$f_J(2220)$

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

OMITTED FROM SUMMARY TABLE

THE $f_J(2220)$

Written March 1998 by M. Doser (CERN).

This state has been seen in $J/\psi(1S)$ radiative decay into $K\overline{K}$ (K^+K^- and $K^0_S K^0_S$ modes seen (BALTRUSAITIS 86D, BAI 96B)). An upper limit from DM2 for these modes (AUGUSTIN 88) is at the level at which observation is claimed. There are also indications for further decay modes ($\pi^+\pi^-$ and $\overline{p}p$) in the same production process (BAI 96B), although again at the level at which previous upper limits had been obtained (BALTRUSAITIS 86D); also seen in $\eta\eta$ (ALDE 86B), $K^0_S K^0_S$ (ASTON 88D) and in K^+K^- (ALDE 88F), albeit with very low statistics. Its J^{PC} is determined from the angular distributions of these observations.

It is not seen in Υ radiative decays (BARU 89), B inclusive decays (BEHRENDS 84), nor in $\gamma\gamma$ (GODANG 97). It is also not seen in formation in $\overline{p}p \to K^+K^-$ (BARDIN 87, SCULLI 87), in $\overline{p}p \to K_S K_S$ (BARNES 93, EVANGELISTA 97), nor in $\overline{p}p \to \pi^+\pi^-$ (HASAN 96). The upper limit in $\overline{p}p$ formation can be related to the claimed decay into $\overline{p}p$ to give a lower limit for the process $J/\psi(1S) \to \gamma f_J(2220)$ of $\sim 2.5 \times 10^{-3}$. Such a signal should be visible in the inclusive photon spectrum (BLOOM 82). The limit also leads to the conclusion that two-body final states constitute only a small fraction of all decay modes of the $f_J(2220)$. Observation of further decay modes would be very desirable.

$f_J(2220)$ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
2231.1± 3.5 OUR AVERAGE					
$2235 \pm 4 \pm 6$	74	BAI	96B	BES	$e^+e^- \to J/\psi \to \gamma\pi^+\pi^-$
$2230 {}^{+6}_{-7} \pm 16$	46	BAI	96B	BES	$e^+e^- \to J/\psi \to \gamma K^+K^-$
$2232 {}^{+8}_{-7} \pm 15$	23	BAI	96B	BES	$e^+e^- \to J/\psi \to \gamma K^0_S K^0_S$
$2235 \pm 4 \pm 5$	32	BAI	96B	BES	$e^+e^- \to J/\psi \to \gamma p\overline{p}$
$2209 {}^{+17}_{-15} \pm 10$		ASTON	88F	LASS	$11\ K^-p \to K^+K^-\Lambda$
2230 ± 20		BOLONKIN	88	SPEC	$40\ \pi^-p \to K^0_S K^0_S n$
2220 ± 10	41	[1] ALDE	86B	GA24	38–100 $\pi p \to n\eta\eta'$
$2230 \pm 6 \pm 14$	93	BALTRUSAIT...	86D	MRK3	$e^+e^- \to \gamma K^+K^-$
$2232 \pm 7 \pm 7$	23	BALTRUSAIT...	86D	MRK3	$e^+e^- \to \gamma K^0_S K^0_S$

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

$f_J(2220)$ WIDTH

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
23^{+8}_{-7} OUR AVERAGE					
$19^{+13}_{-11} \pm 12$	74	BAI	96B	BES	$e^+e^- \to J/\psi \to \gamma\pi^+\pi^-$
$20^{+20}_{-15} \pm 17$	46	BAI	96B	BES	$e^+e^- \to J/\psi \to \gamma K^+K^-$
$20^{+25}_{-16} \pm 14$	23	BAI	96B	BES	$e^+e^- \to J/\psi \to \gamma K^0_S K^0_S$
$15^{+12}_{-9} \pm 9$	32	BAI	96B	BES	$e^+e^- \to J/\psi \to \gamma p\overline{p}$
60^{+107}_{-57}		ASTON	88F	LASS	$11\ K^-p \to K^+K^-\Lambda$
80 ± 30		BOLONKIN	88	SPEC	$40\ \pi^-p \to K^0_S K^0_S n$
$26^{+20}_{-16} \pm 17$	93	BALTRUSAIT...	86D	MRK3	$e^+e^- \to \gamma K^+K^-$
$18^{+23}_{-15} \pm 10$	23	BALTRUSAIT...	86D	MRK3	$e^+e^- \to \gamma K^0_S K^0_S$

