The experiment of γA$\rightarrow \pi^0\pi^0$X reaction at SPring-8

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By studying the π-π correlations from decay of I=J=0 state in the nuclear medium new insight in hadron physics can be gained since it is related to the scalar iso-scalar σ meson. The σ meson is the chiral partner of the π meson and its mass and width are expected to be $\sim$600 MeV and $\sim$500 MeV, respectively. Because of its large width, there is no clear evidence for the existence of the σ meson experimentally. According to Ref.[1], the σ meson corresponds to an amplitude fluctuation of the quark-antiquark condensate ($\langle\bar{q}q\rangle$) in the QCD vacuum. Recent theoretical works have predicted that chiral symmetry would be restored at high density and/or high temperature. Hatsuda *et al.* reported that chiral symmetry can be partially restored even in the case of normal nuclear densities due to the $\langle\bar{q}q\rangle$ softening[1]. They predict that as a result the σ-meson mass distribution in the nuclear medium shows an enhancement near the 2π threshold. The characteristic enhancement of the σ mass in normal nuclear matter near the 2π threshold could enable the experimental observation of the σ meson.

Recently, two experimental results for pion-induced 2π production off nuclear targets have been reported by the CHAOS[2, 3] and the Crystal Ball[4] collaboration. The CHAOS collaboration measured the $\pi^+\pi^-$ invariant mass distribution in the π^+A $\rightarrow \pi^+\pi^-$X reaction (p_{π^+} = 399 MeV/c). The Crystal Ball collaboration performed measurements of the $\pi^0\pi^0$ invariant mass in the π^-A $\rightarrow \pi^0\pi^0$X reaction (p_{π^-} = 408 MeV/c).

Using a photon beam instead of a pion beam has the advantage that the entire nuclear volume is probed. Therefore, one can effectively study higher nuclear densities. Studying the $\pi^0\pi^0$ decay channel is preferable over the $\pi^+\pi^-$ channel in this case, because for the latter a strong background from decay of the ρ^0 is expected. A series of experiments to study the γA$\rightarrow \pi^0\pi^0$X reaction have been performed at SPring-8.

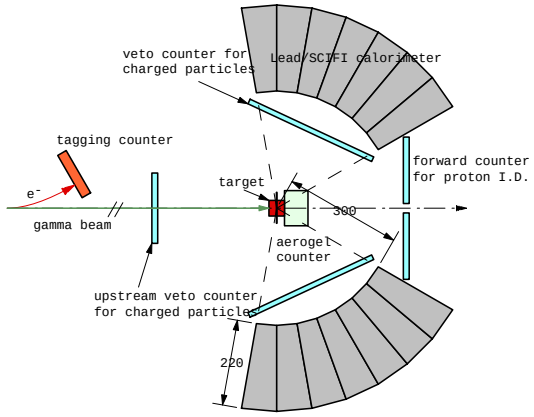

Figure 1: The setup for the experiment. A tagged photon beam generated at 70m upstream from the target is injected on to a nuclear target.

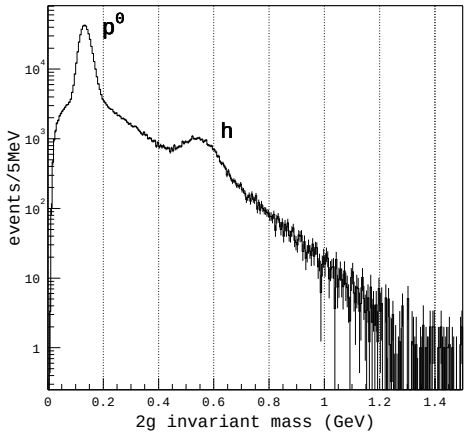

Figure 2: Preliminary reconstructed 2γ invariant mass distribution with a CH_2 target. This plot is obtained after subtraction of the empty-target contribution

Figure 1 shows the setup of the experiment. Multi photons coming from $\pi^0\pi^0$ decay are detected in an electro-magnetic calorimeter, consisting of 252 modules of lead scintillating fiber (Lead/SCIFI) blocks. The calorimeter was set up at the LEPS beam line at SPring-8. Photons of an energy between 1.5 and 2.4 GeV are produced by backward compton scattering of laser photons off electrons in the SPring-8 storage ring[5]. The average intensity obtained was 5×10^5 photons per second. CH_2(50 mm), C(40 mm), Cu(3 mm), and W(0.7 mm) were used as targets.

Figure 2 shows the reconstructed 2γ invariant-mass distribution obtained with a CH_2 target after subtraction of the empty-target contribution. In this plot, π^0 and η meson production events are observed. In the 4γ-cluster events, $\pi^0\pi^0$ events are also clearly identified. To obtain the cross sections for the $\pi^0\pi^0$ production, further analysis is in progress.

Acknowledgements

This work was supported in part by the Grant-in-Aid for Scientific Research No. 1440071 from the Ministry of Education and Science of Japan.

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