

$f_J(2220)$

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

OMITTED FROM SUMMARY TABLE

See our mini-review in the 2004 edition of this *Review*, PDG 04.

NODE=M082

NODE=M082

NODE=M082M

NODE=M082M

 $f_J(2220)$ 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	$J/\psi \rightarrow \gamma\pi^0\pi^0$
¹ ALDE 86B uses data from both the GAMS-2000 and GAMS-4000 detectors. ² $J^{PC} = 2^{++}$. Systematic uncertainties not evaluated				

OCCUR=2

OCCUR=3

OCCUR=4

OCCUR=2

NODE=M082M;LINKAGE=A
NODE=M082M;LINKAGE=VL **$f_J(2220)$ 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			¹ VLADIMIRSK...08	SPEC	40 $\pi^-p \rightarrow K_S^0 K_S^0 n + m\pi^0$
<80	90		ALDE	87C GAM2	38 $\pi^-p \rightarrow \eta'\eta n$
¹ $J^{PC} = 2^{++}$. Systematic uncertainties not evaluated					

NODE=M082W

NODE=M082W

OCCUR=2

OCCUR=3

OCCUR=4

OCCUR=2

NODE=M082W;LINKAGE=VL

 $f_J(2220)$ DECAY MODES

Mode	Fraction (Γ_i/Γ)
$\Gamma_1 \pi\pi$	not seen
$\Gamma_2 \pi^+\pi^-$	not seen
$\Gamma_3 K\bar{K}$	not seen
$\Gamma_4 p\bar{p}$	not seen
$\Gamma_5 \gamma\gamma$	not seen
$\Gamma_6 \eta\eta'(958)$	seen
$\Gamma_7 \phi\phi$	not seen
$\Gamma_8 \eta\eta$	not seen

NODE=M082215;NODE=M082

DESIG=5

DESIG=6;OUR EST;→ UNCHECKED ←
DESIG=1DESIG=4;OUR EST;→ UNCHECKED ←
DESIG=2;OUR EST;→ UNCHECKED ←DESIG=3;OUR EST;→ UNCHECKED ←
DESIG=7;OUR EST;→ UNCHECKED ←

DESIG=8;OUR EST;→ UNCHECKED ←

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

NODE=M082220

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

VALUE (eV)	CL%	DOCUMENT ID	TECN	COMMENT
< 1.4	95	¹ 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	¹ GODANG	97 CLE2	$\gamma\gamma \rightarrow K_S^0 K_S^0$
< 86	95	¹ ALBRECHT	90G ARG	$\gamma\gamma \rightarrow K^+ K^-$
< 1000	95	² 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	$\gamma\gamma \rightarrow \pi^+ \pi^-$

¹ Assuming $J^P = 2^+$.² True for $J^P = 0^+$ and $J^P = 2^+$.NODE=M082G3
NODE=M082G3NODE=M082G1;LINKAGE=D
NODE=M082G1;LINKAGE=C $f_J(2220) \Gamma(i) \Gamma(p\bar{p}) / \Gamma^2(\text{total})$

NODE=M082223

 $\Gamma(p\bar{p}) / \Gamma_{\text{total}} \times \Gamma(\pi\pi) / \Gamma_{\text{total}}$ $\Gamma_4 / \Gamma \times \Gamma_1 / \Gamma$

VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT
< 18	95	¹ 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	² HASAN	96 SPEC	$1.35-1.55 p\bar{p} \rightarrow \pi^+ \pi^-$
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NODE=M082GG1
NODE=M082GG1 $\Gamma(p\bar{p}) / \Gamma_{\text{total}} \times \Gamma(\phi\phi) / \Gamma_{\text{total}}$ $\Gamma_4 / \Gamma \times \Gamma_7 / \Gamma$

VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT
< 6	95	³ EVANGELIS...	98 SPEC	$1.1-2.0 p\bar{p} \rightarrow \phi\phi$

NODE=M082GG2
NODE=M082GG2 $\Gamma(p\bar{p}) / \Gamma_{\text{total}} \times \Gamma(\eta\eta) / \Gamma_{\text{total}}$ $\Gamma_4 / \Gamma \times \Gamma_8 / \Gamma$

VALUE (units 10^{-5})	CL%	DOCUMENT ID	TECN	COMMENT
< 4	95	¹ AMSLER	01 CBAR	$1.4-1.5 p\bar{p} \rightarrow \eta\eta$

¹ For $J^P = 2^+$ in the mass range 2222-2240 MeV and the total width between 10 and 20 MeV.² For $J^P = 2^+$ and $J^P = 4^+$ in the mass range 2220-2245 MeV and the total width of 15 MeV.³ For $J^P = 2^+$, the mass of 2235 MeV and the total width of 15 MeV.NODE=M082GG3
NODE=M082GG3

