$\psi(2S)$

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

See the Review on "$\psi(2S)$ and χ_c branching ratios" before the $\chi_{c0}(1P)$ Listings.

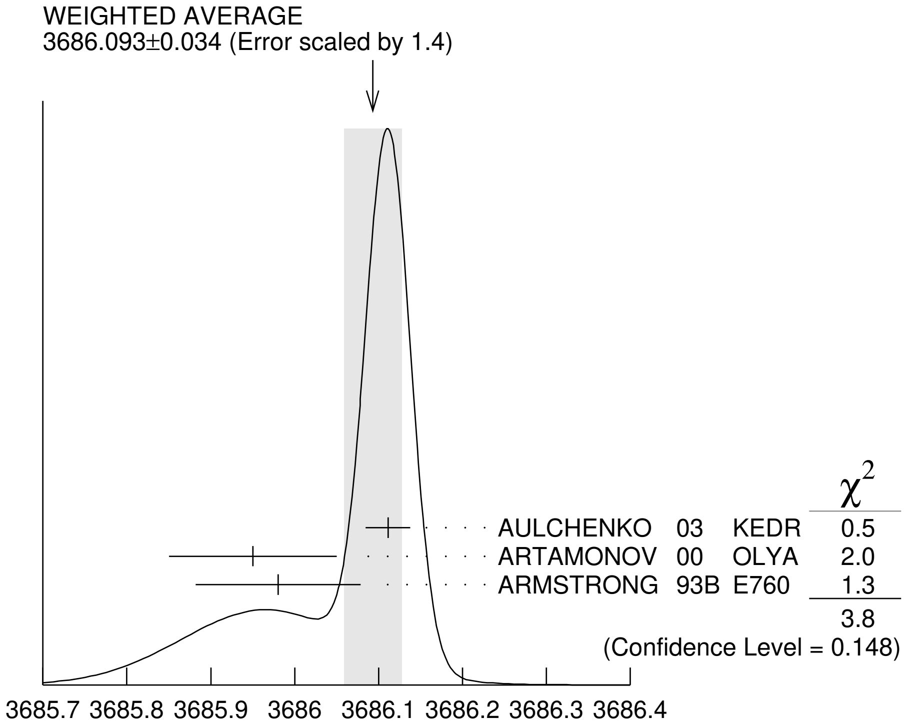
$\psi(2S)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
3686.093±0.034 OUR AVERAGE		Error includes scale factor of 1.4. See the ideogram below.			
3686.111±0.025±0.009		AULCHENKO	03	KEDR	$e^+e^- \to$ hadrons
3685.95 ±0.10	413	[1] ARTAMONOV	00	OLYA	$e^+e^- \to$ hadrons
3685.98 ±0.09 ±0.04		[2] ARMSTRONG	93B	E760	$\overline{p}p \to e^+e^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3684 ±2		GRIBUSHIN	96	FMPS	515 π^- Be $\to 2\mu X$
3683 ±5	77	ANTONIAZZI	94	E705	300 $\pi^\pm$, pLi $\to J/\psi\pi^+\pi^-$ X
3686.00 ±0.10	413	[3] ZHOLENTZ	80	OLYA	e^+e^-

[1] Reanalysis of ZHOLENTZ 80 using new electron mass (COHEN 87) and radiative corrections (KURAEV 85).

[2] Mass central value and systematic error recalculated by us according to Eq. (16) in ARMSTRONG 93B, using the value for the $J/\psi(1S)$ mass from AULCHENKO 03.

[3] Superseded by ARTAMONOV 00.



$\psi(2S)$ mass

$m_{\psi(2S)} - m_{J/\psi(1S)}$

VALUE (MeV)		*DOCUMENT ID*		*TECN*	*COMMENT*
589.188±0.028 OUR AVERAGE					
589.194±0.027±0.011	[4]	AULCHENKO	03	KEDR	$e^+e^- \to$ hadrons
589.7 ±1.2		LEMOIGNE	82	GOLI	190 π^- Be $\to$ 2μ
589.07 ±0.13	[4]	ZHOLENTZ	80	OLYA	e^+e^-
588.7 ±0.8		LUTH	75	MRK1	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
588 ±1	[5]	BAI	98E	BES	e^+e^-

[4] Redundant with data in mass above.
[5] Systematic errors not evaluated.

$\psi(2S)$ WIDTH

VALUE (keV)		*DOCUMENT ID*		*TECN*	*COMMENT*
281±17 OUR FIT					
277±22 OUR AVERAGE					
264±27	[6]	BAI	02B	BES	e^+e^-
306±36±16		ARMSTRONG	93B	E760	$\overline{p}p \to e^+e^-$

[6] From a simultaneous fit to the hadronic and $\mu^+\mu^-$ cross section, assuming $\Gamma = \Gamma_h + \Gamma_e + \Gamma_\mu + \Gamma_\tau$ and lepton universality.

