Light Nuclei Studied With Nucleon Transfer Reactions Using Exotic Beams*

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For decades, single neutron transfer reactions such as (*d,p*) have served as fundamental tools for studying the properties of nuclei throughout the periodic table. The selectivity and ease of interpretation of the (*d,p*) reaction in particular have made it one of the most heavily used reactions for the determination of quantum numbers, and for probing the wave functions of single-particle states in nuclei. With the advent of radioactive beams, interest in direct transfer reactions such as (*d,p*) has been renewed. This renewed interest accompanies significant advances in theoretical methods that can be applied to nuclear structure, including so-called *ab-initio* methods including the Quantum Monte Carlo and No-Core Shell Model techniques which have had considerable success. In many light nuclei far from stability, few data are available with which to test these methods, however with unstable beams many are now within reach. We will discuss two recent examples of studies of the (*d,p*) reaction carried out with ^{8}Li and ^{6}He beams produced at the "in-flight" radioactive beam facility at the ATLAS facility at Argonne National Laboratory to study the light nuclei ^{9}Li [1] and ^{7}He. The neutron spectroscopic factors obtained from the (*d,p*) data are in good agreement with the values obtained from *ab-initio* nuclear structure calculations for low-lying states in ^{9}Li (see Fig. 1), and for the unbound ground state of ^{7}He. We also discuss possible evidence for excited levels in ^{7}He, in particular the suggestion of a low-lying $1/2^{-}$ that has been reported [2]. The challenges and opportunities that can be expected for (*d,p*) as well as other nucleon-transfer reactions with exotic beams in the Coulomb-barrier region will be presented.

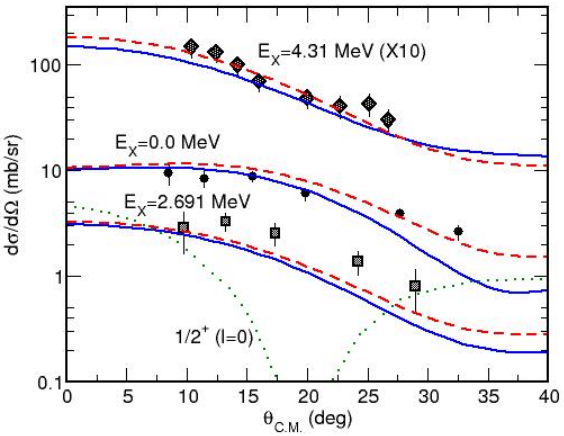

Figure 1. Angular distributions for the ^{2}H(^{8}Li,*p*)^{9}Li reaction, for transitions to the ground, first and second-excited states in ^{9}Li. The solid and dashed curves represent absolute predictions of the cross section using neutron spectroscopic factors from Quantum Monte-Carlo methods.

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