Analysis of the Decay Channels $J/\psi \to \gamma\gamma V$

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I. Motivation

♡ The strcuture of $\iota/\eta(1440)$ is not very clear. Someone suggested the existence of two overlapping pseudoscalar states, one around 1400 GeV decaying into both $K\bar{K}\pi$ and $\eta\pi\pi$, the other one around 1480 Mev decaying only to $K\bar{K}\pi$.

♡ Mark3 ,DM2 and Crystal-ball have studied the decay channel of $J/\psi \to \gamma\gamma\rho$ respectively.

Mass (MeV)	Width (MeV)	$Br(J/\psi \to \gamma X)Br(X \to \gamma\rho)$ $(\times 10^{-4})$	Exp.
$1420 \pm 15 \pm 20$	$133 \pm 55 \pm 20$	$1.0 \pm 0.2 \pm 0.2$	Mark3
1390 ± 25	$185\pm^{110}_{80}$	$1.9 \pm 0.5 \pm 0.4$	Cry.-ball
1401 ± 18	174 ± 44	$0.9 \pm 0.2 \pm 0.14$	DM2

Are these resonances listed above belong to the lower mass of $\eta(1440)$?

♡ Theoretical physicist predicted that :
If X were *glueball*:

$$Br(X \to \gamma\rho) \sim Br(X \to \gamma\phi)$$
$$M_X(X \to \gamma\rho) \sim M_X(X \to \gamma\phi)$$

If X were $q\bar{q}$ *meson or hybrid*:

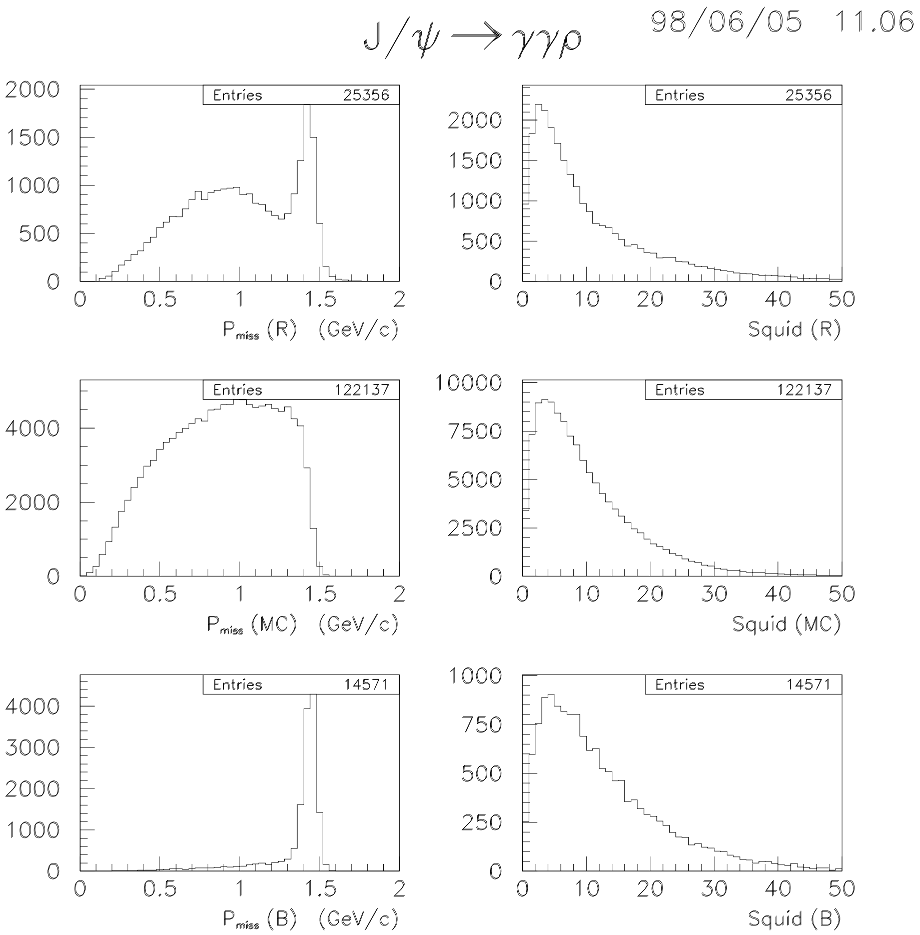
$$M_X(X \to \gamma\phi) \sim 300MeV + M_X(X \to \gamma\rho)$$

II. Event Selections

♠ $\Delta \equiv \sqrt{(\Delta cosx)^2 + (\Delta cosy)^2 + (\Delta cosz)^2}$
♠ $P_{miss} = \sqrt{(\sum P_x)^2 + (\sum P_y)^2 + (\sum P_z)^2}$
$J/\psi \to \gamma\gamma\rho \to \gamma\gamma\pi^+\pi^-$

