Nuclear Structure Studies with ISOL Beams at the HRIBF*

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The Holifield Radioactive Ion Beam Facility (HRIBF) is currently the only facility in the world that is capable of delivering accelerated proton- and neutron-rich ISOL beams up to the Coulomb barrier for nuclear structure, reaction and astrophysics research. To take advantage of these unique beams, we have developed several state-of-the-art detector systems and new experimental techniques that have allowed us to cope with the difficulties of using low-intensity radioactive ion beams for nuclear physics research in general, and gamma-ray spectroscopy in particular. This talk will provide a brief overview of these activities, with a focus on a few of our recent results outlined below.

Since the mid-nineties, Coulomb excitations of radioactive ion beams (RIBs) at projectile-fragmentation facilities have provided unique insight into the structures of the neutron-rich nuclei below Z=20, including early evidence regarding possible modification of the N=20 magic number in neutron-rich nuclei. Since Coulomb excitation of ISOL beams scattered off high-Z targets allows studies of multi-step processes, it would provide an even deeper insight into the nature of quadrupole collectivity in exotic nuclei. With this prospect in mind, we have initiated a Coulomb excitation program with the accelerated RIBs to systematically study the B(*E2*) transition strengths in neutron-rich nuclei near magic number N=50, and those neighboring ^{132}Sn. The first results for several isotopes of Sn and Te indicate that while nearly all of the deduced B(*E2*; 0->2) values follow the expected trends, the value for ^{136}Te is unexpectedly small: It is nearly half of that in ^{132}Te in spite of its much smaller excitation energy. This anomalous result could not be reproduced within the framework of shell model calculations. However, recent QRPA and QMCD calculations have predicted smaller transition rates that are close to the experimental value. The differences in these results primarily reflect the different degrees of contributions of neutrons to the wave function of this state. Within the QRPA model, the very large neutron component of the wave function is attributed to the small neutron pairing strength in this nucleus. We plan to further pursue these studies to provide some constrains on the choice of input parameters for microscopic models.

We have also begun to explore spectroscopy of the single-particle states in the vicinity of ^{132}Sn using selective heavy-ion transfer reactions, such as (^{9}Be, ^{8}Be), (^{13}C, ^{12}C), (^{7}Li, ^{8}Be), and (^{11}B, ^{10}B), in inverse kinematics. Early results from these reactions and for incomplete fusion reactions with ^{6,7}Li targets are very encouraging. We are also exploring the possibility of using light-ion transfer reactions, such as (d, p) and (^{3}He, ^{4}He), to probe spectroscopic factors of single particle states near magic numbers. Some early results from these experiments, as well as our plans for future nuclear structure studies with RIBs will be discussed

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