Spin Physics in Exotic Nuclei and Perspectives for FRIB

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Spin observables in nuclear structure and reaction studies have played a critical role in characterizing the nature of the nuclear force and dynamics. It is now well established that properties of nuclei at the limits of stability are very different from those found near the stability, representing the need to redefine the paradigms of nuclear structure physics. One such example can be found in so-called nuclear halo or skin where valence neutrons have spatially extended wave functions and therefore may induce new structural phenomena.

The decoupled structure of nuclear halo composed of valence neutrons and core is expected to provide a new degree-of-freedom in collective modes. However, due to experimental difficulties, the information on halo excitation modes has been limited so far to the electric dipole mode (spatial oscillation between halo neutron and core), hampering detailed characterization. As a way to observe unique forms and dynamics of exotic isotopes which are often produced in very low amounts, the advanced gamma-ray array GRETINA (Gamma-Ray Energy Tracking In-beam Nuclear Array) has been employed in fast rare-isotope beam programs at NSCL. In the campaign, excited-state lifetime measurements were performed for very neutron-rich C and Ne isotopes close to the drip line, in order to measure magnetic transition rates in these nuclei. The magnetic transition in atomic nuclei can probe the nuclear oscillation in spin spaces, and therefore can quantify spin responses of nuclear halo. This talk will provide an overview of the program and highlight physics results obtained for halo nuclei. Data are compared to modern nuclear structure calculations and possible impacts due to the three-body force and continuum effects will be discussed. Perspectives for future opportunities at FRIB will also be provided.