# Correlations in direct two-proton knockout and details of the reaction mechanism

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In surface-grazing collisions with a light target nucleus 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. In a two-nucleon removal reaction three reaction mechanisms contribute to the cross section: the inelastic removal of both nucleons, the elastic removal of one nucleon and inelastic removal of the second, and the elastic dissociation of both nucleons. The direct two-proton knockout reaction from a $^{28}$Mg beam at 93 MeV/u has been studied at NSCL. First coincidence measurements of the heavy $^{26}$Ne projectile 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 relative and absolute yields of the three contributing mechanisms are compared to reaction model expectations based on the use of eikonal reaction dynamics and *sd*-shell model structure amplitudes. The kinematic correlations of the removed protons are also analyzed. Comparisons with phase-space simulations show that a majority of the triple-coincidence events with two protons display correlations consistent with a two-body, diproton-like removal mechanism. The fraction of such correlated events is also consistent with the fraction of spin $S = 0$ two-proton configurations in the entrance-channel $^{28}$Mg ground state wave function. 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.