Momentum Distribution of η Meson on A (γ, η) Reaction(I. Nuclear Physics)

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journal or publication title	核理研研究報告
volume	33
page range	45-47
year	2000-12
URL	http://hdl.handle.net/10097/30977

Momentum Distribution of η Meson on A(γ, η) Reaction

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The interaction between a meson and a nucleon is one of the most basic interactions to describe the nuclei. The charged pion reaction cross sections on a nucleon were measured in wide kinematic conditions, and the coupling constant $g_{\pi NN}$ was determined. On the other hand, we have little information on the interactions between a nucleon and heavier mesons, such as η and ρ mesons. They play a major role on the short range nuclear force. Thus, it is very important to investigate the interaction between a nucleon and heavier mesons. The measurement of the meson photo production cross sections is one of the useful ways to determine the meson-nucleon interaction, because interactions between photon and nucleon are well understood. Thus, we have measured the momentum differential cross section of photo-η meson production on C, Al and Cu.

Experimental details are described in ref. [1], and here, we report on the results of the analysis of the momentum distributions of η mesons.

In Fig.1, the differential η photo production cross sections are shown as a function of emitted η meson momentum. Open circles, closed circles and squares correspond to the obtained differential cross sections of the (γ,η) reaction on C, Al and Cu, respectively. The reaction cross sections on C, Al and Cu have similar dependence on emitted η momentum. The cross section shows the maximum value at around 400 MeV/c. In order to clarify the cause of the phenomena, we have performed the calculation based on the semi-classical model, Quantum Molecular Dynamics (QMD). QMD was originally developed to describe the high energy heavy ion reactions [2]. We have modified the QMD code to describe the photon induced η production. A solid line corresponds to the results of QMD calculation which assumes that the η-N reactions only occur via S_{11} (1535) nucleon resonance. In this calculation, the η reaction cross section was deduced from the detailed balance analysis of the $\pi^-p \rightarrow \eta n$ cross section. The deduced reaction cross section is displayed as the solid line in Fig.2. These results in Fig.1 almost reproduce the data, but have slightly higher peak positions. It means that assumed reaction cross section is overestimated at the low-momentum region less than 400 MeV/c, and underestimated at

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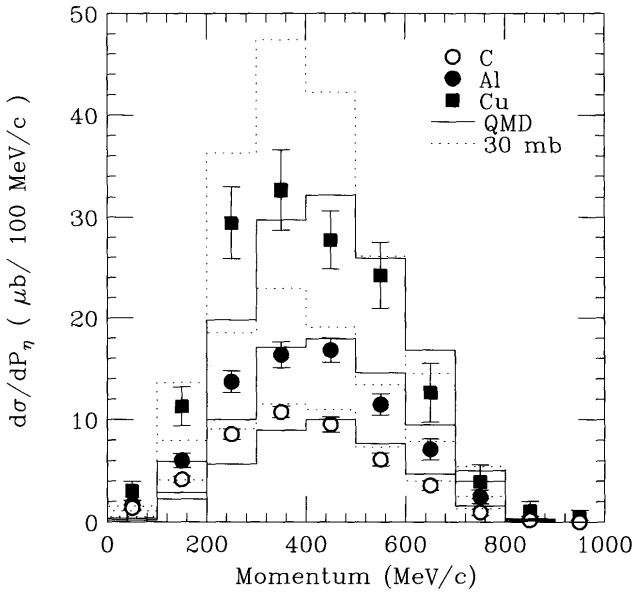

Fig.1. Differential cross sections of (γ,η) reactions on C, Al and Cu as a function of η momentum. Open circles, closed circles and squares show the results on C, Al and Cu, respectively. Solid lines show the results of QMD calculations assuming that the η-N reactions only occur via $S_{11}(1535)$ nucleon resonance. Dotted lines show the results assuming constant reaction cross sections of η mesons, 30 mb.

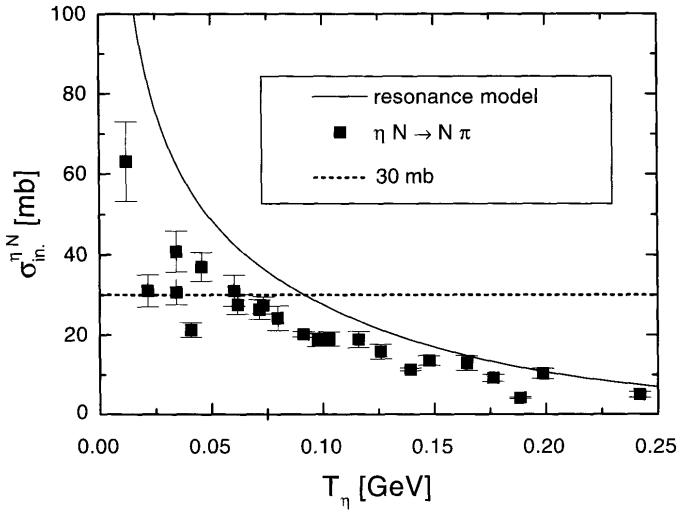

Fig.2. The absorption cross sections of η meson on nucleon, used in the QMD calculations. Squares show the η N $\rightarrow$ π N reaction cross sections deduced from the detailed balance analysis of the π p$\rightarrow$ η n cross section. Solid lines show the resonance model, and dotted line shows the constant reaction cross section of η mesons proposed by M. Effenberger *et al* [3].

the high-momentum region. As a comparison, another calculations are carried out by using constant η-N reaction cross section. Dotted lines correspond to constant reaction cross sections of η mesons, 30 mb, which were obtained by M. Effenberger and A. Sibirtsev from the analysis of the(γ,η) differential cross sections within the Glauber approximation [3]. Their analysis indicates that the η-N reaction cross section is almost independent of the η energy up to 200 MeV. These are the extreme examples that have the opposite momentum dependence to resonance model (see the dotted line in Fig.2). The results can reproduce the peak position, but fail to explain the absolute value of the cross section on Al and Cu. Future analysis to deduce the phenomenological η-N interaction are in progress.

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