$f_J(2220)$ 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	$p\overline{p}$	seen
Γ_5	$\gamma\gamma$	not seen
Γ_6	$\eta\eta'(958)$	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
< 5.6	95	[2] GODANG	97	CLE2	$\gamma\gamma \to K^0_S K^0_S$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 86	95	[2] ALBRECHT	90G	ARG	$\gamma\gamma \to K^+K^-$
<1000	95	[3] ALTHOFF	85B	TASS	$\gamma\gamma$, $K\overline{K}\pi$

[2] Assuming $J^P = 2^+$.

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

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

$\Gamma(p\overline{p}) \times \Gamma(\pi^+\pi^-)/\Gamma_{\text{total}}$ — $\Gamma_4\Gamma_2/\Gamma$

VALUE (keV)	CL%	DOCUMENT ID		TECN	COMMENT
<3.9	99	[4] HASAN	96	SPEC	$\overline{p}p \to \pi^-\pi^+$

[4] Assuming $\Gamma = 15$ MeV and $J^P = 2^+$

$f_J(2220)$ 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. • • •					
<3.0	95	[5] EVANGELISTA	97	SPEC	1.96-2.40$\overline{p}p \to K^0_S K^0_S$
<1.1	99.7	[6] BARNES	93	SPEC	1.3-1.57$\overline{p}p \to K^0_S K^0_S$
<2.6	99.7	[6] BARDIN	87	CNTR	1.3-1.5$\overline{p}p \to K^+K^-$
<3.6	99.7	[6] SCULLI	87	CNTR	1.29-1.55$\overline{p}p \to K^+K^-$

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

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

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

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

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

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

$f_J(2220)$ REFERENCES

EVANGELISTA	97	PR D56 3803	C. Evangelista, Palano, Drijard+	(LEAR Collab.)
GODANG	97	PRL 79 3829	R. Godang, Kinoshita, Lai+	(CLEO Collab.)
BAI	96B	PRL 76 3502	+Chen, Chen+	(BES Collab.)
HASAN	96	PL B388 376	+Bugg	(BRUN, LOQM)
BARNES	93	PL B309 469	+Birien, Breunlich	(PS185 Collab.)
ALBRECHT	90G	ZPHY C48 183	+Ehrlichmann, Harder+	(ARGUS Collab.)
ASTON	88F	PL B215 199	+Awaji+	(SLAC, NAGO, CINC, INUS) JP
BOLONKIN	88	NP B309 426	+Bloshenko, Gorin+	(ITEP, SERP)
BARDIN	87	PL B195 292	+Burgun+	(SACL, FERR, CERN, PADO, TORI)
SCULLI	87	PRL 58 1715	+Christenson, Kreiter, Nemethy, Yamin	(NYU, BNL)
ALDE	86B	PL B177 120	+Binon, Bricman+	(SERP, BELG, LANL, LAPP)
BALTRUSAIT...	86D	PRL 56 107	Baltrusaitis	(CIT, UCSC, ILL, SLAC, WASH)
ALTHOFF	85B	ZPHY C29 189	+Braunschweig, Kirschfink+	(TASSO Collab.)

OTHER RELATED PAPERS

HUANG	96	PL B380 189	+Jin, Zhang, Chao	(BHEP, BEIJ)
BARDIN	87	PL B195 292	+Burgun+	(SACL, FERR, CERN, PADO, TORI)
YAOUANC	85	ZPHY C28 309	+Oliver, Pene, Raynal, Ono	(ORSAY, TOKY)
GODFREY	84	PL 141B 439	+Kokoski, Isgur	(TNTO)
SHATZ	84	PL 138B 209		(CIT)
WILLEY	84	PRL 52 585		(PITT)