$\psi(2S)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Γ_1	hadrons	(97.85±0.13) %	
Γ_2	virtual$\gamma \to$ hadrons	(2.16±0.35) %	S=2.1
Γ_3	e^+e^-	(7.55±0.31) $\times 10^{-3}$	
Γ_4	$\mu^+\mu^-$	(7.3 ±0.8) $\times 10^{-3}$	
Γ_5	$\tau^+\tau^-$	(2.8 ±0.7) $\times 10^{-3}$	
	Decays into $J/\psi(1S)$and anything		
Γ_6	$J/\psi(1S)$anything	(57.6 ±2.0) %	
Γ_7	$J/\psi(1S)$neutrals	(24.6 ±1.2) %	
Γ_8	$J/\psi(1S)\pi^+\pi^-$	(31.7 ±1.1) %	
Γ_9	$J/\psi(1S)\pi^0\pi^0$	(18.8 ±1.2) %	
Γ_{10}	$J/\psi(1S)\eta$	(3.16±0.22) %	
Γ_{11}	$J/\psi(1S)\pi^0$	(9.6 ±2.1) $\times 10^{-4}$	

Hadronic decays

Γ_{12}	$3(\pi^+\pi^-)\pi^0$	$(3.5 \pm 1.6) \times 10^{-3}$	
Γ_{13}	$2(\pi^+\pi^-)\pi^0$	$(3.0 \pm 0.8) \times 10^{-3}$	
Γ_{14}	$\rho a_2(1320)$	$< 2.3 \times 10^{-4}$	CL=90%
Γ_{15}	$\omega\pi^+\pi^-$	$(4.8 \pm 0.9) \times 10^{-4}$	
Γ_{16}	$b_1^{\pm}\pi^{\mp}$	$(3.2 \pm 0.8) \times 10^{-4}$	
Γ_{17}	$\omega f_2(1270)$	$< 1.5 \times 10^{-4}$	CL=90%
Γ_{18}	$\pi^+\pi^- K^+K^-$	$(1.6 \pm 0.4) \times 10^{-3}$	
Γ_{19}	$K^*(892)\overline{K}{}^*_2(1430)^0$	$< 1.2 \times 10^{-4}$	CL=90%
Γ_{20}	$K_1(1270)^{\pm}K^{\mp}$	$(1.00 \pm 0.28) \times 10^{-3}$	
Γ_{21}	$\pi^+\pi^- p\overline{p}$	$(8.0 \pm 2.0) \times 10^{-4}$	
Γ_{22}	$K^+\overline{K}{}^*(892)^0\pi^- +$ c.c.	$(6.7 \pm 2.5) \times 10^{-4}$	
Γ_{23}	$2(\pi^+\pi^-)$	$(4.5 \pm 1.0) \times 10^{-4}$	
Γ_{24}	$\rho^0\pi^+\pi^-$	$(4.2 \pm 1.5) \times 10^{-4}$	
Γ_{25}	ωK^+K^-	$(1.5 \pm 0.4) \times 10^{-4}$	
Γ_{26}	$\omega p\overline{p}$	$(8.0 \pm 3.2) \times 10^{-5}$	
Γ_{27}	$\overline{p}p$	$(2.07 \pm 0.31) \times 10^{-4}$	
Γ_{28}	$\Lambda\overline{\Lambda}$	$(1.81 \pm 0.34) \times 10^{-4}$	
Γ_{29}	$3(\pi^+\pi^-)$	$(1.5 \pm 1.0) \times 10^{-4}$	
Γ_{30}	$\overline{p}p\pi^0$	$(1.4 \pm 0.5) \times 10^{-4}$	
Γ_{31}	$\Delta^{++}\overline{\Delta}{}^{--}$	$(1.28 \pm 0.35) \times 10^{-4}$	
Γ_{32}	$\Sigma^0\overline{\Sigma}{}^0$	$(1.2 \pm 0.6) \times 10^{-4}$	
Γ_{33}	$\Sigma^{*+}\overline{\Sigma}{}^{*-}$	$(1.1 \pm 0.4) \times 10^{-4}$	
Γ_{34}	K^+K^-	$(1.0 \pm 0.7) \times 10^{-4}$	
Γ_{35}	$K^0_S K^0_L$	$(5.2 \pm 0.7) \times 10^{-5}$	
Γ_{36}	$\pi^+\pi^-\pi^0$	$(8 \pm 5) \times 10^{-5}$	
Γ_{37}	$\rho\pi$	$< 8.3 \times 10^{-5}$	CL=90%
Γ_{38}	$\pi^+\pi^-$	$(8 \pm 5) \times 10^{-5}$	
Γ_{39}	$\Xi^-\overline{\Xi}{}^+$	$(9.4 \pm 3.1) \times 10^{-5}$	
Γ_{40}	$K_1(1400)^{\pm}K^{\mp}$	$< 3.1 \times 10^{-4}$	CL=90%
Γ_{41}	$\Xi^{*0}\overline{\Xi}{}^{*0}$	$< 8.1 \times 10^{-5}$	CL=90%
Γ_{42}	$\Omega^-\overline{\Omega}{}^+$	$< 7.3 \times 10^{-5}$	CL=90%
Γ_{43}	$K^+K^-\pi^0$	$< 2.96 \times 10^{-5}$	CL=90%
Γ_{44}	$K^+\overline{K}{}^*(892)^- +$ c.c.	$< 5.4 \times 10^{-5}$	CL=90%
Γ_{45}	$\phi\pi^+\pi^-$	$(1.50 \pm 0.28) \times 10^{-4}$	
Γ_{46}	$\phi f_0(980) \rightarrow \pi^+\pi^-$	$(6.0 \pm 2.2) \times 10^{-5}$	
Γ_{47}	ϕK^+K^-	$(6.0 \pm 2.2) \times 10^{-5}$	
Γ_{48}	$\phi p\overline{p}$	$< 2.6 \times 10^{-5}$	CL=90%
Γ_{49}	$\phi f'_2(1525)$	$< 4.5 \times 10^{-5}$	CL=90%

