Measurement of angular distributions of γ-rays from ^{139}La+n to excited states of ^{140}La

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A clear angular distribution of γ-rays in a transition from the p-wave resonance formed after neutron absorption of ^{139}La to the ground state of ^{140}La has been observed in an experiment using the ANNRI beam line at J-PARC. Measurement of angular distributions of the γ-rays in the transition to the excited states of ^{140}La is reported in the paper.

KEYWORDS: Symmetry violation, Nuclear reaction, Neutron

1. Introduction

Small parity violation caused by the hadronic weak interaction with the size of 10^{-7} has been observed in the proton-proton scattering [1–3]. In neutron absorption reactions of heavy nuclei, very large parity violations with the size of 10^{-1} at maximum have been reported. The parity violation occurs at the p-wave resonance located at a tail of an s-wave resonance of the several nuclei such as ^{139}La, ^{131}Xe, ^{81}Br. This effect is theoretically understood that the tiny parity violation caused by weak interaction is largely enhanced with the interference between the p-wave and s-wave amplitudes. This assumption is referred to as "s-p mixing". The γ-rays from the p-wave resonance formed after the neutron capture have an angular distribution under the assumption of the s-p mixing. The corresponding differential cross section for unpolarized neutrons and unpolarized nuclei can be written as

$$\frac{d\sigma}{d\Omega} = \frac{1}{2}\left(a_0 + a_1 \cos\theta_\gamma + a_3(\cos^2\theta_\gamma - \frac{1}{3})\right), \tag{1}$$

where θ_γ is the emission angle of γ-rays with respect to the incident neutron momentum, and a_0, a_1 and a_3 are the function of the incident neutron momentum, the resonance parameters and the spin of the final state. For detail descriptions of a terms, please see Ref [4] and Ref [5]. The coefficient a_0 is described as an ordinal symmetric Brite-Wigner function, and a_1 is antisymmetric around the peak energy of the resonance. Therefore, neutron energy dependence of the differential cross section of the p-wave resonance is described as the Brite-Wigner function distorted by the effect of a_1 for the angle of $\cos\theta_\gamma \neq 0$.

The angular distribution of the γ-rays has been measured in the neutron absorption reaction of ^{139}La [5]. In the paper, the angular distribution was evaluated as an asymmetry of the p-wave resonance $A_{\rm LH}$ defined as

$$A_{\rm LH} = \frac{N_{\rm L} - N_{\rm H}}{N_{\rm L} + N_{\rm H}}, \tag{2}$$