Polarized Proton Target for RI Beam Experiments

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Polarized proton beams have been widely used in nuclear physics experiments at wide-ranged energies, where measured polarization observables have provided us rich information on spin-dependences of nuclear interactions, nuclear structure, and reaction mechanism. It is reasonable to expect that use of the polarized proton in radioactive isotope beam experiments will bring stiff understanding of structure of unstable nuclei.

Still, before 2002, no scattering experiment with both a spin-polarized proton and an unstable nucleus had been carried out. This is mainly due to a difficulty in constructing a polarized proton target applicable to RI beam experiments. The difficulty originates from a condition of low temperature of sub-Kelvin and high magnetic field of several Tesla imposed in the conventional polarized proton solid target by a dynamic nuclear polarization method. The condition severely limits detection of recoiled protons.

We have overcome the difficulty by using an electron polarization in the photo-excited triplet state of aromatic molecules, pentacene in a single crystal of naphthalene, to polarize protons in it. Magnitude of the electron polarization depends neither on its temperature nor on a magnetic field strength. This enables us to construct a polarized proton solid target which works at a high temperature and in a low magnetic field. In this condition, recoiled low-energy particles can escape from the target apparatus rather easily and can reach the detectors. We have constructed a polarized proton solid target system based on this method at the Center for Nuclear Study, the University of Tokyo [1,2,3].

The polarized proton solid target was completed in 2003 and applied to a RI beam experiment in 2003 and 2005 by using the projectile fragment separator, RIPS at RIKEN. The maximum polarization reached 20% under the condition of $T = 100$ K and $B = 0.1$ T.

Overview of the polarized target and its application in physics experiments at RIPS and RIBF of RIKEN will be presented.

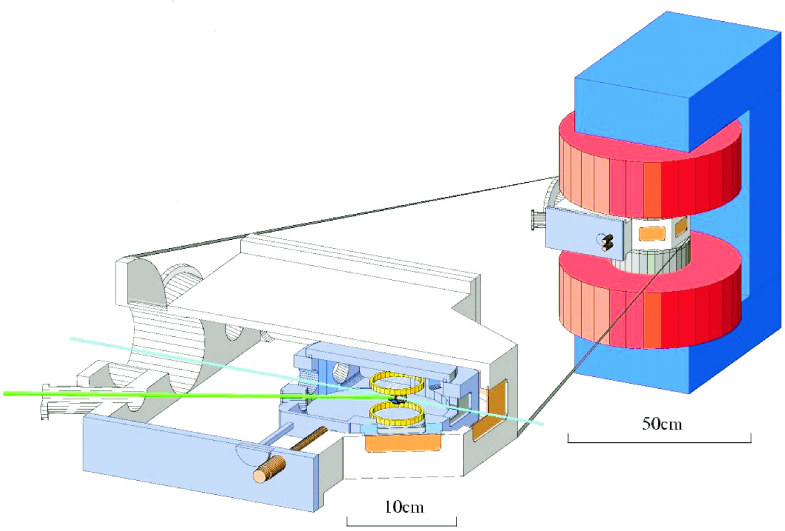

Figure 1: *Overview of the polarized proton target.*

[1] T. Wakui et al., Nucl. Instrum. Methods A **550** (2005) 521.;
[2] M. Hatano et al., Euro. Phys. J. A **25** (2005) 255.
[3] T. Uesaka et al., Nucl. Instrum. Methods A **526** (2004) 186.