Reverse engineering the properties of neutron-rich lanthanides using the r-process rare-earth abundance peak

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The recent observations of the GW170817 electromagnetic counterpart suggest lanthanides were produced in this neutron star merger event. Lanthanide production in heavy element nucleosynthesis is subject to large uncertainties from nuclear physics and astrophysics unknowns. Specifically, the rare-earth abundance peak, a feature of enhanced lanthanide production at $A \sim 164$ seen in the solar r-process residuals, is not robustly produced in r-process calculations when astrophysical and nuclear physics inputs are varied. The proposed dynamical mechanism of peak formation requires the r-process path to encounter a nuclear deformation maximum or sub-shell closure in the rare-earth region which may be within reach of nuclear physics experiments performed at, for example, the CPT at CARIBU and the upcoming FRIB. To maximize what can be learned regarding nucleosynthesis from such precision measurements, we employ Markov Chain Monte Carlo studies to ”reverse engineer” the nuclear masses capable of producing a peak compatible with the observed solar r-process abundances given different sets of astrophysical conditions. Here I will present the latest results for the masses found to produce the rare-earth peak in a low entropy accretion disk wind scenario and compare directly with recent mass measurements from the CPT at CARIBU. Such collaborative efforts between theory and experiment could soon be in a position to make definitive statements regarding the mechanism of rare-earth peak formation and thus the astrophysical site of the r process.