

NEUTRON KNOCKOUT REACTIONS AT MEDIUM ENERGIES

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We plan to study neutron knockout reactions at medium energies to investigate the radial distributions of neutrons in nuclei. Knockout reactions are well-suited to such studies because all values of momentum transfer (including zero) are kinematically accessible. By contrast, the momentum transfers accessible with pickup reactions such as (p,d) or (d,t) are larger than momenta typically found in nuclei. We plan to use both (p,pn) and (α , α n) knockout reactions because the radial localization of these reactions (due to absorption) should be quite different,¹ and a consistent treatment of the two reactions should be sensitive to an accurate description of the radial extent of the wavefunctions of the knocked-out neutrons.

Initial work will be a study of the (p,pn) reaction at 150 MeV on ⁴⁰Ca and ⁴⁸Ca. The matter radii of the calcium isotopes have been the subject of considerable interest for some time. Electron scattering studies^{2,3} and μ -mesic atom studies⁴ show that the r.m.s. charge radii of ⁴⁰Ca and ⁴⁸Ca are essentially identical. By contrast, other series of isotopes such as nickel or tin show⁵ a steady increase of the r.m.s. charge radius with mass number A. This anomaly has stimulated considerable interest in determining the neutron distribution of ⁴⁸Ca; more specifically, where do the $f_{7/2}$ neutrons lie?

Over the past decade there have been many attempts to determine r.m.s. matter radii and/or neutron radii for the calcium isotopes through studies of elastic scattering of various strongly interacting projectiles, through

studies of total reaction cross sections and through studies of Coulomb energy shifts. Many conflicting answers have been obtained; but to date, no one has been able to isolate specifically the behavior of the neutrons in the $f_{7/2}$ orbit. Because knockout reactions can isolate various orbits in nuclei by their separation energies, we should be able to determine the radial distributions of both the $1f_{7/2}$ shell neutrons and the 2s-1d shell neutrons in ⁴⁸Ca and compare this with the 2s-1d shell neutrons in ⁴⁰Ca. Also we will be able to compare our (p,pn) results with work at the IUCF by Roos et al.⁶ on the ⁴⁰Ca(p,2p)³⁹K reaction at 150 MeV.

A scattering chamber designed specifically for this work was installed in the QDDM spectrometer hall at an intermediate focus on the beam line that passes through into the beam swinger area. From this location neutron flight paths of about 20 m are available within the QDDM hall. With a 20 m flight path, we expect to obtain neutron energy and separation energy resolutions better than 1 MeV. Proton energies will be measured with an intrinsic germanium counter telescope.

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