$f_J(2220)$

$I^G(J^{PC}) = 0^+(2^{++} \text{ or } 4^{++})$

OMITTED FROM SUMMARY TABLE

Needs confirmation. See our mini-review in the 2004 edition of this *Review*, PDG 04.

$f_J(2220)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
2231.1± 3.5 OUR AVERAGE					
$2235 \pm 4 \pm 6$	74	BAI	96B	BES	$e^+e^- \rightarrow J/\psi \rightarrow \gamma\pi^+\pi^-$
$2230\ ^{+6}_{-7} \pm 16$	46	BAI	96B	BES	$e^+e^- \rightarrow J/\psi \rightarrow \gamma K^+K^-$
$2232\ ^{+8}_{-7} \pm 15$	23	BAI	96B	BES	$e^+e^- \rightarrow J/\psi \rightarrow \gamma K^0_S K^0_S$
$2235 \pm 4 \pm 5$	32	BAI	96B	BES	$e^+e^- \rightarrow J/\psi \rightarrow \gamma p\overline{p}$
$2209\ ^{+17}_{-15} \pm 10$		ASTON	88F	LASS	$11\ K^- p \rightarrow K^+K^-\Lambda$
2230 ± 20		BOLONKIN	88	SPEC	$40\ \pi^- p \rightarrow K^0_S K^0_S n$
2220 ± 10	41	[1] ALDE	86B	GA24	38–100 $\pi p \rightarrow n\eta\eta'$
$2230 \pm 6 \pm 14$	93	BALTRUSAIT...	86D	MRK3	$e^+e^- \rightarrow \gamma K^+K^-$
$2232 \pm 7 \pm 7$	23	BALTRUSAIT...	86D	MRK3	$e^+e^- \rightarrow \gamma K^0_S K^0_S$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2246 ± 36		BAI	98H	BES	$J/\psi \rightarrow \gamma\pi^0\pi^0$

[1] ALDE 86B uses data from both the GAMS-2000 and GAMS-4000 detectors.

$f_J(2220)$ WIDTH

VALUE (MeV)	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{23^{+8}_{-7}}$ **OUR AVERAGE**						
$19^{+13}_{-11} \pm 12$		74	BAI	96B	BES	$e^+e^- \rightarrow J/\psi \rightarrow \gamma\pi^+\pi^-$
$20^{+20}_{-15} \pm 17$		46	BAI	96B	BES	$e^+e^- \rightarrow J/\psi \rightarrow \gamma K^+K^-$
$20^{+25}_{-16} \pm 14$		23	BAI	96B	BES	$e^+e^- \rightarrow J/\psi \rightarrow \gamma K^0_S K^0_S$
$15^{+12}_{-9} \pm 9$		32	BAI	96B	BES	$e^+e^- \rightarrow J/\psi \rightarrow \gamma p\overline{p}$
60^{+107}_{-57}			ASTON	88F	LASS	$11\ K^- p \rightarrow K^+K^-\Lambda$
80 ± 30			BOLONKIN	88	SPEC	$40\ \pi^- p \rightarrow K^0_S K^0_S n$
$26^{+20}_{-16} \pm 17$		93	BALTRUSAIT...	86D	MRK3	$e^+e^- \rightarrow \gamma K^+K^-$
$18^{+23}_{-15} \pm 10$		23	BALTRUSAIT...	86D	MRK3	$e^+e^- \rightarrow \gamma K^0_S K^0_S$
• • • We do not use the following data for averages, fits, limits, etc. • • •						

$<$80	90		ALDE	87C	GAM2	38 $\pi^- p \to \eta' \eta n$

$f_J(2220)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$\pi\pi$	seen
Γ_2	$\pi^+\pi^-$	seen
Γ_3	$K\overline{K}$	seen
Γ_4	$p\overline{p}$	
Γ_5	$\gamma\gamma$	not seen
Γ_6	$\eta\eta'(958)$	seen
Γ_7	$\phi\phi$	not seen
Γ_8	$\eta\eta$	not seen

