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Masses and Beta-Decay Spectroscopy of Neutron-Rich Nuclei: Isomers and Sub-shell Gaps with Large Deformation

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The structure of deformed, neutron-rich nuclei in the rare-earth region is of significant interest for both the nuclear-structure and astrophysics fields. Although much progress is being made in our understanding of the r-process, a satisfactory explanation for the elemental peak in abundance near A=160 is still elusive. Understanding the origin of this peak may be a key to correctly identifying the astrophysical conditions for the r-process. Theoretical models of element production are dependent on masses and lifetimes of neutron-rich, deformed rare-earth nuclei in this region where little or no information is known. The available nuclear structure information is also scarce, owing to difficulties in the production of these nuclei.
In order to address these issues, an experimental program has been initiated at Argonne National Laboratory using high-purity radioactive beams produced by the CARIBU facility. Mass measurements using the Canadian Penning Trap (CPT) and beta-gamma coincidence studies using the SATURN moving tape system and the X-Array spectrometer, comprising of five Ge clover detectors, were carried out. A number of two-quasiparicle isomers were discovered in odd-odd nuclei using CPT and in several cases their properties were elucidated by complementary beta-decay studies. Evidences were found for changes in the single-particle structure, which in turn resulted in the formation of a sizable sub-shell gap at N=98 and large deformation.
Results from these measurements will be presented, together with predictions based on deformed shell model that includes effects of pairing and spin-depended, nucleon-nucleon interactions. The newly-commissioned beta-decay station at Gammasphere will also be discussed and results from the first experimental campaign will also be presented.

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