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Development of in-situ 3He spin filter for epithermal neutrons to search for unknown T-violation using compound nuclei

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A significant enhancement of parity violation in the nucleon-nucleon interaction has been observed in compound nuclei formed when medium-mass nuclei such as 139La and 131Xe capture neutrons at specific resonance energies. This enhancement is considered to result from the mixing of s and p wave neutron amplitudes. Theoretically, similar mechanisms are also expected to greatly amplify T-violation effects. Utilizing this amplification, we are planning an experimental search for unknown T-violation in the nucleon-nucleon interaction using polarized nuclear targets and polarized neutrons.

We have selected 139La as the candidate for the polarized nuclear target, as it exhibits a large enhancement effect and has a p-wave resonance at 0.75 eV. For neutron polarization, we plan to use a 3He spin filter, which polarizes neutrons based on the spin dependence of the 3He nuclear absorption cross section. Although 3He spin filters are already used in various experiments at J-PARC, their neutron polarization at 0.75 eV is currently limited to approximately 30–40%.

To address this, we are developing a 3He spin filter for epithermal neutrons, capable of achieving up to 80% polarization at 0.75 eV. We fabricated a 20 cm long, 3-atm 3He cell, about two to three times longer than those currently used. In addition, we optimized the magnetic field uniformity, which is one of the factors in 3He polarization relaxation, using finite element simulations to design a new coil system and evaluated the performance of the 3He spin filter for epithermal neutrons. Furthermore, we are developing a compact system for in-situ 3He polarization at neutron beamlines, incorporating a 100 W laser and optical components housed in a light-shielded enclosure. We have conducted 3He polarization tests with this system off-beamline and achieved the polarization sufficient for the planned experiment. In this presentation, we report the detailed status of these developments.

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