Direct Reaction Studies at RIKEN RI Beam Factory

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Studies of direct reaction with exotic beams have been developed with intermediate-energy beams of radioactive isotopes (RIs). Since 1990s, an accelerator complex at RIKEN has provided heavy-ion beams with the maximum energy of 135 MeV/nucleon. These beams were used to produce fast RI beams by the projectile fragmentation scheme. Studies on nuclear structure of unstable nuclei and astrophysical processes involving short-lived nuclei have been successfully made with the RI beams. To overcome the difficulties arising from the low intensity and poor quality of the beams, various experimental techniques, determination of the excitation energy by the invariant mass or gamma-ray measurement in inverse kinematics, for example, have been employed. The Coulomb dissociation measurements for simulating astrophysical capture reactions or for exploring the structure of halo nuclei, and the Coulomb excitation to extract transition probabilities in nuclei far from the stability valley are such examples. On of the advantage of these RI-beam experiments is easiness of changing the probe particle, the target in the inverse kinematics. Note that in the normal kinematics, to make experiments with both the ^{208}Pb and proton beam in the same facility is not possible in practice. An example of exploiting this advantage is the study of the 2^+ state in ^{16}C, where the contribution of proton and neutron excitation was obtained separately by coupling the results from the inelastic scattering experiments with hydrogen and lead targets using RI beams of ^{16}C.

Construction of a new accelerator complex called RI Beam Factory (RIBF) has been completed in the end of 2006. It is aimed at greatly extending the capability of producing beams of nuclei very far from the stability valley. First results are for production of new isotopes ^{125}Pd and ^{126}Pd with 345 MeV/nucleon U beams with intensity yet lower by a few order of magnitude than the goal. Perspective of nuclear structure studies as well as new equipment being built or planned at RIBF will be presented.