$f_J(2220)$ $\Gamma(i)\Gamma(\gamma\gamma)/\Gamma(\text{total})$

$\Gamma(K\overline{K}) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ — $\Gamma_3\Gamma_5/\Gamma$

VALUE (eV)	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
$<$ 1.4	95	[2] ACCIARRI	01H	L3	$\gamma\gamma \to K^0_S K^0_S$, E^{ee}_{cm}= 91, 183–209 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<$ 5.6	95	[2] GODANG	97	CLE2	$\gamma\gamma \to K^0_S K^0_S$
$<$ 86	95	[2] ALBRECHT	90G	ARG	$\gamma\gamma \to K^+ K^-$
$<$1000	95	[3] ALTHOFF	85B	TASS	$\gamma\gamma$, $K\overline{K}\pi$

$\Gamma(\pi\pi) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ — $\Gamma_1\Gamma_5/\Gamma$

VALUE (eV)	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<2.5	95	ALAM	98C	CLE2	$\gamma\gamma \to \pi^+\pi^-$

[2] Assuming $J^P = 2^+$.
[3] True for $J^P = 0^+$ and $J^P = 2^+$.

$f_J(2220)$ $\Gamma(i)\Gamma(p\overline{p})/\Gamma^2(\text{total})$

$\Gamma(p\overline{p}) \times \Gamma(\pi\pi)/\Gamma^2_{\text{total}}$ — $\Gamma_4\Gamma_1/\Gamma^2$

VALUE (units 10^{-5})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<18	95	[4] AMSLER	01	CBAR	1.4–1.5 $p\overline{p} \to \pi^0\pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<$(11–42)	99	[5] HASAN	96	SPEC	1.35–1.55 $p\overline{p} \to \pi^+\pi^-$

$\Gamma(p\overline{p}) \times \Gamma(\phi\phi)/\Gamma^2_{\text{total}}$ — $\Gamma_4\Gamma_7/\Gamma^2$

VALUE (units 10^{-5})	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<6	95	[6] EVANGELIS...	98	SPEC	1.1-2.0 $p\overline{p} \to \phi\phi$

$\Gamma(p\overline{p}) \times \Gamma(\eta\eta)/\Gamma^2_{\text{total}}$ — $\Gamma_4\Gamma_8/\Gamma^2$

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
<4	95	[4] AMSLER	01	CBAR	1.4–1.5 $p\overline{p} \rightarrow \eta\eta$

[4] For $J^P = 2^+$ in the mass range 2222–2240 MeV and the total width between 10 and 20 MeV.

[5] For $J^P = 2^+$ and $J^P = 4^+$ in the mass range 2220–2245 MeV and the total width of 15 MeV.

[6] For $J^P = 2^+$, the mass of 2235 MeV and the total width of 15 MeV.

$f_J(2220)$ BRANCHING RATIOS

$\Gamma(p\overline{p})/\Gamma_{\text{total}}$ — Γ_4/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
not seen		WANG	05A	BELL	$B^+ \rightarrow \overline{p}pK^+$
<3.0	95	[8] EVANGELIS...	97	SPEC	1.96-2.40 $\overline{p}p \rightarrow K^0_S K^0_S$
<1.1	99.7	[7] BARNES	93	SPEC	1.3-1.57 $\overline{p}p \rightarrow K^0_S K^0_S$
<2.6	99.7	[7] BARDIN	87	CNTR	1.3-1.5 $\overline{p}p \rightarrow K^+K^-$
<3.6	99.7	[7] SCULLI	87	CNTR	1.29-1.55 $\overline{p}p \rightarrow K^+K^-$

[7] Assuming Γ = 30-35 MeV, $J^P = 2^+$ and B($f_J(2220) \rightarrow K\overline{K}$) = 100%.

