

$f_J(2220)$

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

OMITTED FROM SUMMARY TABLE

Needs confirmation.

THE $f_J(2220)$

Updated April 2002 by M. Doser (CERN).

This state has been seen in $J/\psi(1S)$ radiative decay into $K\bar{K}$ (K^+K^- and $K_S^0K_S^0$ 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 $\bar{p}p$ (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 is also seen in $\eta\eta$ (ALDE 86B), $K_S^0K_S^0$ (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, MASEK 02), B inclusive decays (BEHRENDT 84), or in $\gamma\gamma$ (GODANG 97, ALAM 98C, ACCIARRI 01H), which would not be surprising if it were a glueball, since its two-photon width would then be expected to be small. It is also not seen in formation in $\bar{p}p \rightarrow K^+K^-$ (BARDIN 87, SCULLI 87), in $\bar{p}p \rightarrow K_S K_S$ (BARNES 93, EVANGELISTA 97), $\bar{p}p \rightarrow \phi\phi$ (EVANGELISTA 98), in $\bar{p}p \rightarrow \eta\eta$ (AMSLER 01), or in $\bar{p}p \rightarrow \pi\pi$ (HASAN 96, AMSLER 01). The upper limit in $\bar{p}p$ formation can be related to the claimed decay into $\bar{p}p$ to give a lower limit for the process $J/\psi(1S) \rightarrow \gamma\xi$ 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 conclusion that the reported two-body final states constitute only a small fraction of all decay modes of the ξ . A recent speculation that a handful of events may have been seen in charmless B decays

(CHUA 02) underlines that observation of further decay modes and confirmation of the $p\bar{p}$ decay would be very desirable.

References

References may be found at the end of the $f_J(2220)$ Listing.

$f_J(2220)$ MASS

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

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

$f_J(2220)$ DECAY MODES

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

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

$\Gamma(K\bar{K}) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$					$\Gamma_3\Gamma_5/\Gamma$
VALUE (eV)	CL%	DOCUMENT ID	TECN	COMMENT	
< 1.4	95	² ACCIARRI	01H L3	$\gamma\gamma \rightarrow K_S^0 K_S^0, E_{\text{cm}}^{\text{ee}} = 91, 183-209 \text{ GeV}$	

• • • We do not use the following data for averages, fits, limits, etc. • • •

< 5.6	95	² GODANG	97 CLE2	$\gamma\gamma \rightarrow K_S^0 K_S^0$
< 86	95	² ALBRECHT	90G ARG	$\gamma\gamma \rightarrow K^+ K^-$
<1000	95	³ ALTHOFF	85B TASS	$\gamma\gamma, K\bar{K}\pi$

$\Gamma(\pi\pi) \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$					$\Gamma_1\Gamma_5/\Gamma$
VALUE (eV)	CL%	DOCUMENT ID	TECN	COMMENT	
<2.5	95	ALAM	98C CLE2	$\gamma\gamma \rightarrow \pi^+\pi^-$	

² Assuming $J^P = 2^+$.

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

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

$\Gamma(p\bar{p}) \times \Gamma(\pi\pi)/\Gamma_{\text{total}}^2$					$\Gamma_4\Gamma_1/\Gamma^2$
VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT	
<18	95	⁴ AMSLER	01 CBAR	$1.4-1.5 p\bar{p} \rightarrow \pi^0\pi^0$	

• • • We do not use the following data for averages, fits, limits, etc. • • •

<(11-42)	99	⁵ HASAN	96 SPEC	$1.35-1.55 p\bar{p} \rightarrow \pi^+\pi^-$
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$\Gamma(p\bar{p}) \times \Gamma(\phi\phi)/\Gamma_{\text{total}}^2$					$\Gamma_4\Gamma_7/\Gamma^2$
VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT	
<6	95	⁶ EVANGELISTA	98 SPEC	$1.1-2.0 p\bar{p} \rightarrow \phi\phi$	

$\Gamma(\rho\bar{\rho}) \times \Gamma(\eta\eta)/\Gamma_{\text{total}}^2$ $\Gamma_4\Gamma_8/\Gamma^2$

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

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

$\Gamma(\rho\bar{\rho})/\Gamma_{\text{total}}$ Γ_4/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID	TECN	COMMENT
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• • • We do not use the following data for averages, fits, limits, etc. • • •

<3.0	95	⁸ EVANGELISTA 97	SPEC	1.96-2.40 $p\bar{p} \rightarrow K_S^0 K_S^0$
<1.1	99.7	⁷ BARNES	93	SPEC 1.3-1.57 $p\bar{p} \rightarrow K_S^0 K_S^0$
<2.6	99.7	⁷ BARDIN	87	CNTR 1.3-1.5 $p\bar{p} \rightarrow K^+ K^-$
<3.6	99.7	⁷ SCULLI	87	CNTR 1.29-1.55 $p\bar{p} \rightarrow K^+ K^-$

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

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

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

$\Gamma(\rho\bar{\rho})/\Gamma(K\bar{K})$ Γ_4/Γ_3

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

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

$f_J(2220)$ REFERENCES

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BAI	96B	PRL 76 3502	J.Z. Bai <i>et al.</i>	(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	
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