Simulation of Statistical Neutron Capture Processes Using Monte Carlo Methods with TALYS

DREW D. DYCUS, Tenn. Tech. Univ., MICHAEL BERTOLLI, MICHAEL S. SMITH, ORNL, RAYMOND L. KOZUB, Tenn. Tech. Univ. — The rapid neutron capture process (r-process) is thought to be responsible for the synthesis of about half of the nuclear species heavier than Fe. Calculations for the r-process suggest the $^{130}$Sn($n,\gamma$)$^{131}$Sn reaction rate plays a pivotal role in nucleosynthesis, engendering global effects on isotopic abundances over a wide mass range during the freeze-out epoch following ($n,\gamma$) $\leftrightarrow$ ($\gamma, n$) equilibrium. This is owing, in part, to the long $\beta$-decay lifetime of $^{130}$Sn (162 s). Direct neutron capture (DC) is likely the dominant reaction at late times in the r-process near the $N=82$ closed shell, but the reaction rate and nucleosynthesis calculations require ($n,\gamma$) cross sections for both DC and statistical capture. The latter depend heavily on the level density, and that is not yet well established for $^{131}$Sn. In order to acquire better estimates of the statistical contribution in the doubly magic $^{132}$Sn region, we have undertaken Monte Carlo methods of varying the nuclear reaction model parameters to calculate ($n,\gamma$) cross sections for a range of incident neutron energies using the code TALYS. Results will be presented. Research supported by the U. S. Department of Energy.

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Date submitted: 23 Jul 2014

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