Study of $\Sigma\pi$ invariant mass spectrum in the $d(\gamma, K^+)X$ reaction

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Recently, an interesting result was reported by J-PARC E27 experiment. They studied $d(\pi^+, K^+)X$ reaction with the beam energy of 1.69 GeV/c, and obtained an inclusive missing mass spectrum. The broad peak structure in the hyperon resonance ($\Lambda(1405)/\Sigma(1385)$) region was shifted to low mass side as compared with a simulated spectrum based on the quasi-free model, by about 30 MeV [1]. One of the possible reasons of this shift is the strong interaction between hyperon resonance and spectator nucleon. Especially, $\Lambda(1405)N$ interaction is important to understand the cause of this shift for the following reasons: $\Lambda(1405)$ is predicted to have a $\overline{K}N$ component in the Chiral Unitary model, and $\overline{K}N$ interaction is strongly attractive in isospin 0 channel. To clear up the cause of this shift, a systematic investigation in various reactions is essential.

This situation motivated us to study an photon-induced reaction. We adopted the $d(\gamma, K^+)X$ reaction which is complementary to π-induced reaction. A different point from $d(\pi^+, K^+)X$ is the charge of the final state X. If the shift was caused by the strong interaction between $\Lambda(1405)$ and N, a similar structure is expected to be observed in the missing mass spectrum of the $d(\gamma, K^+)X$ reaction.

The experiment was performed at LEPS facility (Laser Electron Photon experiment at SPring-8). There, a high-intensity (10^6cps) photon beam with energies from 1.5 to 2.4 GeV by the backward Compton scattering process was irradiated to a liquid deuterium target to study the $d(\gamma, K^+)X$ reaction. The energy of γ was measured by the tagging counter system with the resolution of 12 MeV, and charged particles from the target were identified and momentum-analyzed by the LEPS spectrometer. An inclusive missing mass spectrum was obtained with the resolution of about 15 MeV/c in the hyperon resonance region, and was compared with the simulated spectrum based on quasi-free model.

In addition to the inclusive analysis, we studied the exclusive analysis by identifying the final state of $\Sigma\pi$. π was detected by the LEPS spectrometer except for K^+, and Σ was selected with MMSA (Minimum Momentum Spectator Approximation). By selecting $\Sigma\pi$ final state, the ratio of $\Lambda(1405)$ to $\Sigma(1385)$ is able to be controlled [2][3]. We can increase $\Lambda(1405)$ contribution in the hyperon resonance region. An $\Sigma\pi$ invariant mass spectrum was obtained, and was compared with the case when using a liquid hydrogen as a target. MMSA enable us to correct the smearing effect by Fermi motion, and we can directly compare the $\Sigma\pi$ invariant mass spectrum of each target.

In this talk, the detail of the inclusive and exclusive analysis of the $d(\gamma, K^+)X$ reaction will be presented.

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[2] J. K. Ahn , Nucl.Phys. A721 (2003) 715-718

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