A New Proposal to the High Intensity Gamma-Ray Source (HIGS) PAC-10

The Role of Deformation on the Dipole Strength Distribution of the Pygmy Dipole Resonance: Xenon Isotopes

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1 Experiment Summary

In stable and closed shell nuclei, a resonance like concentration of dipole strength is observed at excitation energies around the neutron-separation energy. This clustering of strong dipole transitions has been named the pygmy dipole resonance (PDR). In hydrodynamic and collective approaches, it was suggested that an oscillation of a small portion of neutron-rich nuclear matter relative to the rest of the nucleus is responsible for the generation of pygmy resonances. From the analysis of transition densities, the unique behavior of the PDR mode is revealed, making it distinct from the well-known giant dipole resonance (GDR). The systematic studies of the PDR over isotonic and isotopic chains of nuclei indicate a correlation between the observed total $B(E1)$ strength of the PDR and the neutron-to-proton ratio $N = Z$ nucleon excess. The existence of the PDR mode near the neutron threshold has also important astrophysical implications. For example, the reaction rate of the $(\gamma, n)$ and $(n, \gamma)$ reactions in explosive nucleosynthesis of certain neutron deficient heavy nuclei may be significantly enhanced by the PDR. Furthermore, for very neutron-rich exotic nuclei, the PDR is an important topic of study at the new generation of radioactive ion beam facilities.

However up to now, this nuclear structure phenomenon have been observed only in nuclei with spherical semi-magic shells ($N = 82$ and $N = 50$ isotones). We propose extending this investigation at HIGS to examine the PDR in nuclei that have constant deformation in their ground states in order to understand the role of deformation on the fragmentation of the PDR strength and its evolution when ones moves away from the closed shell. Xenon isotopes with atomic numbers 130, 132, and 136 are the main targets of interest in this proposal.