Contribution ID: **34** Type: **Invited Presentation**

Informing Neutron Capture on Tin Isotopes in r-process Freeze Out

Tuesday, 30 May 2017 17:50 (15 minutes)

About half of the elements heavier than iron are formed in rapid neutron capture, r-process nucleosynthesis. Mumpower, Surman, McLaughlin, and Aprahamian [1] have identified unknown nuclear observables that can significantly impact final abundances and could also help to constrain the site of the r process. One of these observables are neutron capture rates at late times, freeze-out, in an r-process event, in particular on the N<82 isotopes of tin. To determine spectroscopic strengths and inform neutron capture rates, the (d,p) reactions were measured in inverse kinematics with radioactive 126,128,130,132Sn and stable 124Sn beams at the Holifield Radioactive Ion Beam Facility. Reaction protons were measured with SuperORRUBA highly segmented silicon strip detectors. The experimental differential cross sections were analyzed in the Finite-Range ADiabatic Wave Approximation framework [2] with Koning-Delaroche global optical model parameters to deduce neutron spectroscopic factors that were then used to calculate the direct-semi-direct (DSD) neutron capture cross sections with the CUPIDO code [3]. The present DSD cross sections are lower than those calculated by Chiba et al. [4] before the excitation energies and spectroscopic factors of 1/2- and 3/2- states in neutron-rich Sn isotopes had been measured, and significantly lower than the (n,γ) cross sections from statistical processes expected for N<82 tin isotopes. To understand the statistical contribution to the (n,γ) rate requires a valid surrogate and techniques that can exploit radioactive ion beams. The (d,pγ) reaction has recently been validated as such a surrogate [5] and the Gammasphere-ORRUBA setup [6] is well-suited for such measurements in inverse kinematics. The present talk would present the DSD results for neutron-rich Sn isotopes and the prospects for deducing the statistical component of neutron capture near the r-process path.
This work by the ORRUBA collaboration is in supported in part by the U.S. Department of Energy and National Science Foundation.
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Session Classification: Breakout 1