Joint Nuclear and Astrophysics Seminar

When: Friday November 8th at 12.00PM
Where: Room 228 Cyclotron Institute
Speakers: Sunghoon Ahn and Terese T. Hansen

Study of the direct neutron capture cross section on ^{80}Ge

The rapid neutron capture process (r-process) occurs in astrophysical environments with exceedingly high temperatures ($>$ 1 GK) and neutron densities ($> 10^{22}/\mathrm{cm}^3$) such as neutron star mergers. It is also known as the source of roughly half of the elements heavier than iron. During r-process freeze-out, the temperature drops and the $(n,\gamma)-(\gamma,n)$ equilibrium breaks. Neutron capture reactions on abundant nuclei can significantly alter the number of free neutrons, affecting the final abundances of hundreds of nuclei. Sensitivity studies by R. Surman *et al.* demonstrated that this effect at the $A = 80$ peak in the solar abundance pattern occurs on select nuclei around neutron closed shells, including ^{80}Ge. The ^{80}Ge(n,γ) rate was shown to have a significant impact on final abundances with more than twice the impact of either the ^{82}Ge(n,γ) or ^{84}Se(n,γ) reaction rates. It has not been possible to estimate the direct (n,γ) rate on ^{80}Ge with any level of confidence because the spin assignments and spectroscopic strengths of low-lying ^{81}Ge levels were unknown. The low-lying levels of the $N = 49$ nucleus ^{81}Ge have been studied by measuring the ^{80}Ge(d,p)^{81}Ge neutron transfer reaction at 310 MeV (3.875 MeV/u) in inverse kinematics at the Holifield Radioactive Ion Beam Facility at Oak Ridge National Laboratory. Newly-measured spins and spectroscopic factors of low-lying states of ^{81}Ge are determined, and the neutron-capture cross section on ^{80}Ge was calculated in a direct-semi-direct model to provide a more realistic (n,γ) reaction rate for r-process simulations. Details of the experimental setup and interpretation of the data analysis will be discussed.

The R-Process Alliance - a new search for r-process enhanced stars

A small fraction (5%) of metal-poor stars show large enhancement in r-process elements. These stars are excellent laboratories for studying the r-process as the gas from which these stars formed was polluted by at most a few enrichment events — perhaps even a single explosion. However, many of the currently known r-process enhanced stars are faint, impeding a detailed abundance analysis. A full abundance pattern for these stars is needed to disentangle nucleosynthesis signatures from different r-process element production sites. I will report on recent results from the R-Process Alliance (RPA), a new effort to uncover bright metal-poor halo stars with r-process element enhancements. The RPA has already identified >30 new r-II stars, increasing the number of known r-II stars by alomost 100%. This sample includes the brightest, most metal-rich, and most Uranium enhanced r-II stars discovered to date.