Radiative decays

Γ_{50}	$\gamma\chi_{c0}(1P)$	$(8.6 \pm 0.7)\%$		
Γ_{51}	$\gamma\chi_{c1}(1P)$	$(8.4 \pm 0.8)\%$		
Γ_{52}	$\gamma\chi_{c2}(1P)$	$(6.4 \pm 0.6)\%$		
Γ_{53}	$\gamma\eta_c(1S)$	$(2.8 \pm 0.6) \times 10^{-3}$		
Γ_{54}	$\gamma\eta_c(2S)$			
Γ_{55}	$\gamma\pi^0$			
Γ_{56}	$\gamma\eta'(958)$	$(1.5 \pm 0.4) \times 10^{-4}$		
Γ_{57}	$\gamma f_2(1270)$	$(2.1 \pm 0.4) \times 10^{-4}$		
Γ_{58}	$\gamma f_0(1710) \rightarrow \gamma\pi\pi$	$(3.0 \pm 1.3) \times 10^{-5}$		
Γ_{59}	$\gamma f_0(1710) \rightarrow \gamma K\overline{K}$	$(6.0 \pm 1.6) \times 10^{-5}$		
Γ_{60}	$\gamma\gamma$	< 1.5	$\times 10^{-4}$	CL=90%
Γ_{61}	$\gamma\eta$	< 9	$\times 10^{-5}$	CL=90%
Γ_{62}	$\gamma\eta(1405) \rightarrow \gamma K\overline{K}\pi$	< 1.2	$\times 10^{-4}$	CL=90%

$\psi(2S)$ PARTIAL WIDTHS

Γ(hadrons) Γ_1

VALUE (keV)	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
258 ± 26	BAI	02B	BES	e^+e^-
224 ± 56	LUTH	75	MRK1	e^+e^-

$\Gamma(e^+e^-)$ Γ_3

VALUE (keV)	*DOCUMENT ID*		*TECN*	*COMMENT*
2.12±0.12 OUR FIT				
2.14±0.21	ALEXANDER	89	RVUE	See Υ mini-review
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2.44 ± 0.21	[8] BAI	02B	BES	e^+e^-
2.0 ± 0.3	BRANDELIK	79C	DASP	e^+e^-
2.1 ± 0.3	[7] LUTH	75	MRK1	e^+e^-

[7] From a simultaneous fit to e^+e^-, $\mu^+\mu^-$, and hadronic channels assuming $\Gamma(e^+e^-) = \Gamma(\mu^+\mu^-)$.

$\Gamma(\gamma\gamma)$ Γ_{60}

VALUE (eV)	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<43	90	BRANDELIK	79C	DASP	e^+e^-

[8] From a simultaneous fit to e^+e^-, $\mu^+\mu^-$, and hadronic channel, assuming $\Gamma_e = \Gamma_\mu = \Gamma_\tau/0.38847$.

$\psi(2S)$ $\Gamma(i)\Gamma(e^+e^-)/\Gamma(\text{total})$

This combination of a partial width with the partial width into e^+e^- and with the total width is obtained from the integrated cross section into channel$_I$ in the e^+e^- annihilation. We list only data that have not been used to determine the partial width $\Gamma(I)$ or the branching ratio $\Gamma(I)$/total.

$\Gamma(\text{hadrons}) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ — $\Gamma_1\Gamma_3/\Gamma$

VALUE (keV)	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2.2±0.4	ABRAMS	75	MRK1	e^+e^-

$\Gamma(e^+e^-) \times \Gamma(J/\psi(1S)\pi^+\pi^-)/\Gamma_{\text{total}}$ — $\Gamma_3\Gamma_8/\Gamma$

VALUE (keV)	*DOCUMENT ID*		*TECN*	*COMMENT*
0.67±0.05 OUR FIT				
0.68±0.09	[9] BAI	98E	BES	e^+e^-

[9] The value of $\Gamma(e^+e^-)$ quoted in BAI 98E is derived using $B(\psi(2S) \to J/\psi(1S)\pi^+\pi^-) = (32.4 \pm 2.6) \times 10^{-2}$ and $B(J/\psi(1S) \to \ell^+\ell^-) = 0.1203 \pm 0.0038$. Recalculated by us using $B(J/\psi(1S) \to \ell^+\ell^-) = 0.1181 \pm 0.0020$.

$\psi(2S)$ BRANCHING RATIOS

$\Gamma(\text{hadrons})/\Gamma_{\text{total}}$ — Γ_1/Γ

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.9785±0.0013 OUR AVERAGE				
0.9779±0.0015	[10] BAI	02B	BES	e^+e^-
0.981 ±0.003	[10] LUTH	75	MRK1	e^+e^-

$\Gamma(\text{virtual}\gamma \to \text{hadrons})/\Gamma_{\text{total}}$ — Γ_2/Γ

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.0216±0.0035 OUR AVERAGE	Error includes scale factor of 2.1.			
0.0199±0.0019	[11] BAI	02B	BES	e^+e^-
0.029 ±0.004	[11] LUTH	75	MRK1	e^+e^-

$\Gamma(e^+e^-)/\Gamma_{\text{total}}$ — Γ_3/Γ

VALUE (units 10^{-4})	*DOCUMENT ID*		*TECN*	*COMMENT*
75.5± 3.1 OUR FIT				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
88 ±13	[12] FELDMAN	77	RVUE	e^+e^-

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

VALUE (units 10^{-4})	*DOCUMENT ID*
73±8 OUR FIT	

$\Gamma(\tau^+\tau^-)/\Gamma_{\text{total}}$ — Γ_5/Γ

VALUE (units 10^{-4})	*DOCUMENT ID*
28±7 OUR FIT	

$\Gamma(\mu^+\mu^-)/\Gamma(e^+e^-)$ — Γ_4/Γ_3

VALUE	DOCUMENT ID		TECN	COMMENT
0.97±0.13 OUR FIT				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.89±0.16	BOYARSKI	75C	MRK1	e^+e^-

[10] Includes cascade decay into $J/\psi(1S)$.