NODE=M082GG;LINKAGE=A

NODE=M082GG;LINKAGE=B

NODE=M082GG;LINKAGE=C

 $f_J(2220) \text{ BRANCHING RATIOS}$

NODE=M082225

 $\Gamma(\pi\pi) / \Gamma_{\text{total}}$ Γ_1 / Γ

VALUE	DOCUMENT ID	COMMENT
not seen	¹ DOBBS 15	$J/\psi \rightarrow \gamma\pi\pi$
not seen	¹ DOBBS 15	$\psi(2S) \rightarrow \gamma\pi\pi$

¹ Using CLEO-c data but not authored by the CLEO Collaboration.NODE=M082R00
NODE=M082R00

OCCUR=2

NODE=M082R00;LINKAGE=A

 $\Gamma(K\bar{K}) / \Gamma_{\text{total}}$ Γ_3 / Γ

VALUE	DOCUMENT ID	COMMENT
not seen	¹ DOBBS 15	$J/\psi \rightarrow \gamma K\bar{K}$
not seen	¹ DOBBS 15	$\psi(2S) \rightarrow \gamma K\bar{K}$

¹ Using CLEO-c data but not authored by the CLEO Collaboration.NODE=M082R01
NODE=M082R01

OCCUR=2

NODE=M082R01;LINKAGE=A

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

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

NODE=M082R2
NODE=M082R2 $\Gamma(p\bar{p}) / \Gamma_{\text{total}}$ 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		¹ AUBERT	07AV BABR	$B \rightarrow p\bar{p}K(*)$
not seen		WANG	05A BELL	$B^+ \rightarrow \bar{p}pK^+$
< 3.0	95	² EVANGELIS...	97 SPEC	$1.96-2.40 p\bar{p} \rightarrow K_S^0 K_S^0$
< 1.1	99.7	³ BARNES	93 SPEC	$1.3-1.57 p\bar{p} \rightarrow K_S^0 K_S^0$
< 2.6	99.7	³ BARDIN	87 CNTR	$1.3-1.5 p\bar{p} \rightarrow K^+ K^-$
< 3.6	99.7	³ SCULLI	87 CNTR	$1.29-1.55 p\bar{p} \rightarrow K^+ K^-$

NODE=M082R1
NODE=M082R1

¹ Assuming $\Gamma < 30$ MeV.
² Assuming $\Gamma \sim 20$ MeV, $J^P = 2^+$ and $B(f_J(2220) \rightarrow K\bar{K}) = 100\%$.
³ Assuming $\Gamma = 30\text{--}35$ MeV, $J^P = 2^+$ and $B(f_J(2220) \rightarrow K\bar{K}) = 100\%$.

NODE=M082R1;LINKAGE=AU
NODE=M082R1;LINKAGE=C
NODE=M082R1;LINKAGE=B

$\Gamma(p\bar{p})/\Gamma(K\bar{K})$				Γ_4/Γ_3
VALUE	DOCUMENT ID	TECN	COMMENT	
0.17±0.09	BAI	96B BES	$e^+e^- \rightarrow J/\psi \rightarrow \gamma p\bar{p}, K\bar{K}$	

NODE=M082R3
NODE=M082R3

$f_J(2220)$ REFERENCES

NODE=M082

DOBBS	15	PR D91 052006	S. Dobbs <i>et al.</i>	(NWES)
VLADIMIRSK...	08	PAN 71 2129	V.V. Vladimirsky <i>et al.</i>	(ITEP)
		Translated from YAF 71 2166.		
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>	(PDG Collab.)
ACCIARRI	01H	PL B501 173	M. Acciarri <i>et al.</i>	(L3 Collab.)
AMSLER	01	PL B520 175	C. Amsler <i>et al.</i>	(Crystal Barrel Collab.)
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.)
EVANGELIS...	97	PR D56 3803	C. Evangelista <i>et al.</i>	(LEAR Collab.)
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 <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)
ALDE	87C	SJNP 45 255	D. Alde <i>et al.</i>	
		Translated from YAF 45 405.		
BARDIN	87	PL B195 292	G. Bardin <i>et al.</i>	(SACL, FERR, CERN, PADO+)
SCULLI	87	PRL 58 1715	J. Sculli <i>et al.</i>	(NYU, BNL)
ALDE	86B	PL B177 120	D.M. Alde <i>et al.</i>	(SERP, BELG, LANL, LAPP)
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.)

REFID=56805
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REFID=48558
REFID=46326
REFID=46342
REFID=46365
REFID=45687
REFID=45760
REFID=44736
REFID=45197
REFID=43601
REFID=41374
REFID=40585
REFID=40580
REFID=47474

OTHER RELATED PAPERS

DEL-AMO-SA...	100	PRL 105 172001	P. del Amo Sanchez <i>et al.</i>	(BABAR Collab.)
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REFID=53533