

## Inclusive Quasifree Scattering Cross Sections from Medium-Mass Neutron-Rich Nuclei

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Direct nucleon removal has become a tool of choice to study structure and reactions in exotic nuclei [1,2,3]. Despite the pervasiveness of this method, theoretical approaches to describe these reactions remain incomplete. To remedy this, part of the community has focused on experiments with pure proton targets at intermediate energies where the quasifree scattering paradigm may be invoked and the reaction mechanism simplified [3,4]. However, to date, little data exists for exotic nuclei.

At the Radioactive Isotope Beam Factory, we have measured 77 single proton and neutron removal inclusive cross sections from neutron-rich exotic nuclei from Cr ( $Z=24$ ) to Tc ( $Z=43$ ). Obtained on a 10 cm thick liquid hydrogen target [5] at  $\sim 250$  MeV/U, consistent with quasifree scattering, these results provide a systematic exploration of direct reaction cross sections with isospin and across the  $N=50$  shell closure. The evolution of the cross sections with mass and separation energy will be presented, and the results compared to state-of-the-art Intranuclear Cascade Model and Distorted Wave Eikonal calculations.

[1] T. Wakasa, K. Ogata, T. Noro, Proton-induced knockout reactions with polarized and unpolarized beams, *Progress in Particle and Nuclear Physics* 96, 32 (2017).

[2] V. Panin et al, Exclusive measurements of quasi-free proton scattering reactions in inverse and complete kinematics, *Physics Letters B* 753, 204 (2016).

[3] T. Aumann, C. A. Bertulani, J. Ryckebusch, Quasifree (p,p) and (p,pn) reactions with unstable nuclei, *Phys. Rev. C* 88, 06461010 (2013).

[4] A. Obertelli and T. Uesaka, Hydrogen targets for exotic-nuclei studies developed over the past 10 years. *Eur. Phys. J. A* 47: 105 (2011).

[5] A. Obertelli et al, MINOS: A vertex tracker coupled to a thick liquid-hydrogen target for in-beam spectroscopy of exotic nuclei. *Eur. Phys. J. A* 50: 8 (2014).

### Summary

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