[11] Included in $\Gamma(\text{hadrons})/\Gamma_{\text{total}}$.

[12] From an overall fit assuming equal partial widths for e^+e^- and $\mu^+\mu^-$. For a measurement of the ratio see the entry $\Gamma(\mu^+\mu^-)/\Gamma(e^+e^-)$ below. Includes LUTH 75, HILGER 75, BURMESTER 77.

DECAYS INTO $J/\psi(1S)$ AND ANYTHING

$\Gamma(J/\psi(1S)\text{anything})/\Gamma_{\text{total}}$ — Γ_6/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.576±0.020 OUR FIT				
0.55 ±0.07 OUR AVERAGE				
0.51 ±0.12	BRANDELIK	79C	DASP	$e^+e^- \rightarrow \mu^+\mu^- X$
0.57 ±0.08	ABRAMS	75B	MRK1	$e^+e^- \rightarrow \mu^+\mu^- X$

$\Gamma(J/\psi(1S)\text{neutrals})/\Gamma_{\text{total}}$ — Γ_7/Γ

VALUE	DOCUMENT ID
0.246±0.012 OUR FIT	

$\Gamma(J/\psi(1S)\pi^+\pi^-)/\Gamma_{\text{total}}$ — Γ_8/Γ

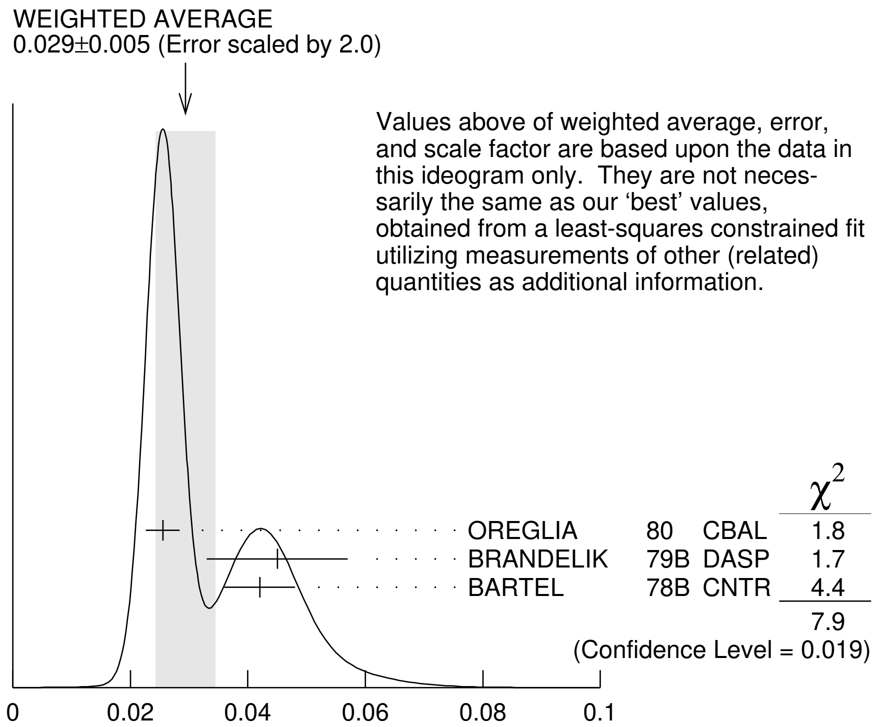
VALUE	DOCUMENT ID		TECN	COMMENT
0.317±0.011 OUR FIT				
0.323±0.013 OUR AVERAGE				
0.323±0.014	BAI	02B	BES	e^+e^-
0.32 ±0.04	ABRAMS	75B	MRK1	$e^+e^- \rightarrow J/\psi\pi^+\pi^-$

$\Gamma(J/\psi(1S)\pi^0\pi^0)/\Gamma_{\text{total}}$ — Γ_9/Γ

VALUE	DOCUMENT ID
0.188±0.012 OUR FIT	

$\Gamma(J/\psi(1S)\eta)/\Gamma_{\text{total}}$ — Γ_{10}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0316±0.0022 OUR FIT					
0.029 ±0.005 OUR AVERAGE Error includes scale factor of 2.0. See the ideogram below.					
0.0255±0.0029	386	[13] OREGLIA	80	CBAL	$e^+e^- \rightarrow J/\psi 2\gamma$
0.045 ±0.012	17	[14] BRANDELIK	79B	DASP	$e^+e^- \rightarrow J/\psi 2\gamma$
0.042 ±0.006	164	[14] BARTEL	78B	CNTR	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.043 ±0.008	44	TANENBAUM	76	MRK1	e^+e^-



$\Gamma\big(J/\psi(1S)\eta\big)/\Gamma_{\text{total}}$

$\Gamma\big(J/\psi(1S)\pi^0\big)/\Gamma_{\text{total}}$ — Γ_{11}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
9.6±2.1 OUR AVERAGE					
14 ±6	7	HIMEL	80	MRK2	e^+e^-
9 ±2 ±1	23	[13] OREGLIA	80	CBAL	$\psi(2S) \rightarrow J/\psi 2\gamma$

$\Gamma\big(J/\psi(1S)\text{neutrals}\big)/\Gamma\big(J/\psi(1S)\pi^+\pi^-\big)$ — Γ_7/Γ_8

VALUE	DOCUMENT ID		TECN	COMMENT
0.777±0.032 OUR FIT				
0.73 ±0.09	TANENBAUM	76	MRK1	e^+e^-

$\Gamma\big(J/\psi(1S)\pi^+\pi^-\big)/\Gamma\big(J/\psi(1S)\text{anything}\big)$ — Γ_8/Γ_6

