

$f_J(2220)$

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

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 ± 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

VALUE (MeV)	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
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. ● ● ●					

<80

90

ALDE

87C GAM2 38 $\pi^- p \rightarrow \eta' \eta n$
 $f_J(2220)$ DECAY MODES

Mode	Fraction (Γ_i/Γ)
Γ_1 $\pi\pi$	seen
Γ_2 $\pi^+\pi^-$	seen
Γ_3 $K\bar{K}$	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	$\gamma\gamma \rightarrow K_S^0 K_S^0, E_{\text{cm}}^{\text{ee}} = 91, 183\text{--}209$ 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	$1.4\text{--}1.5$ $p\bar{p} \rightarrow \pi^0\pi^0$	

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

<(11–42)	99	⁵ HASAN	96 SPEC	$1.35\text{--}1.55$ $p\bar{p} \rightarrow \pi^+\pi^-$
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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 EVANGELIS...	98 SPEC	$1.1\text{--}2.0$ $p\bar{p} \rightarrow \phi\phi$	

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

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

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. • • •

not seen		⁷ AUBERT	07AV	BABR $B \rightarrow \rho\bar{\rho}K(*)$
not seen		WANG	05A	BELL $B^+ \rightarrow \bar{\rho}\rho K^+$
<3.0	95	⁸ EVANGELIS...	97	SPEC 1.96-2.40 $\bar{\rho}\rho \rightarrow K_S^0 K_S^0$
<1.1	99.7	⁹ BARNES	93	SPEC 1.3-1.57 $\bar{\rho}\rho \rightarrow K_S^0 K_S^0$
<2.6	99.7	⁹ BARDIN	87	CNTR 1.3-1.5 $\bar{\rho}\rho \rightarrow K^+ K^-$
<3.6	99.7	⁹ SCULLI	87	CNTR 1.29-1.55 $\bar{\rho}\rho \rightarrow K^+ K^-$

⁷ Assuming $\Gamma < 30$ MeV.

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

⁹ Assuming $\Gamma = 30\text{--}35$ 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 $e^+e^- \rightarrow J/\psi \rightarrow \gamma \rho\bar{\rho}, K\bar{K}$

$f_J(2220)$ REFERENCES

AUBERT	07AV	PR D76 092004	B. Aubert <i>et al.</i>	(BABAR Collab.)
WANG	05A	PL B617 141	M.-Z. Wang <i>et al.</i>	(BELLE Collab.)
PDG	04	PL B592 1	S. Eidelman <i>et al.</i>	
ACCIARRI	01H	PL B501 173	M. Acciarri <i>et al.</i>	(L3 Collab.)
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ALAM	98C	PRL 81 3328	M.S. Alam <i>et al.</i>	(CLEO Collab.)
BAI	98H	PRL 81 1179	J.Z. Bai <i>et al.</i>	(BES Collab.)
EVANGELIS...	98	PR D57 5370	C. Evangelista <i>et al.</i>	(JETSET Collab.)
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GODANG	97	PRL 79 3829	R. Godang <i>et al.</i>	(CLEO Collab.)
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	
ALBRECHT	90G	ZPHY C48 183	H. Albrecht <i>et al.</i>	(ARGUS Collab.)
ASTON	88F	PL B215 199	D. Aston <i>et al.</i>	(SLAC, NAGO, CINC, INUS) JP
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Translated from YAF 45 405.

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BALTRUSAIT...	86D	PRL 56 107	R.M. Baltrusaitis	(CIT, UCSC, ILL, SLAC+)
ALTHOFF	85B	ZPHY C29 189	M. Althoff <i>et al.</i>	(TASSO Collab.)

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