The selection of "good" γ
♡ $2 \leq N_{neu} \leq 10$
♡ The number of layers which have been hitted by γ in SC should be great than two, and the first fired layer should be less than five.
♡ $E_\gamma \geq 0.07$ GeV
♡ $\Delta \leq 0.35$
♡ $cos\theta_{\gamma q} \leq 0.99$
The selection of charged particles
♡ $\sqrt{x_0^2 + y_0^2} < 0.8cm$, $|z_0| < 14cm$
♡ Two charged particles, and $\sum Q = 0$
♡ MFIT=2 or -19 for every charged particles
♡ At least one π track per event
Kinematic fit
♡ $P_{miss} \leq 1.25$ GeV/c
♡ $\chi^2_{J/\psi \to 2\gamma\pi^+pi^-} < \chi^2_{J/\psi \to 2\gamma K^+K^-}$
$\chi^2_{J/\psi \to 2\gamma\pi^+pi^-} < \chi^2_{J/\psi \to \pi^0\pi^+\pi^-}$
$\chi^2_{J/\psi \to 2\gamma\pi^+pi^-} < \chi^2_{J/\psi \to \eta\pi^+\pi^-}$
$\chi^2_{J/\psi \to 2\gamma\pi^+pi^-} < \chi^2_{J/\psi \to 3\gamma\pi^+\pi^-}$
$\chi^2_{J/\psi \to 2\gamma\pi^+pi^-} < \chi^2_{J/\psi \to \gamma\pi^+\pi^-}$
And finally: $\chi^2_{J/\psi \to 2\gamma\pi^+pi^-} \leq 10$
♡ $0.57 GeV/c^2 \leq M_{\pi^+\pi^-} \leq 0.82 GeV/c^2$

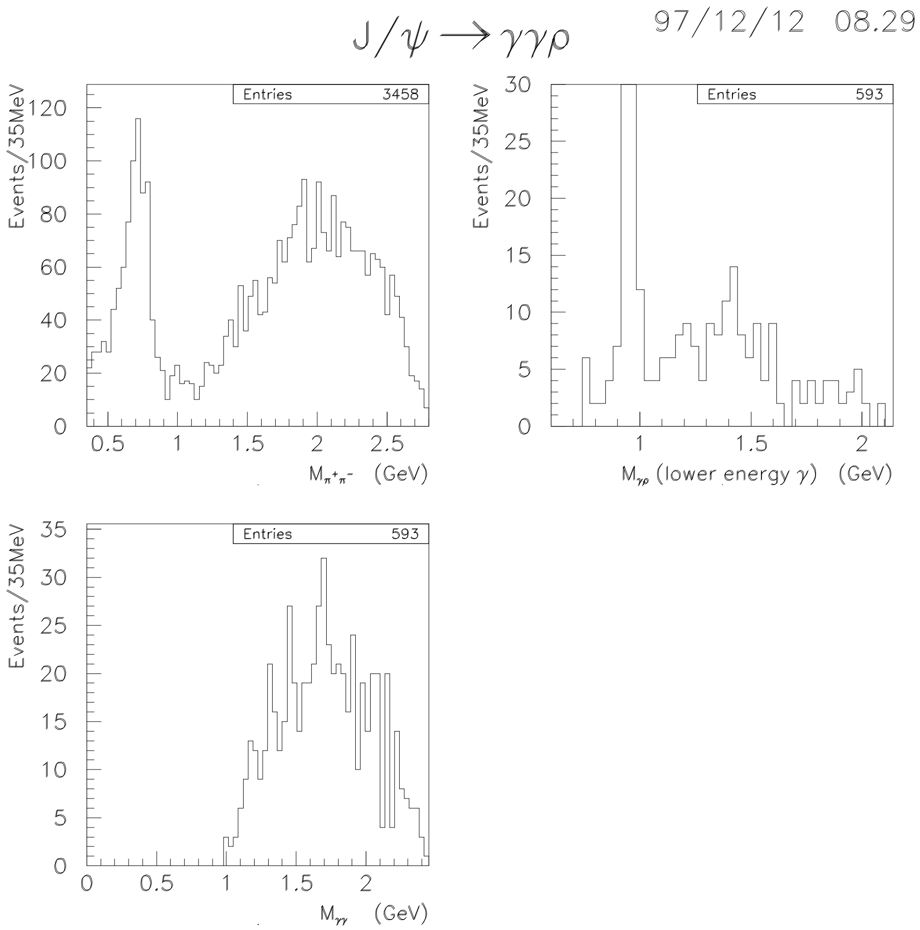
$J/\psi \to \gamma\gamma\phi \to \gamma\gamma K^+K^-$
The selection of "good" γ
♡ $2 \leq N_{neu} \leq 10$
♡ The number of layers which have been hitted by γ in SC should be great than two, and the first fired layer should be less than five.
♡ $E_\gamma \geq 0.07$ GeV
♡ $\Delta \leq 0.35$
♡ $cos\theta_{\gamma q} \leq 0.99$
The selection of charged particles
♡ $\sqrt{x_0^2 + y_0^2} < 0.8cm$, $|z_0| < 14cm$



