Analyzing Power Measurement for Elastic Scattering of ^{6}He on Polarized Protons

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Through scattering experiments making use of radioactive ion (RI) beams, a plenty of new phenomena, such as neutron skin and the change of shell structure, have been discovered. On the other hand, direct reactions induced by polarized protons have revealed various aspects of nuclear structure and reaction mechanisms in the study of stable nuclei. It is naturally expected that polarized protons play a central role also in the study of unstable nuclei and provide valuable information through polarization observables.

However, there has been no RI-beam experiment with polarized protons due to the lack of polarized target for RI-beam experiments. In this situation, we succeeded in constructing a solid polarized proton target that can be used in RI-beam experiments. Its unique applicability was realized by a technical break-through which allows the operation under very modest conditions; low magnetic field of 0.1 T and high temperature of 100 K.

Making use of the solid polarized proton target, the analyzing power was measured for the p+^{6}He elastic scattering at 71 MeV/u. A large discrepancy was found between the data and calculations of the microscopic theory which well describes the proton elastic scattering with various stable nuclei. This discrepancy indicates an inadequacy of current microscopic optical models in the description of spin-orbit potentials and polarization phenomena in weakly bound nuclei. We thus determined the spin-orbit potential by a phenomenological optical model analysis and compared it with those of neighboring stable nuclei. It was indicated that the ^{6}He has a relatively shallow and widely extended spin-orbit potential. This unexpected shape may contain important information on the neutron skin structure of ^{6}He particles.