$f_J(2220)$

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

OMITTED FROM SUMMARY TABLE

THE $f_J(2220)$

Updated April 2000 by M. Doser (CERN).

This state has been observed in $J/\psi(1S)$ radiative decay into $K\overline{K}$ (K^+K^- and $K^0_SK^0_S$ 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 $\overline{p}p$ (BAI 96B) and $\pi^0\pi^0$ (BAI 98H)) in the same production process, although again at the level at which previous upper limits had been obtained (BALTRUSAITIS 86D). This was also seen in $\eta\eta$ (ALDE 86B), $K^0_SK^0_S$ (ASTON 88D), and K^+K^- (ALDE 88 F), 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, ALAM 98C), which is not surprising, since if it were a glueball, its two-photon width would be expected to be small. It is also not seen in formation in $\overline{p}p \to K^+K^-$ (BARDIN 87, SCULLI 87), in $\overline{p}p \to K_SK_S$ (BARNES 93, EVANGELISTA 97), $\overline{p}p \to \phi\phi$ (EVANGELISTA 98), 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 $J/\psi \to \gamma f_J(2220)$ of $\sim 2.3 \times 10^{-3}$ (GODFREY 99). Such a signal should be visible in the inclusive photon spectrum (BLOOM 85). The limit also leads to the surprising conclusion that the reported two-body final states constitute only a small fraction of all decay modes of the $f_J(2220)$. Observation of further decay modes and confirmation of the $\overline{p}p$ decay would be very desirable.

$f_J(2220)$ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
2231.1± 3.5 OUR AVERAGE					
2235 ± 4 ± 6	74	BAI	96B	BES	$e^+e^- \to J/\psi \to \gamma\pi^+\pi^-$
2230 $^{+\ 6}_{-\ 7}$ ±16	46	BAI	96B	BES	$e^+e^- \to J/\psi \to \gamma K^+K^-$
2232 $^{+\ 8}_{-\ 7}$ ±15	23	BAI	96B	BES	$e^+e^- \to J/\psi \to \gamma K^0_S K^0_S$
2235 ± 4 ± 5	32	BAI	96B	BES	$e^+e^- \to J/\psi \to \gamma p\overline{p}$
2209 $^{+17}_{-15}$ ±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 ± 6 ±14	93	BALTRUSAIT..86D		MRK3	$e^+e^- \to \gamma K^+K^-$
2232 ± 7 ± 7	23	BALTRUSAIT..86D		MRK3	$e^+e^- \to \gamma K^0_S K^0_S$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2246 ±36		BAI	98H	BES	$J/\psi \to \gamma\pi^0\pi^0$

[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*
23$^{+\ 8}_{-\ 7}$ OUR AVERAGE						
19$^{+\ 13}_{-\ 11}$ ±12		74	BAI	96B	BES	$e^+e^- \to J/\psi \to \gamma\pi^+\pi^-$
20$^{+\ 20}_{-\ 15}$ ±17		46	BAI	96B	BES	$e^+e^- \to J/\psi \to \gamma K^+K^-$
20$^{+\ 25}_{-\ 16}$ ±14		23	BAI	96B	BES	$e^+e^- \to J/\psi \to \gamma K^0_S K^0_S$
15$^{+\ 12}_{-\ 9}$ ± 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$^{+\ 20}_{-\ 16}$ ±17		93	BALTRUSAIT..86D		MRK3	$e^+e^- \to \gamma K^+K^-$
18$^{+\ 23}_{-\ 15}$ ±10		23	BALTRUSAIT..86D		MRK3	$e^+e^- \to \gamma K^0_S K^0_S$
• • • 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	$p\overline{p}$	seen
Γ_5	$\gamma\gamma$	not seen
Γ_6	$\eta\eta'(958)$	seen
Γ_7	$\phi\phi$	not seen

$f_J(2220)$ $\Gamma(i)\Gamma(\gamma\gamma)/\Gamma(total)$

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

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 $J^P = 2^+$.

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

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

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

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

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 $J^P = 2^+$

$\Gamma(p\overline{p}) \times \Gamma(\phi\phi)/\Gamma_{total}$ $\Gamma_4\Gamma_7/\Gamma$

VALUE (keV)	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<0.9	95	[5] EVANGELISTA	98	SPEC	1.1-2.0 $p\overline{p} \to \phi\phi$

[5] Assuming $J^P = 2^+$, M=2235 MeV and $\Gamma_{total} = 15$ MeV.

$f_J(2220)$ BRANCHING RATIOS

$\Gamma(p\overline{p})/\Gamma_{total}$ 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	[6] EVANGELISTA	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 $\overline{p}p \rightarrow K^+ K^-$

[6] Assuming $\Gamma \sim 20$ MeV, $J^P = 2^+$ and B($f_J(2220) \rightarrow K\overline{K}$) = 100%.
[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	$e^+e^- \rightarrow J/\psi \rightarrow \gamma p\overline{p}, K\overline{K}$

$f_J(2220)$ REFERENCES

ALAM	98C	PRL 81 3328	M.S. Alam *et al.*	(CLEO Collab.)
BAI	98H	PRL 81 1179	J.Z. Bai *et al.*	(BES Collab.)
EVANGELISTA	98	PR D57 5370	C. Evangelista *et al.*	
EVANGELISTA	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	D. Alde *et al.*	
		Translated from YAF 45 405.		
BARDIN	87	PL B195 292	G. Bardin *et al.*	(SACL, FERR, CERN, PADO+)
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ALTHOFF	85B	ZPHY C29 189	M. Althoff *et al.*	(TASSO Collab.)

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EISENHAND...	75	NP B96 109	E. Eisenhandler *et al.*	(LOQM, LIVP, DARE+)