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Spin-asymmetry measurement in proton resonant scattering from unstable nuclei

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Spin asymmetry in direct reactions is rich source of information on nuclear structure, reaction mechanism, and spin-dependent interactions. From more than half century ago, a number of scattering experiments using polarized light ions have been performed at facilities all over the world. Application of such powerful methods to the field of unstable nuclei should enable us to reveal new aspects of atomic nuclei. With such a motivation, we have constructed a solid polarized proton target for radioactive-ion beam experiments under inverse kinematics [1]. The target can be operated in a low magnetic field of 0.1 T, which allows detection of recoil protons with good angular and energy resolutions. The target has been applied to several RI-beam experiments at intermediate energies of several tens to a few hundred MeV/nucleon [2].

One of the future directions of such polarization study is to apply the target to low- energy beam experiments at several to a few tens of MeV/nucleon. Combination of low-energy RI-beam and polarized proton target will open up new possibilities of the spin-asymmetry measurement for low-energy reactions such as resonant scattering and transfer reaction. We could also polarize the RIs embedded in the target, or polarize slow neutrons by using the difference between spin parallel and antiparallel p–n cross sections.

Among them, a special focus will be put on the possibility of the resonant proton scattering, which is a powerful spectroscopic tool for extracting single-particle information of exotic nuclei. Spin asymmetry in resonant scattering will be useful in determining the spin-parity of the resonance states without model dependence. The spin asymmetry will also be effective in identifying broad resonances which overlap with each other. This would be particularly important in the spectroscopy of nuclei near/beyond the dripline, where the resonance width is extremely large [3].

In this presentation, we will discuss the physics opportunities expected in the low- energy beam experiment with polarized protons. We will also introduce an experimental plan of 9C+¥vec{p} resonant scattering to probe 10N levels (mirror nucleus of 10Li), which provide important information on n-9Li potential for constructing the three-body model of 11Li (9Li+n+n).

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[2] T. Uesaka, S. Sakaguchi et al., Phys. Rev. C 82, 021602(R) (2010); S. Sakaguchi et al., Phys. Rev. C 84, 024604 (2011); S. Sakaguchi et al., Phys. Rev. C 87, 021601(R) (2013).
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