S-wave resonance analysis of ^{139}La and ^{109}Ag in the compound nuclear process towards T-violation search

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The interference between the p-wave and s-wave resonance in neutron-induced nuclear reactions is expected to provide a useful tool to search for the violation of the time-reversal symmetry (T-violation). To improve the current upper limit of the T-violation effect, it is necessary to measure the asymmetry of the spin dependence of the p-wave resonance cross section with an accuracy better than $O(10^{-5})$. In order to study the systematic effects in the measurement, we made precise analyses of the s-wave resonances of ^{139}La and ^{109}Ag whose asymmetries are expected to be negligible small. In this paper, the detail of the experiments performed at the J-PARC/MLF/BL04 beam line and the experimental results are presented.

KEYWORDS: Symmetry violation, Neutron physics, Nuclear reaction

1. Introduction

In the neutron compound nuclear resonance reaction, it has been discovered that the violation of the parity symmetry (P-violation) is amplified up to about 10^6 times compared to nucleon-nucleon scatterings. This phenomenon is explained as an interference effect between the p-wave resonance and the tail of the s-wave resonance with different parities and the same total angular momenta [1]. It has been suggested that the similar mechanism may also amplify the violation of the time-reversal symmetry (T-violation) [2]. The forward amplitude f of the slow neutron scattering is given as

$$f = A + B\boldsymbol{\sigma}\cdot\boldsymbol{I} + C\boldsymbol{\sigma}\cdot\boldsymbol{k} + D\boldsymbol{\sigma}\cdot(\boldsymbol{I}\times\boldsymbol{k}), \tag{1}$$

where $\boldsymbol{\sigma}$, $\boldsymbol{I}$ and $\boldsymbol{k}$ are the incident neutron spin, the target nuclear spin and the neutron momentum, respectively. A, B, C and D are correlation coefficients, and only the D term in Eq. (1) changes the sign