φ photo-production off nuclei at SPring-8/LEPS

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Modification of vector meson properties in nuclei is a subject of interest. Some theoretical calculations predict a mass shift and a change of the decay width of ϕ meson in a nucleus [1]. High-energy heavy-ion experiments try to detect such an evidence. On the other hand, the ϕ-nucleon total cross section ($\sigma_{\phi N}$), the real-imaginary ratio of the ϕ-nucleon scattering amplitude ($\alpha_{\phi N}$), and the ϕ-nucleon coupling constant ($f_{\phi N}$), which are the fundamental parameters to describe ϕ-nucleon scattering, are not well determined.

ϕ photo-production off nuclei is the best way to determine these parameters because the nucleus is transparent to the photon probe, and the multistep process can be negligible. One measurement of the ϕ photo-production cross section off nuclei at high energies (6.4 ~ 9.0 GeV) was performed to determine the fundamental parameters mentioned above [2]. Since the coherent process is dominant at 6.4 ~ 9.0 GeV, an optical model for the coherent production was used [3]. To deduce $\sigma_{\phi N}$ from the target mass number dependence of the production cross section, the model for the coherent production requires three parameters — $\sigma_{\phi N}$, $\alpha_{\phi N}$, and $f_{\phi N}$. A unique solution for $\sigma_{\phi N}$ could not be determined due to the fact that the number of parameters is many. However, at low energies just above the ϕ meson photo-production threshold, the coherent production is expected to be suppressed as compared to the incoherent one since the minimum momentum transfer $|t|$ is large. An optical model for the incoherent production can be used to deduce $\sigma_{\phi N}$ [3]. In the model for the incoherent production, only two parameters —

$\sigma_{\phi N}$ and $\alpha_{\phi N}$ — are related with the target mass number dependence of the production cross section. Thus $\sigma_{\phi N}$ and $\alpha_{\phi N}$ can be determined with less ambiguities. In addition, these parameters can be used to check the quark model [4].

The cross sections of ϕ photo-production at E_γ=1.6~2.4 GeV were measured for four targets (Li, C, Al, and Cu) at SPring-8/LEPS. The ϕ meson events are identified by detecting K^+ and K^- mesons. Figure shows the invariant mass of K^+K^- pairs measured with an Al target. The ϕ meson peaks (1.02 GeV) were observed for all the targets.

The target mass number dependence of ϕ photo-production cross sections, $\sigma_{\phi N}$, and $\alpha_{\phi N}$ will be reported.

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