Study of G-parity violating decay $J/\psi \to \omega\pi^0$

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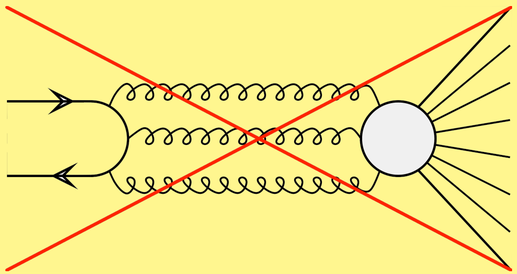
Agenda

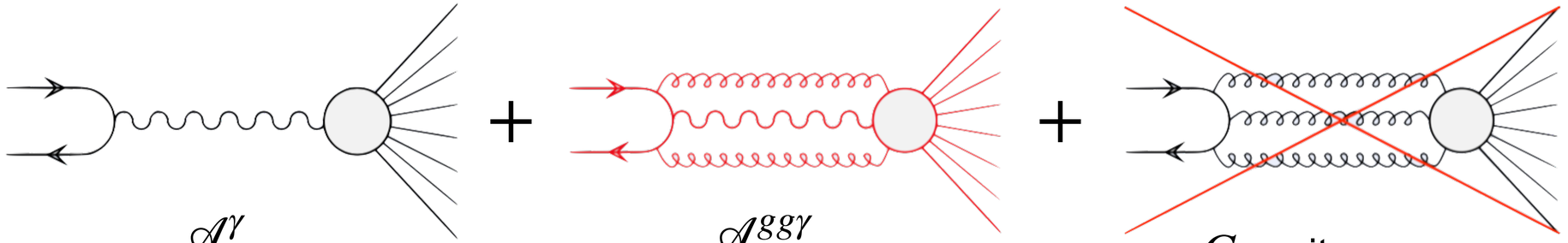
- The decay $J/\psi \to \omega\pi^0$
- Event selection
- Backgrounds
- Study of the invariant mass

$$J/\psi \to \omega\pi^0$$



G-parity violating decay

The decay $J/\psi \to \omega\pi^0$

$\mathcal{A}_{J/\psi} =$  + + G-parity cons.

$\mathcal{A}^{\gamma}_{J/\psi}$ $\mathcal{A}^{gg\gamma}_{J/\psi}$

$J/\psi \to \omega\pi^0$

$G_{J/\psi} = -1$ $G_\omega G_{\pi^0} = +1$

G-parity violating decay

We can study this decay from a theoretical point of view as done for the decay $J/\psi \to \pi^+\pi^-$

Phys. Rev. C 98 045210

Using the Cutkosky rule we can calculate the imaginary part of the amplitude $\mathcal{A}(J/\psi \to \omega\pi^0)$

At present: $\mathrm{BR}_{\mathrm{PDG}}(\omega \to \pi^0\eta\gamma) < 3.3 \times 10^{-5}$

The decay $J/\psi \to \omega\pi^0$

Using CLEO data on the $\sigma(e^+e^- \to \omega\pi^0)$ @ 3.67 GeV $\simeq 15$ pb Phys. Rev. D 73 012002

and BABAR data on the $\sigma(e^+e^- \to \omega\pi^0)$ @ 2.50 GeV $\simeq 200$ pb Phys. Rev. D 96 092009

we can give an estimation of the EM BR:

$$\mathrm{BR}^{\gamma}(J/\psi \to \omega\pi^0) = \mathrm{BR}(J/\psi \to \mu^+\mu^-) \left.\frac{\sigma(e^+e^- \to \omega\pi^0)}{\sigma(e^+e^- \to \mu^+\mu^-)}\right|_{q^2=M^2_{J/\psi}} \to \mathrm{BR}^{\gamma}(J/\psi \to \omega\pi^0) \simeq (3.1 \pm 0.6) \times 10^{-4}$$

to be compared to the PDG value for the total BR: $\mathrm{BR}_{\mathrm{PDG}}(J/\psi \to \omega\pi^0) = (4.5 \pm 0.5) \times 10^{-4}$

New analysis for a precise measurement of $\sigma(e^+e^- \to \omega\pi^0)$ at J/ψ mass

