Nuclear Physics Seminar

MONDAY

OCTOBER 19

4:00 P.M.

RM 124 NSH

Discovery of Supernova-produced ^{60}Fe in the Earth's Fossil Record

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Approximately 1.8 to 2.8 Myr before the present our planet was subjected to the debris of a supernova explosion. The terrestrial proxy for this event was the discovery of live atoms of ^{60}Fe in a deep-sea ferromanganese crust [1]. The signature of this supernova event should also reside in magnetite (Fe_3O_4) magnetofossils produced by magnetotactic bacteria [2], which live in the ocean sediments, extant at the time of the Earth-supernova interaction. We have conducted accelerator mass spectrometry (AMS) measurements, searching for live ^{60}Fe atoms in the magnetofossil component of Pacific Ocean sediment cores (ODP cores 848 and 851). We find a time-resolved ^{60}Fe signal in both sediment cores, above background, centered at approximately 2 Myr ago and spanning approximately 700 kyr duration (full width half maximum), which will require eventual astrophysical interpretation to understand.

The production of elements beyond Fe occurs partly in what is known as the "r-process". This process involves the rapid capture of neutrons on time scales of milliseconds, temperatures of GK and densities of 10^9 g/cm^3. The global physics of how the r-process works is largely understood; what is not known, however, is where in the universe it occurs. Candidate sites for the r-process are core collapse supernovae or binary neutron star mergers. The former is theoretically and observationally known to produce ^{60}Fe; the latter is theoretically expected to produce negligible amounts of ^{60}Fe. The heavy actinides, for example, are themselves r-process "only" nuclides; that is, they can only be made through the r-process. Present theoretical models favour r-process production in neutron star mergers over core collapse supernovae. Therefore, any future finding of a short-lived r-process "only" isotope in terrestrial reservoirs, coincident in time with the observed ^{60}Fe signal, would show that core collapse supernovae are at least one site, in our cosmos, in which the r-process occurs.

This talk is designed to be accessible to a broad audience.

[1] Knie et al., Phys. Rev. Lett. **93**, 171103 (2004).
[2] S. Bishop and R. Egli, Icarus **212**, 960 (2011).

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