

r-Process Radioisotopes from Near-Earth Supernovae and Kilonovae

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 ^{60}Fe 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, ^{244}Pu has now been detected, mostly overlapping with ^{60}Fe pulses. However, the ^{244}Pu flux may extend to before 12Myr ago, pointing to a different origin. Motivated by these observations and difficulties for *r*-process nucleosynthesis in SN models, we propose that ejecta from a KN enriched the giant molecular cloud that gave rise to the Local Bubble where the Sun resides. Accelerator Mass Spectrometry (AMS) measurements of ^{244}Pu 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., 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 ^{244}Pu , other *r*-process species such as ^{93}Zr , ^{107}Pd , ^{129}I , ^{135}Cs , ^{182}Hf , ^{236}U , ^{237}Np and ^{247}Cm should be present. Their abundances and well-resolved time histories could distinguish between SN and KN scenarios, and we discuss prospects for their detection in deep-ocean deposits and lunar regolith. We show that AMS ^{129}I measurements in Fe-Mn crusts already constrain a possible nearby KN scenario. Thus, we urge searches for *r*-process radioisotopes in deep-ocean Fe-Mn crusts, and in the lunar regolith samples brought to Earth recently by the Chang'e-5 lunar mission and upcoming missions including Artemis.

Length of presentation requested

Oral presentation: 17 min + 3 min questions

Please select between one and three keywords related to your abstract

Nucleosynthesis

2nd keyword (optional)

Stellar explosions and mergers - theory

3rd keyword (optional)

Nuclear physics - experimental

Primary authors: WANG, Xilu (Institute of High Energy Physics, Chinese Academy of Sciences); CLARK, Adam; ELLIS, John (CERN); ERTEL, Adrienne; FIELDS, Brian (University of Illinois); FRY, Brian; LIU, Zheng-hai; MILLER, Jesse; SURMAN, Rebecca (University of Notre Dame)

Presenter: WANG, Xilu (Institute of High Energy Physics, Chinese Academy of Sciences)