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(I) Using statistical methods to determine the astrophysical origins of heavy nuclei

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For more than 60 years the solar isotopic abundances have been providing clues to the astrophysical origins of elements such as the heavy species formed by the rapid neutron capture process (r-process). Although the era of multi-messenger astronomy presents new opportunities to probe single r-process events, the solar abundances still serve as the key informant of the contributions of a given site to the enrichment of the Solar System. To assess the dominant source of heavy r-process elements in a modern way, statistical methods offer a fresh and innovative approach. We apply such techniques to the r-process rare-earth abundance peak due to its high sensitivity to the nuclear properties of lanthanides as well as the astrophysical environment. I will describe recent results which derive the masses capable of forming the rare-earth peak in accretion disk winds as well as neutron star merger dynamical ejecta. I will also discuss how the latest precision measurements and upcoming experiments are in a prime position to illuminate key nuclear properties which affect these studies.

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