Production of Polarized Radioactive Beams via The Inverse-kinematics Reactions and Their Applications

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Recoil products in the low-energy nucleon-transfer reaction are known to be spin-polarized when the recoil angle and kinetic energy are selected. The direct consequence of this reaction in the inverse-kinematics scheme is that the secondary beams produced from such processes should show substantial polarization provided the emission angle and energy are properly selected. Based on this view, we propose to establish a methodology of producing spin-polarized radioactive beams via the inverse-kinematics reactions, and to initiate researches to apply these well-focused, conveniently energetic spin-polarized radioactive beams to nuclear structure physics and material science.

A beam of radioactive nuclei (RNB) with their spins polarized is useful in various fields. Its application extends from studies in nuclear physics such as nuclear moments and decays, to those in condensed matter physics including magnetism in metals and insulators, impurity and electronic dynamics in semiconductors, and superconductivity. It may even be an exclusive tool to investigate surfaces, layers and nano-sized structures, if the energy and/or spatial distribution (spot size) of the spin-polarized RNB could be controlled with sufficient precision.

We are measuring polarization of ^{17,18}N beam from the ^{9}Be(^{18}O, N) B reaction, with the β-NMR technique using CNS radioactive ion beam separator (CRIB). In addition, we are searching for the optimal conditions to obtaining the highest polarized beam with a large yield.

When we success to produce the high polarized beam, the polarized ^{17}N beam is implanted in Type Ib diamond single crystal, in order to study the structure of the N impurity in diamond. The polarized ^{18}N beam is implanted in diamond in order to measure the ground-state magnetic moment and electric quadrupole moment, for which two largely contradicting results are reported from experiments with different experimental methods.