$\Gamma(\pi\pi)/\Gamma(K\overline{K})$ — Γ_1/Γ_3

VALUE	DOCUMENT ID		TECN	COMMENT
1.0±0.5	BAI	96B	BES	$e^+e^- \rightarrow J/\psi \rightarrow \gamma 2\pi, K\overline{K}$

$\Gamma(p\overline{p})/\Gamma(K\overline{K})$ — Γ_4/Γ_3

VALUE	DOCUMENT ID		TECN	COMMENT
0.17±0.09	BAI	96B	BES	$e^+e^- \rightarrow J/\psi \rightarrow \gamma p\overline{p}, K\overline{K}$

[8] Assuming $\Gamma \sim 20$ MeV, $J^P = 2^+$ and B($f_J(2220) \rightarrow K\overline{K}$) = 100%.

$f_J(2220)$ REFERENCES

WANG	05A	PL B617 141	M.-Z. Wang et al.	(BELLE Collab.)
PDG	04	PL B592 1	S. Eidelman et al.	
ACCIARRI	01H	PL B501 173	M. Acciarri et al.	(L3 Collab.)
AMSLER	01	PL B520 175	C. Amsler et al.	(Crystal Barrel Collab.)
ALAM	98C	PRL 81 3328	M.S. Alam et al.	(CLEO Collab.)
BAI	98H	PRL 81 1179	J.Z. Bai et al.	(BES Collab.)
EVANGELIS...	98	PR D57 5370	C. Evangelista et al.	(JETSET Collab.)
EVANGELIS...	97	PR D56 3803	C. Evangelista et al.	(LEAR Collab.)
GODANG	97	PRL 79 3829	R. Godang et al.	(CLEO Collab.)
BAI	96B	PRL 76 3502	J.Z. Bai et al.	(BES Collab.)
HASAN	96	PL B388 376	A. Hasan, D.V. Bugg	(BRUN, LOQM)
BARNES	93	PL B309 469	P.D. Barnes, P. Birien, W.H. Breunlich	
ALBRECHT	90G	ZPHY C48 183	H. Albrecht et al.	(ARGUS Collab.)
ASTON	88F	PL B215 199	D. Aston et al.	(SLAC, NAGO, CINC, INUS) JP
BOLONKIN	88	NP B309 426	B.V. Bolonkin et al.	(ITEP, SERP)
ALDE	87C	SJNP 45 255 Translated from YAF 45 405.	D. Alde et al.	
BARDIN	87	PL B195 292	G. Bardin et al.	(SACL, FERR, CERN, PADO+)
SCULLI	87	PRL 58 1715	J. Sculli et al.	(NYU, BNL)
ALDE	86B	PL B177 120	D.M. Alde et al.	(SERP, BELG, LANL, LAPP)
BALTRUSAIT...	86D	PRL 56 107	R.M. Baltrusaitis	(CIT, UCSC, ILL, SLAC+)
ALTHOFF	85B	ZPHY C29 189	M. Althoff et al.	(TASSO Collab.)

OTHER RELATED PAPERS

CHUA	02	PL B544 139	C.-K. Chua, W.-S. Hou, S.U. Tsai	
MASEK	02	PR D65 072002	G. Masek *et al.*	(CLEO Collab.)
LIU	00A	JPG 26 L59	L.C. Liu, W.H. Ma	
WANG	00A	PR D62 017503	Z. Wang	
ANISOVICH	99D	PL B452 180	A.V. Anisovich *et al.*	
Also		NP A651 253	A.V. Anisovich *et al.*	
ANISOVICH	99F	NP A651 253	A.V. Anisovich *et al.*	
PROKOSHKIN	99	PAN 62 356	Yu.D. Prokoshkin	
		Translated from YAF 62 396.		
HUANG	96	PL B380 189	T. Huang *et al.*	(BHEP, BEIJ)
BARDIN	87	PL B195 292	G. Bardin *et al.*	(SACL, FERR, CERN, PADO+)
LEYAOUANC	85	ZPHY C28 309	A. Le Yaouanc *et al.*	(ORSAY, TOKY)
GODFREY	84	PL 141B 439	S. Godfrey, R. Kokoski, N. Isgur	(TNTO)
SHATZ	84	PL 138B 209	M.P. Shatz	(CIT)
WILLEY	84	PRL 52 585	R.S. Willey	(PITT)
EISENHAND...	75	NP B96 109	E. Eisenhandler *et al.*	(LOQM, LIVP, DARE+)