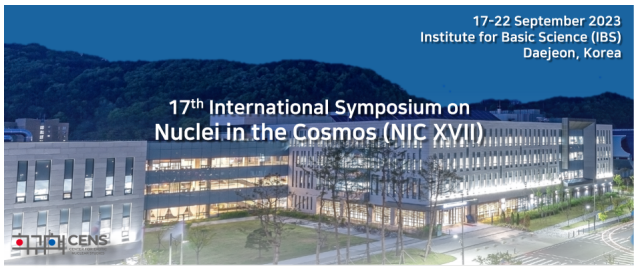

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Retrospective r process and supernova signatures in deep-sea archives

Tuesday, 19 September 2023 13:45 (30 minutes)

Half of the heavy elements are produced in r-process nucleosynthesis, which is exclusively responsible for actinide production, such as Pu-244 ($t_{1/2}$=81 Myr). The r-process requires an explosive scenario but is far from being fully understood; in particular, its sites and history.

The solar system moves through the interstellar medium (ISM) and collects interstellar dust particles that contain such signatures, including the radionuclides Fe-60 ($t_{1/2}$=2.6 Myr) and Pu-244. These nuclides are incorporated into terrestrial archives over millions of years and once recovered can be measured with Accelerator Mass Spectrometry (AMS) with high sensitivity.

Recent technical developments have seen an exceptional gain in measurement efficiency and sensitivity, in particular for actinides, including Pu-244. On the other hand, very large accelerators with >10 million volts allow for effective isobar separation using techniques derived from nuclear physics research. Such AMS systems are unique but required for the identification of small traces of interstellar Fe-60.

New data demonstrate a global Fe-60 influx and is evidence for exposure of Earth to recent (<10 Myr) supernova explosions. In addition, the recent finding in deep-sea archives of ISM-Pu-244, exclusively produced by the r-process, allows to link supernovae and r-process signatures. The low concentrations of Pu-244 measured in deep-sea archives suggest a low abundance of interstellar Pu and supports the hypothesis that the dominant actinide r-process nucleosynthesis is rare. However, the data allow some actinide production in supernovae while implying r-process contributions from additional sources.

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