VALUE	DOCUMENT ID		TECN	COMMENT
0.549±0.011 OUR FIT				
0.496±0.037	ARMSTRONG	97	E760	$\overline{p}p \rightarrow \psi(2S)$

$\Gamma\big(J/\psi(1S)\pi^0\pi^0\big)/\Gamma\big(J/\psi(1S)\text{anything}\big)$ — Γ_9/Γ_6

VALUE	DOCUMENT ID		TECN	COMMENT
0.327±0.012 OUR FIT				
0.327±0.014 OUR AVERAGE				
0.328±0.013±0.008	AMBROGIANI	00A	E835	$p\overline{p} \rightarrow \psi(2S)$
0.323±0.033	ARMSTRONG	97	E760	$\overline{p}p \rightarrow \psi(2S)$

$\Gamma(J/\psi(1S)\pi^0\pi^0)/\Gamma(J/\psi(1S)\pi^+\pi^-)$ — Γ_9/Γ_8

VALUE	DOCUMENT ID		TECN	COMMENT
0.59±0.05 OUR FIT				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.53±0.06	TANENBAUM	76	MRK1	e^+e^-
0.64±0.15	[15] HILGER	75	SPEC	e^+e^-

$\Gamma(J/\psi(1S)\eta)/\Gamma(J/\psi(1S)\text{anything})$ — Γ_{10}/Γ_6

VALUE	DOCUMENT ID		TECN	COMMENT
0.055±0.004 OUR FIT				
0.069±0.008 OUR AVERAGE				
0.072±0.009	AMBROGIANI	00A	E835	$p\overline{p} \rightarrow \psi(2S)$
0.061±0.015	ARMSTRONG	97	E760	$\overline{p}p \rightarrow \psi(2S)$

$\Gamma(J/\psi(1S)\eta)/\Gamma(J/\psi(1S)\pi^+\pi^-)$ — Γ_{10}/Γ_8

VALUE	DOCUMENT ID		TECN	COMMENT
0.100±0.008 OUR FIT				
0.091±0.021	[16] HIMEL	80	MRK2	$e^+e^- \rightarrow \psi(2S)X$

$\Gamma(e^+e^-)/\Gamma(J/\psi(1S)\text{anything})$ — Γ_3/Γ_6

VALUE	DOCUMENT ID		TECN	COMMENT
0.0131±0.0010 OUR FIT				
0.0131±0.0006 OUR AVERAGE	Error includes scale factor of 1.8.			
0.0128±0.0003±0.0002	[17] AMBROGIANI	00A	E835	$p\overline{p} \rightarrow \psi(2S)$
0.0144±0.0008±0.0002	[17] ARMSTRONG	97	E760	$\overline{p}p \rightarrow \psi(2S)$

$\Gamma(e^+e^-)/\Gamma(J/\psi(1S)\pi^+\pi^-)$ — Γ_3/Γ_8

VALUE	DOCUMENT ID		TECN	COMMENT
0.0238±0.0017 OUR FIT				
0.0252±0.0028±0.0011	[17] AUBERT	02B	BABR	e^+e^-

$\Gamma(\mu^+\mu^-)/\Gamma(J/\psi(1S)\text{anything})$ — Γ_4/Γ_6

VALUE	DOCUMENT ID		TECN	COMMENT
0.0127±0.0033 OUR FIT				
0.014 ±0.003	HILGER	75	SPEC	e^+e^-

$\Gamma(\mu^+\mu^-)/\Gamma(J/\psi(1S)\pi^+\pi^-)$ — Γ_4/Γ_8

VALUE	DOCUMENT ID		TECN	COMMENT
0.0231±0.0030 OUR FIT				
0.0224±0.0029 OUR AVERAGE				
0.0216±0.0026±0.0014	[18] AUBERT	02B	BABR	e^+e^-
0.0327±0.0077±0.0072	[18] GRIBUSHIN	96	FMPS	515 π^- Be $\rightarrow 2\mu X$

$\Gamma(\tau^+\tau^-)/\Gamma(J/\psi(1S)\pi^+\pi^-)$ — Γ_5/Γ_8

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
8.7 ±2.2 OUR FIT				
8.73±1.39±1.57	BAI	02	BES	e^+e^-

[13] Recalculated by us using B($J/\psi(1S) \rightarrow \ell^+ \ell^-$) = 0.1181 ± 0.0020.
[14] Recalculated by us using B($J/\psi(1S) \rightarrow \mu^+ \mu^-$) = 0.0588 ± 0.0010.
[15] Ignoring the $J/\psi(1S)\eta$ and $J/\psi(1S)\gamma\gamma$ decays.
[16] The value for B($\psi(2S) \rightarrow J/\psi(1s)\eta$) reported in HIMEL 80 is derived using B(ψ(2S)) → $J/\psi(1S)\pi^+\pi^-$) = (33 ± 3))% and B($J/\psi(1S) \rightarrow \ell^+ \ell^-$) = 0.138 ± 0.018. Calculated by us using B($J/\psi(1S) \rightarrow \ell^+ \ell^-$) = (0.1181 ± 0.0020).
[17] Using B($J/\psi(1S) \rightarrow e^+ e^-$) = 0.0593 ± 0.0010.
[18] Using B($J/\psi(1S) \rightarrow \mu^+ \mu^-$) = 0.0588 ± 0.0010.

