

Actinide-Rich or Actinide-Poor, Same r -Process Progenitor

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The astrophysical production site of the heaviest elements in the universe remains a mystery. Incorporating heavy element signatures of metal-poor, r -process enhanced stars into theoretical studies of r -process production can offer crucial constraints on the origin of heavy elements. We apply the “Actinide-Dilution with Matching” model to a variety of stellar groups ranging from actinide-deficient to actinide-enhanced to empirically characterize r -process ejecta mass as a function of electron fraction (Y_e). We find that actinide-boost stars do not indicate the need for a unique and separate r -process progenitor. Rather, small variations of neutron richness within the same type of r -process event can account for all observed levels of actinide enhancements. The very low- Y_e , fission-cycling ejecta of an r -process event need only constitute 10–30% of the total ejecta mass to accommodate most actinide abundances of metal-poor stars. We find that our empirical Y_e distributions of ejecta are similar to those inferred from studies of GW170817 mass ejecta ratios, which is consistent with neutron-star mergers being a source of the heavy elements in metal-poor, r -process enhanced stars.