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Recent results on intermediate energy two-proton removal reactions

K. Wimmer[1]

[1] *Department of Physics, Central Michigan University, Mount Pleasant, MI 48859, USA*

Contact email: *wimme1k@cmich.edu*

The explanation of the magic numbers for nuclei in the valley of stability was one of the milestones in the understanding of nuclear structure. However, in recent years, several theoretical and experimental investigations found evidence that these magic numbers change when going away from stability towards more exotic nuclei. Nucleon knockout reactions using fast rare isotope beams are a well suited tool to study single-particle properties of exotic nuclei and the evolution of nuclear shell structure towards the drip-lines. Recently, a series of experiments has been performed at the National Superconducting Cyclotron Laboratory at Michigan State University in order to study reaction mechanism in nucleon knockout reactions. Such experiments are key for validation of the theoretical description of the reaction mechanism and use for quantitative spectroscopy of very exotic nuclei. In particular the sudden removal of two protons from an intermediate-energy neutron-rich projectile has been shown to proceed as a direct reaction. In addition to giving spectroscopic information, this type of reaction promises a rather unique tool assign spins by measuring the momentum distributions of the heavy reaction residues. First coincidence measurements of the heavy reaction residues and the removed protons enabled the relative cross sections from each elastic and inelastic nucleon removal mechanism to be determined. These more final-state-exclusive measurements are key for further validation of this direct reaction and its use for quantitative spectroscopy of highly neutron-rich nuclei. The kinematic correlations of the removed protons are also analyzed. A Dalitz-plot analysis and comparisons with simulations show that a majority of the triple-coincidence events with two protons display phase-space correlations consistent with the (two-body) kinematics of a spatially correlated pair-removal mechanism. This result promises access to a new, more specific probe of the spin and spatial correlations of valence nucleon pairs in exotic nuclei produced as fast beams.

In this talk I will present recent results from experiments at the interplay of nuclear structure and reactions performed at the NSCL.