HADRONIC DECAYS

$\Gamma(3(\pi^+\pi^-)\pi^0)/\Gamma_{total}$ — Γ_{12}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
35±16	6	FRANKLIN	83	MRK2	$e^+e^- \rightarrow$ hadrons

$\Gamma(2(\pi^+\pi^-)\pi^0)/\Gamma_{total}$ — Γ_{13}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
30±8	42	FRANKLIN	83	MRK2	e^+e^-

$\Gamma(\omega\pi^+\pi^-)/\Gamma_{total}$ — Γ_{15}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
4.8±0.6±0.7	100±22	[19] BAI	03B	BES	$\psi(2S) \rightarrow 2(\pi^+\pi^-)\pi^0$

$\Gamma(b_1^\pm\pi^\mp)/\Gamma_{total}$ — Γ_{16}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
3.2±0.6±0.5	61 ± 11	[19,20] BAI	03B	BES	$\psi(2S) \rightarrow 2(\pi^+\pi^-)\pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
5.2±0.8±1.0		[20] BAI	99C	BES	Repl. by BAI 03B

$\Gamma(\omega f_2(1270))/\Gamma_{total}$ — Γ_{17}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<1.5	90	[19] BAI	03B	BES	$\psi(2S) \rightarrow 2(\pi^+\pi^-)\pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<1.7	90	BAI	98J	BES	Repl. by BAI 03B

$\Gamma(\pi^+\pi^-K^+K^-)/\Gamma_{total}$ — Γ_{18}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
16±4	[21] TANENBAUM	78	MRK1	e^+e^-

$\Gamma(K_1(1270)^\pm K^\mp)/\Gamma_{total}$ — Γ_{20}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
10.0±1.8±2.1	[22] BAI	99C	BES	e^+e^-

$\Gamma(\pi^+\pi^-p\overline{p})/\Gamma_{total}$ — Γ_{21}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
8 ±2	[21] TANENBAUM	78	MRK1	e^+e^-

$\Gamma(K^+ \overline{K}^*(892)^0 \pi^- + \text{c.c.})/\Gamma_{\text{total}}$ — Γ_{22}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
6.7±2.5	TANENBAUM	78	MRK1	$e^+ e^-$

$\Gamma(\omega K^+ K^-)/\Gamma_{\text{total}}$ — Γ_{25}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
1.5±0.3±0.2	23.0± 5.2	[19] BAI	03B	BES	$\psi(2S) \to K^+ K^- \pi^+ \pi^- \pi^0$

$\Gamma(\omega p \overline{p})/\Gamma_{\text{total}}$ — Γ_{26}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
0.8 ±0.3 ±0.1	14.9± 0.1	[19] BAI	03B	BES	$\psi(2S) \to p \overline{p} \pi^+ \pi^- \pi^0$

$\Gamma(2(\pi^+ \pi^-))/\Gamma_{\text{total}}$ — Γ_{23}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
4.5±1.0	TANENBAUM	78	MRK1	$e^+ e^-$

$\Gamma(\rho^0 \pi^+ \pi^-)/\Gamma_{\text{total}}$ — Γ_{24}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
4.2±1.5	TANENBAUM	78	MRK1	$e^+ e^-$

$\Gamma(\rho a_2(1320))/\Gamma_{\text{total}}$ — Γ_{14}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<2.3	90	BAI	98J	BES	$e^+ e^-$

$\Gamma(\overline{p} p)/\Gamma_{\text{total}}$ — Γ_{27}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
2.07±0.31 OUR AVERAGE					
2.16±0.15±0.36	201	[23] BAI	01	BES	$e^+ e^- \to \psi(2S)$
1.4 ±0.8	4	BRANDELIK	79C	DASP	$e^+ e^-$
2.3 ±0.7		FELDMAN	77	MRK1	$e^+ e^-$

$\Gamma(\Lambda \overline{\Lambda})/\Gamma_{\text{total}}$ — Γ_{28}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
1.81±0.20±0.27		80	[23] BAI	01	BES	$e^+ e^- \to \psi(2S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<4	90		FELDMAN	77	MRK1	$e^+ e^-$

$\Gamma(3(\pi^+ \pi^-))/\Gamma_{\text{total}}$ — Γ_{29}/Γ

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
1.5±1.0	[21] TANENBAUM	78	MRK1	$e^+ e^-$

$\Gamma(\overline{p} p \pi^0)/\Gamma_{\text{total}}$ — Γ_{30}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
1.4±0.5	9	FRANKLIN	83	MRK2	$e^+ e^-$

$\Gamma(K^+K^-)/\Gamma_{total}$ — Γ_{34}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
1.0±0.7		BRANDELIK	79C	DASP	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.5	90	FELDMAN	77	MRK1	e^+e^-

$\Gamma(K^0_S K^0_L)/\Gamma_{total}$ — Γ_{35}/Γ

VALUE (units 10^{-5})	EVTS	DOCUMENT ID		TECN	COMMENT
5.24±0.47±0.48	156±14	[24] BAI	04B	BES2	$\psi(2S) \rightarrow K^0_S K^0_L \rightarrow \pi^+\pi^- X$

$\Gamma(\pi^+\pi^-)/\Gamma_{total}$ — Γ_{38}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
0.8±0.5		BRANDELIK	79C	DASP	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.5	90	FELDMAN	77	MRK1	e^+e^-

$\Gamma(\pi^+\pi^-\pi^0)/\Gamma_{total}$ — Γ_{36}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
0.85±0.46	4	FRANKLIN	83	MRK2	$e^+e^- \rightarrow$ hadrons

$\Gamma(\Delta^{++}\overline{\Delta}^{--})/\Gamma_{total}$ — Γ_{31}/Γ

VALUE (units 10^{-5})	EVTS	DOCUMENT ID		TECN	COMMENT
12.8±1.0±3.4	157	[23] BAI	01	BES	$e^+e^- \rightarrow \psi(2S)$

