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Predicting Neutron Capture Cross Sections from Nuclear Masses: implications for r-process Nucleosynthesis

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A growing body of work has shown that individual neutron capture cross sections play an important role in the final isotopic abundances from a wide range of possible astrophysical scenarios, including wind ejecta from neutron star mergers. Unfortunately, the isotopes which seem to show the greatest impact are far from stability and not within experimental reach for direct measurements in the coming years. While indirect techniques are actively being developed to improve the state of the art, there is still a heavy reliance on Hauser Feshbach reaction theories, whose predictions quickly diverge by more than a factor of ten off stability. Motivated by this, we have recently discovered a previously unrecognized correlation between the neutron capture cross-section and the two-neutron separation energy. This offers several exciting possibilities. First, by parameterizing this simple correlation, we have been able to provide a new set of cross section predictions that can be used for nucleosynthesis studies. Second, because two-neutron separation energies can be measured with achievable rare beam intensities, the quality and quantity of S_2n data is far more reaching than what is available for neutron capture, allowing experimentally based extrapolations. Finally, this may offer hints into where traditional reaction theories have missed underlying physics that is needed to more accurately model the capture reaction process. We will present the discovered correlations as well as results from initial studies of the impact the deduced cross sections would have on r-process scenarios.

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