERAGE					
3417.8± 0.4±4		[1] GAISER	86	CBAL	$\psi(2S) \to \gamma X$
3414.8± 1.1		[2,3] HIMEL	79	MRK2	$e^+e^- \to$ hadrons
3422.0±10.0		[2] BARTEL	78B	CNTR	$e^+e^- \to J/\psi 2\gamma$
3416.0± 3 ±4		[2] TANENBAUM	78	MRK1	e^+e^-
3415.0± 9.0		[2] BIDDICK	77	CNTR	$e^+e^- \to \gamma X$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3407.0± 8.0	2	[4] WIIK	75	DASP	$e^+e^- \to J/\psi 2\gamma$

[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.
[3] Systematic error added linearly by us.
[4] Only two events; this mass apparently never published.

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

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
13.5±3.3±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	$2(\pi^+\pi^-)$	(3.7 ± 0.7) %	
Γ_2	$\pi^+\pi^-K^+K^-$	(3.0 ± 0.7) %	
Γ_3	$\rho^0\pi^+\pi^-$	(1.6 ± 0.5) %	
Γ_4	$3(\pi^+\pi^-)$	(1.5 ± 0.5) %	
Γ_5	$K^+\overline{K}^*(892)^0\pi^-$ + c.c.	(1.2 ± 0.4) %	
Γ_6	$\pi^+\pi^-$	$(7.5\pm2.1)\times10^{-3}$	
Γ_7	K^+K^-	$(7.1\pm2.4)\times10^{-3}$	
Γ_8	$\pi^+\pi^-p\overline{p}$	$(5.0\pm2.0)\times10^{-3}$	
Γ_9	$\pi^0\pi^0$	$(3.1\pm0.6)\times10^{-3}$	
Γ_{10}	$\eta\eta$	$(2.5\pm1.1)\times10^{-3}$	
Γ_{11}	$p\overline{p}$	$< 9.0 \times10^{-4}$	90%
	Radiative decays		
Γ_{12}	$\gamma J/\psi(1S)$	$(6.6\pm1.8)\times10^{-3}$	
Γ_{13}	$\gamma\gamma$	$(4.0\pm2.3)\times10^{-4}$	

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

$\Gamma(\gamma\gamma)$ — Γ_{13}

VALUE (keV)	CL%	DOCUMENT ID		TECN	COMMENT
< 6.2	95	CHEN	90B	CLEO	$e^+e^- \to e^+e^-\chi_{c0}$
4.0±2.8		LEE	85	CBAL	$\psi' \to$ photons
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<17	95	AIHARA	88D	TPC	$e^+e^- \to e^+e^-X$

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

HADRONIC DECAYS

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.037±0.007	[5] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.030±0.007	[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	[5] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.015±0.005	[5] TANENBAUM	78	MRK1	$\psi(2S) \to \gamma\chi_{c0}$