♡ Two charged particles, and $\sum Q = 0$
♡ MFIT=2 or -19 for every charged particles
♡ At least one K track per event

Kinematic fit

♡ $P_{miss} \leq$ 1.25 GeV/c
♡ $\chi^2_{J/\psi\to 2\gamma K^+K^-} < \chi^2_{J/\psi\to 2\gamma\pi^+\pi^-}$
$\chi^2_{J/\psi\to 2\gamma K^+K^-} < \chi^2_{J/\psi\to \gamma K^+K^-}$
$\chi^2_{J/\psi\to 2\gamma K^+K^-} < \chi^2_{J/\psi\to 3\gamma K^+K^-}$
And finally: $\chi^2_{J/\psi\to 2\gamma K^+K^-} \leq 25$
♡ $0.99 GeV/c^2 \leq M_{K^+K^-} \leq 1.03 GeV/c^2$
♡ $M_{\gamma\gamma} \geq 0.6 GeV/c^2$



III. Results and Discussions

Decay Modes	Mass (MeV)	Width (MeV)	Br($J/\psi \rightarrow \gamma X)Br(X \rightarrow \gamma V)$ ($\times 10^{-4}$)
$X \rightarrow \gamma\rho$	1409 ± 16	90 ± 30	$1.4 \pm 0.4 \pm 0.7$
$X \rightarrow \gamma\phi$	1410 ± 13	80 ± 20	$1.4 \pm 0.3 \pm 0.4$
$X \rightarrow \gamma\omega$	1400 ± 9	95 ± 9	$1.5 \pm 1.2 \pm 1.4$

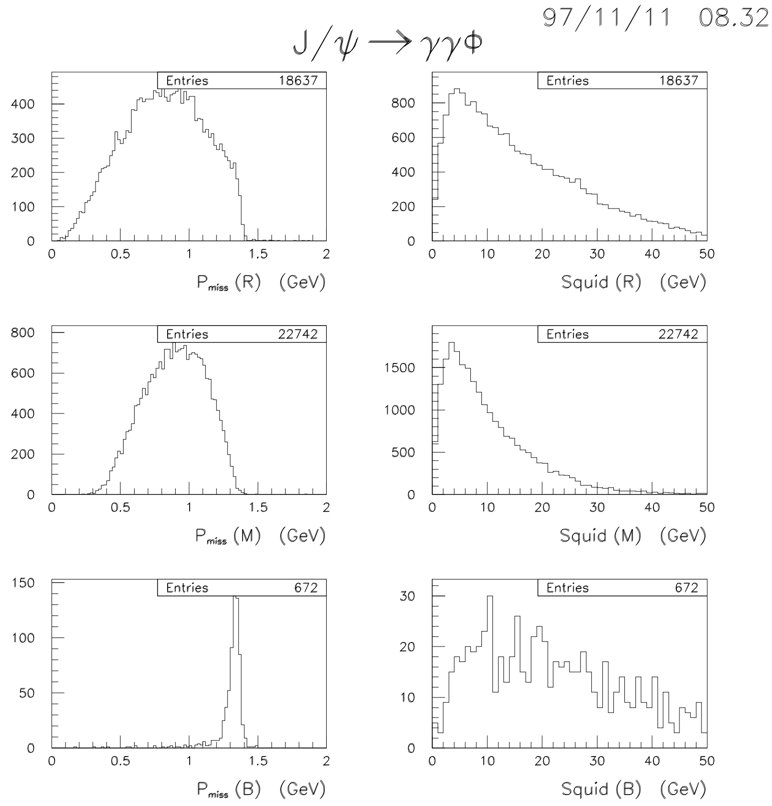
♡ According to its decay property about the $\eta(1400)$ we got here, it is probably the lower mass of $\eta(1440)$.

