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r-Process Radioisotopes from Near-earth Supernovae and Kilonovae

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The astrophysical sites where r-process elements are synthesized remain mysterious: it is clear that neutron star mergers (kilonovae, KNe) contribute, and some classes of core-collapse supernovae (SNe) are also possible sources of at least the lighter r-process species. The discovery of 60Fe on the Earth and Moon implies that one or more astrophysical explosions have occurred near the Earth within the last few Million years (Myr), probably SNe. Intriguingly, 244Pu has recently been discovered in deep-sea deposits spanning the past 10 Myr, a period that includes two 60Fe pulses from nearby supernovae. 244Pu is among the heaviest r-process products, and we consider whether it was created in the supernovae, which is disfavored by nucleosynthesis simulations, or in an earlier kilonova event that seeded 244Pu in the nearby interstellar medium that was subsequently swept up by the supernova debris. Accelerator mass spectrometry (AMS) measurements of 244Pu and searches for other live isotopes could probe the origins of the r-process and the history of the solar neighborhood, including triggers for mass extinctions, e.g., that at the end of the Devonian epoch, motivating the calculations of the abundances of live r-process radioisotopes produced in SNe and KNe that we present here. Given the presence of 244Pu, other r-process species such as 93Zr, 107Pd, 129I, 135Cs, 182Hf, 236U, 237Np, and 247Cm should be present. Their abundances and well-resolved time histories could distinguish between the SN and KN scenarios, and we discuss prospects for their detection in deep-ocean deposits and the lunar regolith samples returned to Earth by missions such as *Chang'e* and *Artemis*.

Student Submission

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