$\Gamma(\Sigma^0\overline{\Sigma}^0)/\Gamma_{total}$ — Γ_{32}/Γ

VALUE (units 10^{-5})	EVTS	DOCUMENT ID		TECN	COMMENT
12±4±4	8	[23] BAI	01	BES	$e^+e^- \rightarrow \psi(2S)$

$\Gamma(\Sigma^{*+}\overline{\Sigma}^{*-})/\Gamma_{total}$ — Γ_{33}/Γ

VALUE (units 10^{-5})	EVTS	DOCUMENT ID		TECN	COMMENT
11±3±3	14	[23] BAI	01	BES	$e^+e^- \rightarrow \psi(2S)$

$\Gamma(K_1(1400)^{\pm}K^{\mp})/\Gamma_{total}$ — Γ_{40}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<3.1	90	[25] BAI	99C	BES	e^+e^-

$\Gamma(\Xi^-\overline{\Xi}^+)/\Gamma_{total}$ — Γ_{39}/Γ

VALUE (units 10^{-5})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
9.4±2.7±1.5		12	[23] BAI	01	BES	$e^+e^- \rightarrow \psi(2S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<20	90		FELDMAN	77	MRK1	e^+e^-

$\Gamma(\Xi^{*0}\overline{\Xi}^{*0})/\Gamma_{total}$ — Γ_{41}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
<8.1	90	[23] BAI	01	BES	$e^+e^- \rightarrow \psi(2S)$

$\Gamma(\Omega^-\overline{\Omega}^+)/\Gamma_{total}$ — Γ_{42}/Γ

VALUE (units 10^{-5})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<7.3	90	[23] BAI	01	BES	$e^+e^- \rightarrow \psi(2S)$

$\Gamma(\rho\pi)/\Gamma_{total}$ — Γ_{37}/Γ

VALUE (units 10^{-4})	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
< 0.83	90	1	FRANKLIN	83	MRK2	e^+e^-
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<10	90		BARTEL	76	CNTR	e^+e^-
<10	90		[26] ABRAMS	75	MRK1	e^+e^-

$\Gamma(K^+K^-\pi^0)/\Gamma_{total}$ — Γ_{43}/Γ

VALUE (units 10^{-5})	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
<2.96	90	1	FRANKLIN	83	MRK2	$e^+e^- \rightarrow$ hadrons

$\Gamma(K^+\overline{K}^*(892)^- + \text{c.c.})/\Gamma_{total}$ — Γ_{44}/Γ

VALUE (units 10^{-5})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<5.4	90	FRANKLIN	83	MRK2	$e^+e^- \rightarrow$ hadrons

$\Gamma(K^*(892)\overline{K}_2^*(1430)^0)/\Gamma_{total}$ — Γ_{19}/Γ

VALUE (units 10^{-4})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<1.2	90	BAI	98J	BES	e^+e^-

$\Gamma(\phi\pi^+\pi^-)/\Gamma_{total}$ — Γ_{45}/Γ

VALUE (units 10^{-4})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1.5 ±0.2 ±0.2	51.5± 8.3	[19] BAI	03B	BES	$\psi(2S) \rightarrow K^+K^-\pi^+\pi^-$

$\Gamma(\phi f_0(980) \rightarrow \pi^+\pi^-)/\Gamma_{total}$ — Γ_{46}/Γ

VALUE (units 10^{-4})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.6 ±0.2 ±0.1	18.4± 6.4	[19] BAI	03B	BES	$\psi(2S) \rightarrow K^+K^-\pi^+\pi^-$

$\Gamma(\phi K^+K^-)/\Gamma_{total}$ — Γ_{47}/Γ

VALUE (units 10^{-4})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.6 ±0.2 ±0.1	16.1± 5.0	[19] BAI	03B	BES	$\psi(2S) \rightarrow 2(K^+K^-)$

$\Gamma(\phi p\overline{p})/\Gamma_{total}$ — Γ_{48}/Γ

VALUE (units 10^{-4})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<0.26	90	[19] BAI	03B	BES	$\psi(2S) \rightarrow K^+K^-p\overline{p}$

$\Gamma(\phi f'_2(1525))/\Gamma_{total}$ Γ_{49}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<0.45	90	BAI	98J	BES	$e^+ e^- \rightarrow 2(K^+ K^-)$

[19] Normalized to B($\psi(2S) \rightarrow J/\psi \pi^+ \pi^-$) = 0.305 ± 0.016.
[20] Assuming B($b_1 \rightarrow \omega \pi$)=1.
[21] Assuming entirely strong decay.
[22] Assuming B($K_1(1270) \rightarrow K \rho$)=0.42 ± 0.06
[23] Estimated using B($\psi(2S) \rightarrow J/\psi \pi^+ \pi^-$)= 0.310 ± 0.028.
[24] Using B($K^0_S \rightarrow \pi^+ \pi^-$) = 0.6860 ± 0.0027.
[25] Assuming B($K_1(1400) \rightarrow K^* \pi$)=0.94 ± 0.06
[26] Final state $\rho^0 \pi^0$.