Event selection

$$e^+e^- \to \omega\pi^0 \to \pi^+\pi^-\gamma\gamma\gamma\gamma$$

$$\pi^+\pi^-\pi^0$$

vertex reconstruction from $\pi^+\pi^-$

ω reconstruction through $\pi^+\pi^-\pi^0$

π^0 identification through $\gamma\gamma$

$\gamma\gamma\gamma\gamma$ with smallest $\chi^2_{\pi^0\pi^0}$

$$\chi^2_{\pi^0\pi^0} = \frac{\left(M(\gamma_1\gamma_2) - M^{\mathrm{PDG}}_{\pi^0}\right)^2}{\sigma^2_{\pi^0}} + \frac{\left(M(\gamma_3\gamma_4) - M^{\mathrm{PDG}}_{\pi^0}\right)^2}{\sigma^2_{\pi^0}}$$

resolution $\sigma^2_{\pi^0\pi^0}$ from signal MC sample

Charged tracks (MDC):

Origin: $V_r < 1.0$ cm,

$|V_z| < 10.0$ cm

$|\cos\theta| < 0.93$

Neutral tracks (EMC):

Endcap: $0.86 < |\cos\theta| < 0.92$

$E_{\mathrm{endcap}} > 50$ MeV

Barrel: $|\cos\theta| < 0.8$

$E_{\mathrm{barrel}} > 25$ MeV

Backgrounds

arXiv:2009.08099 [hep-ex]

possible background channels from $q\bar{q}$ MC sample

No.	decay chain	final states	iTopo	nEvt	nTot
0	$e^+e^- \to \pi^-\pi^0\pi^0\pi^+$	$e^+e^- \to \pi^+\pi^0\pi^0\pi^-$	0	1761	1761
1	$e^+e^- \to \gamma\gamma^*,\ \gamma^* \to \pi^-\pi^0\pi^0\pi^+$	$e^+e^- \to \gamma\pi^+\pi^0\pi^0\pi^-$	2	159	1920
2	$e^+e^- \to \gamma\gamma^*,\ \gamma^* \to \pi^-\pi^+ f_2(1270),\ f_2(1270) \to \pi^0\pi^0$	$e^+e^- \to \gamma\pi^+\pi^0\pi^0\pi^-$	1	22	1942
3	$e^+e^- \to \gamma\gamma^*,\ \gamma^* \to \pi^-\pi^0\pi^0\pi^+$	$e^+e^- \to \gamma\pi^+\pi^0\pi^0\pi^-$	4	15	1957
4	$e^+e^- \to \gamma\gamma^*,\ \gamma^* \to \pi^- a_1^+,\ a_1^+ \to \pi^0\rho^+,\ \rho^+ \to \pi^0\pi^+$	$e^+e^- \to \gamma\pi^+\pi^0\pi^0\pi^-$	3	2	1959
5	$e^+e^- \to \gamma\gamma^*,\ \gamma^* \to a_1^-\pi^+,\ a_1^- \to \rho^-\pi^0,\ \rho^- \to \pi^-\pi^0$	$e^+e^- \to \gamma\pi^+\pi^0\pi^0\pi^-$	9	2	1961
6	$e^+e^- \to \gamma\gamma^*,\ \gamma^* \to \pi^0 a_1^0,\ a_1^0 \to \rho^-\pi^+,\ \rho^- \to \pi^-\pi^0$	$e^+e^- \to \gamma\pi^+\pi^0\pi^0\pi^-$	6	1	1962
7	$e^+e^- \to \gamma\gamma^*,\ \gamma^* \to \pi^0\pi^0\rho^0,\ \rho^0 \to \pi^-\pi^+$	$e^+e^- \to \gamma\pi^+\pi^0\pi^0\pi^-$	7	1	1963
8	$e^+e^- \to \gamma\omega,\ \omega \to \pi^-\pi^0\pi^+$	$e^+e^- \to \gamma\pi^+\pi^0\pi^-$	8	1	1964
9	$e^+e^- \to \gamma\gamma^*,\ \gamma^* \to \rho^-\pi^0\pi^+,\ \rho^- \to \pi^-\pi^0$	$e^+e^- \to \gamma\pi^+\pi^0\pi^0\pi^-$	5	1	1965
10	$e^+e^- \to \gamma\gamma^*,\ \gamma^* \to \pi^0\omega,\ \omega \to \pi^-\pi^0\pi^+$	$e^+e^- \to \gamma\pi^+\pi^0\pi^0\pi^-$	10	1	1966
11	$e^+e^- \to \gamma\gamma^*,\ \gamma^* \to \pi^-\pi^+\eta,\ \eta \to \gamma\gamma$	$e^+e^- \to \gamma\gamma\gamma\pi^+\pi^-$	11	1	1967

