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Nuclear Resonance Fluorescence for Nuclear Structure

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Photon beams provide a uniquely selective probe of the spatial distributions of charge and current within nuclei. Their well-defined spin selectivity and high sensitivity to transition strengths enable spectroscopic studies of dipole excitations with minimal dependence on nuclear models. This approach is particularly powerful for mapping the distribution of electric and magnetic dipole strength from a few MeV up to the particle emission threshold, offering insight into the collective response of the internal degrees of freedom of the nucleus. In this talk, I will present recent advances in experimental techniques and nuclear structure results obtained from photonuclear reactions using the nearly monoenergetic, highly polarized photon beams provided by the High Intensity γ-ray Source (HIγS) facility at TUNL. Emphasis will be placed on precision measurements of dipole strength distributions, the identification of fine structure in the excitation spectrum, and the extraction of observables relevant to fundamental symmetries and astrophysical reaction rates. Where appropriate, the results will be compared with complementary data from hadron-induced reactions, to highlight the distinct selectivity and interpretive advantages of the photonuclear approach. These comparisons provide a more comprehensive understanding of nuclear excitations and help to constrain theoretical models describing nuclear structure and dynamics.

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