RADIATIVE DECAYS

$\Gamma(\gamma \chi_{c0}(1P))/\Gamma_{total}$ Γ_{50}/Γ

VALUE (units 10^{-2})	DOCUMENT ID		TECN	COMMENT
8.6±0.7 OUR FIT				
9.3±0.8 OUR AVERAGE				
9.9±0.5±0.8	[27] GAISER	86	CBAL	$e^+ e^- \rightarrow \gamma X$
7.2±2.3	[27] BIDDICK	77	CNTR	$e^+ e^- \rightarrow \gamma X$
7.5±2.6	[27] WHITAKER	76	MRK1	$e^+ e^-$

$\Gamma(\gamma \chi_{c1}(1P))/\Gamma_{total}$ Γ_{51}/Γ

VALUE (units 10^{-2})	DOCUMENT ID		TECN	COMMENT
8.4±0.8 OUR FIT				
8.7±0.8 OUR AVERAGE				
9.0±0.5±0.7	[28] GAISER	86	CBAL	$e^+ e^- \rightarrow \gamma X$
7.1±1.9	[29] BIDDICK	77	CNTR	$e^+ e^- \rightarrow \gamma X$

$\Gamma(\gamma \chi_{c2}(1P))/\Gamma_{total}$ Γ_{52}/Γ

VALUE (units 10^{-2})	DOCUMENT ID		TECN	COMMENT
6.4±0.6 OUR FIT				
7.8±0.8 OUR AVERAGE				
8.0±0.5±0.7	[30] GAISER	86	CBAL	$e^+ e^- \rightarrow \gamma X$
7.0±2.0	[29] BIDDICK	77	CNTR	$e^+ e^- \rightarrow \gamma X$

$\Gamma(\gamma \eta_c(1S))/\Gamma_{total}$ Γ_{53}/Γ

VALUE (units 10^{-2})	DOCUMENT ID		TECN	COMMENT
0.28±0.06	GAISER	86	CBAL	$e^+ e^- \rightarrow \gamma X$

$\Gamma(\gamma \eta_c(2S))/\Gamma_{total}$ Γ_{54}/Γ

VALUE (units 10^{-2})	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.2 to 1.3	95	EDWARDS	82C	CBAL	$e^+ e^- \rightarrow \gamma X$

$\Gamma(\gamma\pi^0)/\Gamma_{total}$ — Γ_{55}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<$ 54	95	[31] LIBERMAN	75	SPEC	e^+e^-
$<$100	90	WIIK	75	DASP	e^+e^-

$\Gamma(\gamma\eta'(958))/\Gamma_{total}$ — Γ_{56}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
1.54±0.31±0.20		$\sim$ 43	BAI	98F	BES	$\psi(2S) \rightarrow \pi^+\pi^- 2\gamma, \pi^+\pi^- 3\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$<$60	90		[32] BRAUNSCH...	77	DASP	e^+e^-
$<$11	90		[33] BARTEL	76	CNTR	e^+e^-

$\Gamma(\gamma f_2(1270))/\Gamma_{total}$ — Γ_{57}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
2.12±0.19±0.32		[34,35] BAI	03C	BES	$\psi(2S) \rightarrow \gamma\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.08±0.19±0.33	200.6± 18.8	[34] BAI	03C	BES	$\psi(2S) \rightarrow \gamma\pi^+\pi^-$
2.90±1.08±1.07	29.9± 11.1	[34] BAI	03C	BES	$\psi(2S) \rightarrow \gamma\pi^0\pi^0$

$\Gamma(\gamma f_0(1710) \rightarrow \gamma\pi\pi)/\Gamma_{total}$ — Γ_{58}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
0.301±0.041±0.124	35.6± 4.8	[34] BAI	03C	BES	$\psi(2S) \rightarrow \gamma\pi^+\pi^-$

$\Gamma(\gamma f_0(1710) \rightarrow \gamma K\overline{K})/\Gamma_{total}$ — Γ_{59}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.604±0.090±0.132		39.6± 5.9	[34,36] BAI	03C	BES	$\psi(2S) \rightarrow \gamma K^+K^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$<$1.56	90	6.8 ± 3.1	[34,36] BAI	03C	BES	$\psi(2S) \rightarrow \gamma K^0_S K^0_S$

$\Gamma(\gamma\eta)/\Gamma_{total}$ — Γ_{61}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
$<$0.9	90	BAI	98F	BES	$\psi(2S) \rightarrow \pi^+\pi^- 3\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<$2	90	YAMADA	77	DASP	$e^+e^- \rightarrow 3\gamma$

$\Gamma(\gamma\eta(1405) \to \gamma K\overline{K}\pi)/\Gamma_{total}$ — Γ_{62}/Γ

VALUE (units 10^{-3})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<0.12	90	[37] SCHARRE	80	MRK1	e^+e^-

[27] Angular distribution ($1+\cos^2\theta$) assumed.
[28] Angular distribution ($1-0.189\cos^2\theta$) assumed.
[29] Valid for isotropic distribution of the photon.
[30] Angular distribution ($1-0.052\cos^2\theta$) assumed.
[31] Restated by us using B($\psi(2S) \to \mu^+\mu^-$) = 0.0077.
[32] Restated by us using total decay width 228 keV.
[33] The value is normalized to the branching ratio for $\Gamma(J/\psi(1S)\eta)/\Gamma_{total}$.
[34] Normalized to B($\psi(2S) \to J/\psi\pi^+\pi^-$) = 0.305 ± 0.016.
[35] Combining the results from $\pi^+\pi^-$ and $\pi^0\pi^0$ decay modes.
[36] Includes unknown branching fractions to K^+K^- or $K^0_S K^0_S$. We have multiplied the K^+K^- result by a factor of 2 and the $K^0_S K^0_S$ result by a factor of 4 to obtain the $K\overline{K}$ result.
[37] Includes unknown branching fraction $\eta(1405) \to K\overline{K}\pi$.

$\psi(2S)$ CROSS-PARTICLE BRANCHING RATIOS

For measurements involving B($\psi(2S) \to \gamma\chi_{cJ}(1P)$)×B($\chi_{cJ}(1P) \to X$) see the corresponding entries in the $\chi_{cJ}(1P)$ sections.

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