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Active Target-Time Projection Chambers for Reactions Induced by Rare Isotope Beams: Physics and Technology

WOLFGANG MITTIG, Michigan State University-NSCL

Weakly bound nuclear systems can be considered to represent a good testing-ground of our understanding of non-perturbative quantum systems. Great progress in experimental sensitivity has been attained by increase in rare isotope beam intensities and by the development of new high efficiency detectors. It is now possible to study reactions leading to bound and unbound states in systems with very unbalanced neutron to proton ratios. Application of Active Target-Time Projection Chambers to this domain of physics will be illustrated by experiments performed with existing detectors. The NSCL is developing an Active Target-Time Projection Chamber (AT-TPC) to be used to study reactions induced by rare isotope beams at the National Superconducting Cyclotron Facility (NSCL) and at the future Facility for Rare Isotope Beams (FRIB). The AT-TPC counter gas acts as both a target and detector, allowing investigations of fusion, isobaric analog states, cluster structure of light nuclei and transfer reactions to be conducted without significant loss in resolution due to the thickness of the target. The high efficiency and low threshold of the AT-TPC will allow investigations of fission barriers and giant resonances with fast fragmentation rare isotope beams. This detector type needs typically a large number of electronic channels (order of magnitude 10,000) and a high speed DAQ. A reduced size prototype detector with prototype electronics has been realized and used in several experiments. A short description of other detectors of this type under development will be given.