ηn Scattering Length from the $\gamma d \to p\eta n$ Reaction at $E_\gamma \sim 0.9$ GeV

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(Received September 28, 2016)

We plan to conduct a new experiment for the $\gamma d \to p\eta n$ reaction using the FOREST detector at the Research Center for Electron Photon Science, Tohoku University, Japan. The main objective is to determine the low-energy η-neutron scattering parameters. The photon beam with energies around 930 MeV can give the recoilless condition of η mesons by detecting the protons at 0°. The effects of the the η-neutron final-state interaction must be enhanced due to the small relative momentum between an η meson and a residual neutron. In this contribution, the planned FOREST experiment is presented.

KEYWORDS: η-n interaction, recoilless condition, final state interaction, ...

1. Introduction

The interaction properties between a meson and a nucleon are fundamental and important in the non-perturbative QCD phenomenon. Among the two-body dynamics of the meson-nucleon systems, the interaction between the η meson and the nucleon (N) is not well known although it has been found to be attractive [1]. Neither direct η-N scattering experiments nor X-ray measurements from η-mesic atoms can be performed because the η meson is neutral and unstable. The η-N scattering length $a_{\eta N}$ has been extracted using coupled-channel analyses [2–5] from the differential and total cross sections for the $\pi N \to \eta N$ and $\gamma N \to \eta N$ reactions together with the $\pi N \to \pi N$ scattering and $\gamma N \to \pi N$ photoproduction reactions. Although the imaginary part of $a_{\eta N}$ is found to be ~ 0.26 fm for different analyses, its real part is scattered in a wide range from 0.4 to 1.1 fm. Fig. 1 shows the summary of the obtained imaginary and real parts of $a_{\eta N}$. The values are taken from Ref. [6]. The existence of the exotic η-mesic nuclei can highly depend on the value of the real part of $a_{\eta N}$ [7]. It should be noted that all the values are obtained indirectly from the theoretical analyses. Therefore, a direct $a_{\eta N}$ measurement has been desired from the experiment itself.