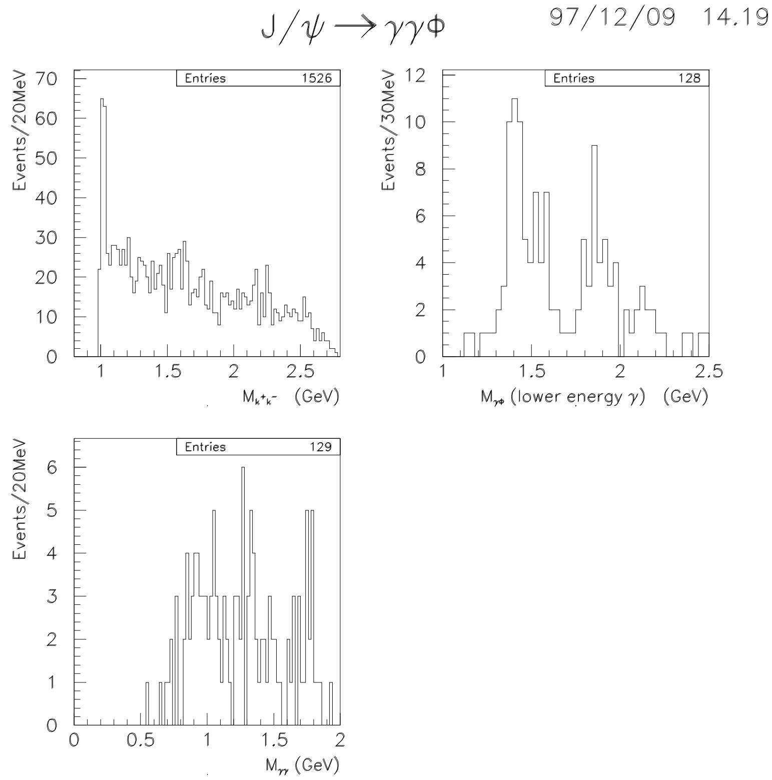
♡

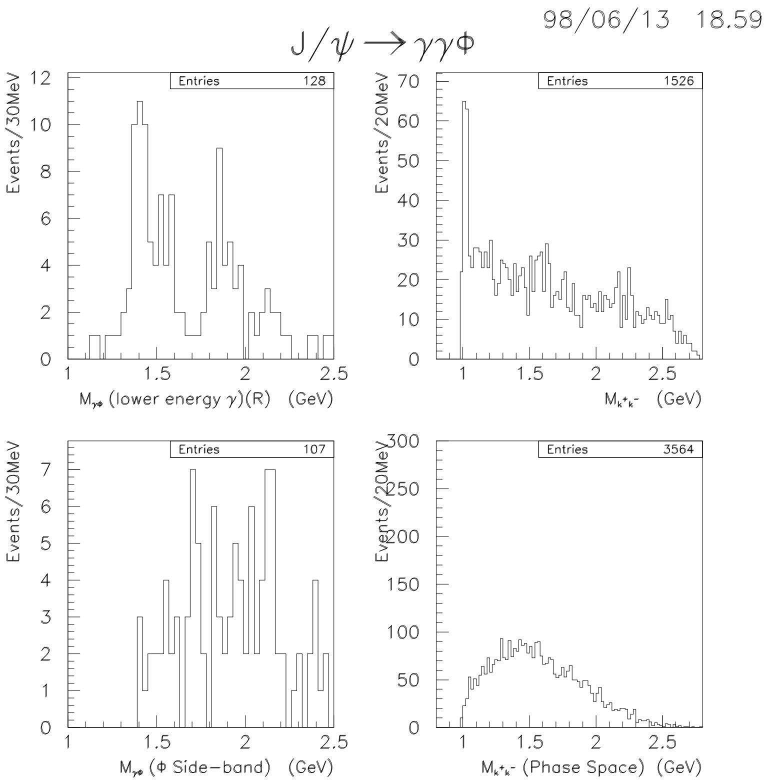
$$Br(J/\psi \rightarrow \gamma X \rightarrow \gamma\gamma\rho) \sim Br(J/\psi \rightarrow \gamma X \rightarrow \gamma\gamma\phi)$$

$$M_{\gamma\rho} \sim M_{\gamma\phi}$$

This property just like the prediction of glueball.


97/11/11 08.32
J/ψ → γγφ
Entries 18637
P_miss (R) (GeV)
Entries 18637
Squid (R) (GeV)
Entries 22742
P_miss (M) (GeV)
Entries 22742
Squid (M) (GeV)
Entries 672
P_miss (B) (GeV)
Entries 672
Squid (B) (GeV)


J/ψ → γγφ
97/12/09 14.19
Events/20MeV
Entries 1526
M_k+k- (GeV)
Events/30MeV
Entries 128
M_γφ (lower energy γ) (GeV)
Events/20MeV
Entries 129
M_γγ (GeV)



98/06/13 18.59
J/ψ → γγΦ
Entries 128
Events/30MeV
M_γΦ (lower energy γ)(R) (GeV)
Entries 1526
Events/20MeV
M_K+K- (GeV)
Entries 107
Events/30MeV
M_γΦ (Φ Side-band) (GeV)
Entries 3564
Events/20MeV
M_K+K- (Phase Space) (GeV)