

$f_J(2220)$

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

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. • • •

2223.9 ± 2.5		² VLADIMIRSK...08	SPEC	40 $\pi^-p \rightarrow K_S^0 K_S^0 n + m\pi^0$
2246 ± 36		BAI	98H BES	$J/\psi \rightarrow \gamma\pi^0\pi^0$

¹ALDE 86B uses data from both the GAMS-2000 and GAMS-4000 detectors.² $J^{PC} = 2^{++}$. Systematic uncertainties not evaluated **$f_J(2220)$ 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. • • •

8.6 ± 2.5 ³VLADIMIRSK...08 SPEC 40 $\pi^- p \rightarrow K_S^0 K_S^0 n$
 $+ m\pi^0$ <80 90 ALDE 87C GAM2 38 $\pi^- p \rightarrow \eta' \eta n$ $^3 J^P = 2^+ +$. Systematic uncertainties not evaluated **$f_J(2220)$ DECAY MODES**

Mode	Fraction (Γ_i/Γ)
$\Gamma_1 \pi\pi$	seen
$\Gamma_2 \pi^+\pi^-$	seen
$\Gamma_3 K\bar{K}$	seen
$\Gamma_4 p\bar{p}$	
$\Gamma_5 \gamma\gamma$	not seen
$\Gamma_6 \eta\eta'(958)$	seen
$\Gamma_7 \phi\phi$	not seen
$\Gamma_8 \eta\eta$	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	⁴ ACCIARRI 01H L3		$\gamma\gamma \rightarrow K_S^0 K_S^0, E_{\text{cm}}^{\text{ee}} = 91, 183\text{--}209 \text{ GeV}$	

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

< 5.6	95	⁴ GODANG 97 CLE2	$\gamma\gamma \rightarrow K_S^0 K_S^0$		
< 86	95	⁴ ALBRECHT 90G ARG	$\gamma\gamma \rightarrow K^+ K^-$		
<1000	95	⁵ 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		$\gamma\gamma \rightarrow \pi^+\pi^-$	

⁴ Assuming $J^P = 2^+$.⁵ True for $J^P = 0^+$ and $J^P = 2^+$. **$f_J(2220) \Gamma(i)\Gamma(p\bar{p})/\Gamma^2(\text{total})$**

$\Gamma(p\bar{p})/\Gamma_{\text{total}} \times \Gamma(\pi\pi)/\Gamma_{\text{total}}$				$\Gamma_4/\Gamma \times \Gamma_1/\Gamma$	
VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT	
<18	95	⁶ 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	⁷ HASAN 96 SPEC	$1.35\text{--}1.55 p\bar{p} \rightarrow \pi^+\pi^-$		
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$\Gamma(p\bar{p})/\Gamma_{\text{total}} \times \Gamma(\phi\phi)/\Gamma_{\text{total}}$				$\Gamma_4/\Gamma \times \Gamma_7/\Gamma$	
VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT	
<6	95	⁸ EVANGELIS... 98 SPEC		$1.1\text{--}2.0 p\bar{p} \rightarrow \phi\phi$	

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

VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT
<4	95	⁶ AMSLER	01	CBAR 1.4–1.5 $p\bar{p} \rightarrow \eta\eta$

⁶ For $J^P = 2^+$ in the mass range 2222–2240 MeV and the total width between 10 and 20 MeV.

⁷ For $J^P = 2^+$ and $J^P = 4^+$ in the mass range 2220–2245 MeV and the total width of 15 MeV.

⁸ For $J^P = 2^+$, the mass of 2235 MeV and the total width of 15 MeV.

 $f_J(2220)$ BRANCHING RATIOS
 $\Gamma(p\bar{p})/\Gamma_{\text{total}}$
 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		⁹ AUBERT	07AV	BABR $B \rightarrow p\bar{p}K^{(*)}$
not seen		WANG	05A	BELL $B^+ \rightarrow \bar{p}pK^+$
<3.0	95	¹⁰ EVANGELIS...	97	SPEC 1.96–2.40 $\bar{p}p \rightarrow K_S^0 K_S^0$
<1.1	99.7	¹¹ BARNES	93	SPEC 1.3–1.57 $\bar{p}p \rightarrow K_S^0 K_S^0$
<2.6	99.7	¹¹ BARDIN	87	CNTR 1.3–1.5 $\bar{p}p \rightarrow K^+ K^-$
<3.6	99.7	¹¹ SCULLI	87	CNTR 1.29–1.55 $\bar{p}p \rightarrow K^+ K^-$

⁹ Assuming $\Gamma < 30$ MeV.

¹⁰ Assuming $\Gamma \sim 20$ MeV, $J^P = 2^+$ and $B(f_J(2220) \rightarrow K\bar{K}) = 100\%$.

¹¹ 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 $e^+e^- \rightarrow J/\psi \rightarrow \gamma 2\pi, K\bar{K}$

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

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

 $f_J(2220)$ REFERENCES

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	Translated from YAF 71 2166.		
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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>	(PDG Collab.)
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.)
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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.)
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HASAN 96	PL B388 376	A. Hasan, D.V. Bugg	(BRUN, LOQM)

BARNES	93	PL B309 469	P.D. Barnes <i>et al.</i>	(PS185 Collab.)
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
BOLONKIN	88	NP B309 426	B.V. Bolonkin <i>et al.</i>	(ITEP, SERP)
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ALDE	86B	PL B177 120	D.M. Alde <i>et al.</i>	(SERP, BELG, LANL, LAPP)
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OTHER RELATED PAPERS

DEL-AMO-SA...	100	PRL 105 172001	P. del Amo Sanchez <i>et al.</i>	(BABAR Collab.)
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