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Constraining bound state potentials of A≈80 nuclei with (d,p) measurements

The empirical spectroscopic properties of unstable nuclei are important input to understanding nucleosynthesis in stars and their explosions, as well as constraining models of nuclear structure. In particular, the spectroscopic factor is a key ingredient in calculating direct-semi-direct neutron capture on weakly bound nuclei, as well as informing the single-particle character of excitations. However, deducing spectroscopic factors is highly sensitive to the shape of the bound state potential; in peripheral reactions spectroscopic factors can vary by factors of 2-4 for reasonable potential parameters. In nuclei away from stability, especially on the neutron-rich side, the validity of bound state parameters common for stable nuclei is unknown, especially for less bound configurations. Mukhamedzhanov and Nunes [1] have proposed measuring the same reaction at two very different energies to constrain the bound-state potential parameters. At low energies, a peripheral reaction constrains the external contribution, the nuclear asymptotic normalization coefficient (ANC). At higher energies, the ANC would not be constrained, yet the reaction would still be sensitive to the unknown bound state parameters. Because, the spectroscopic factor is a property of the many-body wave function of the final bound state populated in the (d,p) reaction, it should be independent of the reaction energy. Therefore, the spectroscopic factor is determined by the value (with uncertainties) consistent with measurements at both reaction energies. We have recently demonstrated the validity of this approach by measuring the (d,p) reaction with 35 MeV/u 86Kr beams at the National Superconducting Cyclotron Laboratory (NSCL) with the Oak Ridge Rutgers University Barrel Array (ORRUBA) and SIlicon Detector Array (SIDAR); the results were compared with previous measurements of the reaction with 86Kr targets and 11 MeV d beams [2]. More recently, we measured at NSCL the (d,p) reaction with 45 MeV/u 84Se beams, which would be combined with the previous study [3] at 4.5 MeV/u. The present talk would summarize the results from the 86Kr measurements, including the deduced bound state parameters for the 87Kr ground state, and present preliminary results from the 84Se beam measurements.

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Primary author: Mr WALTER, David (Rutgers University)

Co-authors: Prof. NUNES, Filomena (Michigan State University); Prof. CIZEWSKI, Jolie (Rutgers University); Dr PAIN, Steven (Oak Ridge National Laboratory)

Presenter: Prof. CIZEWSKI, Jolie (Rutgers University)