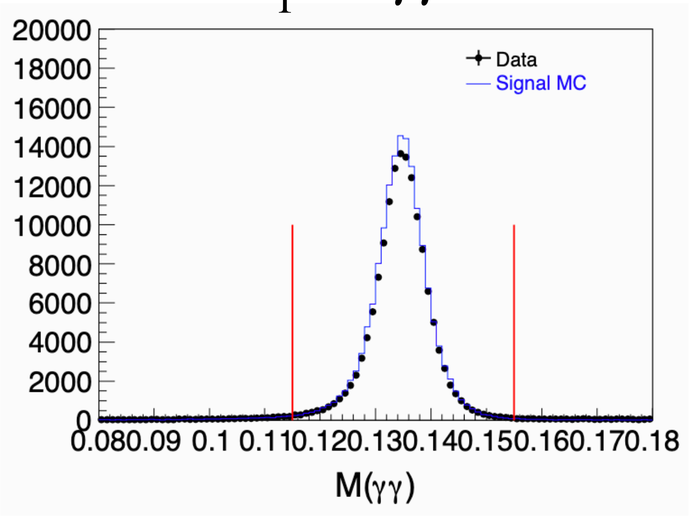
Study of the invariant mass

$$e^+e^- \to \omega\pi_1^0 \to \pi^+\pi^-\pi_2^0(\gamma\gamma)\pi_1^0(\gamma\gamma)$$

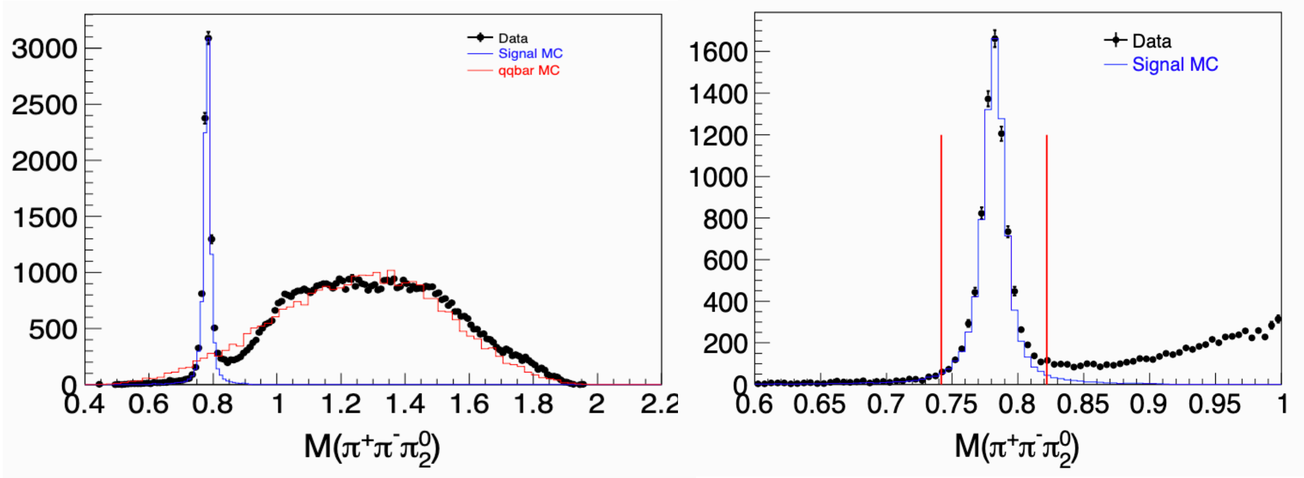
$e^+e^- \to \omega\pi^0$
from 2.0 to 3.08 GeV

arXiv:2009.08099 [hep-ex]

$\pi_1^0 \to \gamma\gamma$



$\omega \to \pi^+\pi^-\pi_2^0$



after all cut

$\gamma\gamma$ invariant mass with cut

$$\left| M(\gamma\gamma) - M_{\pi^0}^{\mathrm{PDG}} \right| < 3\sigma_{\pi^0}$$

$\pi^+\pi^-\pi_2^0$ invariant mass with cut

$$0.6\ \mathrm{GeV} < \mathrm{M}(\pi^+\pi^-\pi_2^0) < 0.95\ \mathrm{GeV}$$

Work in progress…

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