Constraining the conditions for r-process nucleosynthesis via nuclear measurements at CARIBU

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The r-process, a series of rapid neutron-capture reactions in cataclysmic astrophysical events such as neutron star mergers, is responsible for the creation of roughly half of the heavy nuclei in our universe. The conditions present in these events are such that neutron-capture reactions occur on a time scale much shorter than the lifetime of the nuclei involved and the process therefore proceeds mainly through reactions on short-lived very neutron-rich nuclei, most of which having never been observed in the laboratory. Sensitivity studies [1] have looked at various scenarios for the r-process conditions and identified nuclei whose basic properties would have the largest impact on the distribution of produced nuclei. At ANL, a program centered around the ATLAS facility is aimed at improving access to these nuclei and has developed tools to measure the most critical quantities to constrain r-process scenarios.
The talk will discuss the basic nuclear physics inputs required to understand the r-process and will present the CARIBU upgrade of ATLAS that is now providing access to some key nuclei along the r-process path. Recent measurements [2] on nuclei around the N=82 and rare-earth r-process abundance peaks, focusing on Penning trap mass measurements on very exotic isotopes obtained via a new more sensitive cyclotron frequency detection method, will be discussed. Finally, a new facility, the N=126 factory, aimed at providing access to nuclei important for the formation of the heaviest r-process abundance peak, will be presented.
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[2] R. Orford et al, Phys. Rev. Lett. **120**, 262702 (2018).