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Informing direct neutron capture for the weak r-process via the (d,p) reaction with ^{84}Se beams at two energies

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Neutron capture reactions on nuclei near neutron shell closures predominantly proceed via direct-semi-direct processes that require knowledge of the neutron spectroscopic strengths of specific excitations. Understanding neutron capture on neutron-rich nuclei near $N=50$ is also important for understanding the synthesis of nuclei via a weak r-process [1]. Of particular interest is neutron capture on the $N=50$ isotone ^{84}Se . We measured the (d,p) reaction with 45 MeV/u rare isotope ^{84}Se beams at the National Superconducting Cyclotron Laboratory (NSCL) where reaction protons were measured in the Oak Ridge Rutgers University Barrel Array (ORRUBA) of position-sensitive silicon strip detectors in coincidence with beam-like recoils analyzed with the S800 magnetic spectrograph. The results from this measurement were combined with previous measurements [2] at 4.5 MeV/u to constrain the single particle asymptotic normalization coefficient (spANC) and therefore the spectroscopic factors for the ground $5/2^+$ state ($2d_{5/2}$) and first excited $1/2^+$ state ($3s_{1/2}$) were deduced with uncertainties dominated by statistics rather than uncertainties in the bound state potential, using methods from previous studies with stable ^{86}Kr beams [3]. The spectroscopic factors for these $5/2^+$ and $1/2^+$ states were used to deduce direct-semi-direct neutron capture cross sections as a function of neutron energy. This collaboration is also approved to measure the (d,p γ) reaction with ^{80}Ge beams at the Facility for Rare Isotope Beams (FRIB) at the S800 using ORRUBA coupled to GRETINA to realize GODDESS (ORRUBA Gamma Array: Dual Detectors for Experimental Structure Studies). The $^{80}\text{Ge}(\text{d,p})$ reaction has previously been measured at 3.9 MeV/u [4]. The approved experiment would not only inform DSD capture on a nucleus important in understanding weak r-process nucleosynthesis but would also inform the competition between DSD and neutron capture that proceeds via a compound nucleus. The present talk would summarize the results from the ^{84}Se measurements, including the DSD capture results, and the status of mounting GODDESS at FRIB for the ^{80}Ge measurement.

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[1] R. Surman et al., AIP Advances **4**, 041008 (2014).

[2] J.S. Thomas et al., Phys. Rev C **76**, 044302 (2007)

[3] D. Walter et al., Phys. Rev. C **99**, 054625 (2019).

[4] S. Ahn et al., Phys. Rev. C **100**, 044613 (2019)

Topic

Experiment

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