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Fusion studies of low-intensity radioactive beams using an active-target time projection chamber

A.M. Howard[1], J.J. Kolata[1], W. Mittig[2], T. Ahn[2], D. Bazzin[2], F.D. Becchetti[3], S. Beceiro-Novo[2], Z. Chajecki[2], M. Febbrarro[3], A. Fritsch[2], W.G. Lynch[2], A. Roberts[1], A. Shore[2], R.O. Torres-Isea[3]

[1] *Department of Physics, University of Notre Dame, Notre Dame, IN 46556, USA*
[2] *National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, MI 48824, USA*
[3] *Department of Physics, University of Michigan, Ann Arbor, MI 48109, USA*

Contact email: *ahoward3@nd.edu*

The next generation of radioactive-beam facilities, due to enter service in the coming years, offer the opportunity to study nuclei with extreme values of isospin. The fusion characteristics of these exotic systems is of considerable interest as a means of probing the underlying nuclear structure. The development of neutron and proton halos, for example, has been observed to result in fusion cross sections in the vicinity of the Coulomb barrier significantly enhanced relative to those expected from one-dimensional barrier calculations [1]. The magnitude of this enhancement is expected to be sensitive to the spatial extent of the halo wavefunction, with evidence emerging for a decoupling of the halo from the core. Traditional thin-target fusion experiments will be unsuitable for the most exotic beam species due to the low beam intensities expected. An active-target time projection chamber (AT-TPC) is under development at the National Superconducting Cyclotron Laboratory for use with the forthcoming re-accelerated beam facility, ReA, which addresses this issue. The use of a TPC permits an arbitrarily-thick target to be presented, greatly extending the domain of nuclei which may be studied. Furthermore, it enables the simultaneous measurement of beam breakup, an understanding of which is vital to the interpretation of fusion cross sections. A half-scale prototype of the AT-TPC has recently been commissioned using the TwinSol radioactive-beam facility at the University of Notre Dame [2]. We report here on the fusion of neutron-rich ^{6}He and ^{12}B beams with an ^{40}Ar target at near- and sub-barrier energies. Preliminary results will be presented and the scope for future work using the full-scale AT-TPC, and similar devices, discussed.

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