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Neutron transfer reactions with exotic tin beams and neutron capture

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Neutron capture at late times in r process nucleosynthesis can have significant impact on the observed r-process abundances. In particular, uncertainties in neutron capture rates near ^{130}Sn significantly impact network calculations of r-process abundances not only near ^{132}Sn but also for heavier nuclei [1]. We have recently completed the analysis of the (d,p) reactions with exotic A=132,130,128,126 and stable A=124 tin beams accelerated to ≈5 MeV/u at the Holifield Radioactive Ion Beam Facility at Oak Ridge National Laboratory. Measurements were made with CD2 targets. In the ^{124,126,128}Sn measurements, light reaction products were measured with the Super Oak Ridge Rutgers University Barrel Array (SuperORRUBA) of highly segmented silicon strip detectors supplemented by the Silicon Detector Array (SIDAR) at back angles in the laboratory. Previous measurements of the ^{130,132}Sn reactions [2,3] were combined with the ^{124,126,128}Sn results to extract spectroscopic factors using the same Finite Range Adiabatic Wave Approximation (FR-ADWA) formalism [4]. Direct-semi-direct (DSD) neutron capture was calculated with the CUPIDO code [5] constrained by empirical spectroscopic factors for 2f7/2, 3p3/2, and 3p1/2 states in odd A=125-133 Sn isotopes. The deduced DSD cross sections are significantly smaller than previous estimates [6]. Below ^{132}Sn, the role of statistical neutron capture, modeled in the Hauser-Feshbach framework, is expected to become increasingly important. To determine this component of the (n,γ) cross section requires a surrogate, for example the (d,pγ), reaction with exotic beams. The current collaboration has commissioned the Gammasphere-ORRUBA Dual Detectors for Experimental Structure Studies (GODDESS) with the capability to measure inverse kinematics (d,pγ) reactions and validating this reaction as a surrogate for (n,γ).

The present contribution would present the DSD results from the Sn(d,p) campaign and the status of the efforts to develop a valid surrogate for statistical neutron capture on short-lived nuclei.

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