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Study on radiation tolerance of room-temperature polarized solid proton target

Necessity of three-nucleon forces (3NFs) has now become known to describe various nuclear phenomena (e.g. biding energy of light nuclei, observables of few-nucleon scattering). On the other hand, the 3NFs, especially the spin dependence, is not yet fully understood. We plan to perform a polarized deuteron–polarized proton ($\vec{d} - \vec{p}$) scattering experiment to measure the spin correlation coefficients and eventually reveal the spin dependence of 3NFs with a help of the chiral effective field theory.

To measure the spin correlation coefficients, both the deuteron beam and proton target need to be polarized. There are some advantages in scattering experiments if the target is solid and can be polarized under a low magnetic field at room temperature:

- Scattering events are obtained with high statistics.
- Low energy scattered charged particles can be detected due to the relatively low magnetic field.
- There is no need of a complicated cooling system which surround the target and may limit the range of detection angle.
- Room-temperature polarized proton target is supposed to be radiation resistant due to the annealing effect.

In order to realize such a room-temperature polarized solid proton target, we used $p-$terphenyl single crystal doped with a small amount of deuterated pentacene for the target crystal and employed triplet-dynamic nuclear polarization (triplet-DNP) method for our polarized proton target. With this method, we have observed the polarization signals of protons in the solid target under the condition of a low magnetic field (~0.4 T) and room-temperature.

In this conference, the performance and radiation resistance of the target during 135 MeV/nucleon deuteron beam irradiation at RIBF, RIKEN, in January 2024 will be discussed. As a result, the depolarization was not confirmed under the deuteron beam irradiation of 10^7 and 10^8 cps but it was confirmed at 10^9 cps. However, the laser used for the triplet-DNP was damaged by the radiation and little radiation damage on the target crystal was found. This implies that the target crystal is resistant to higher intensity deuteron beams. Further analysis of the result, the current progress and future development of the target system will be also included in the presentation.

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