"Strange" Oxygen in the Sun

Scientists from UMR and Grambling College discovered “strange” Xenon in meteorites over 30 years ago [*Nature* **240** (1972) 99-101]. In “strange” Xenon the heaviest xenon atom, Xenon-136, is about twice its normal abundance.

In 1976 Manuel and Sabu showed that “strange” Xenon accounts for about 7% of the Xenon-136 in the Sun [*Nature* **262** (1976) 28-32], and in 1998 a team of undergraduate UMR students used data from the Galileo mission to Jupiter to show that “strange” Xenon is dominant in the outer regions of the solar system [*Journal of Radioanalytical and Nuclear Chemistry* **238** (1998) 119-121]

Xenon-136 is made by rapid neutron capture in a supernova. The idea of the early solar system containing enough supernova debris to alter the composition of the bulk Sun (or a massive planet like Jupiter) has remained unpopular.

However, in the latest issue of *Nature* [vol. **434** (2005) pp. 619-622], scientists at Osaka University in Japan and the CNRS Research Facility in France report that at least 2.0% (±0.4%) of the Oxygen in the Sun is mono-isotopic Oxygen-16. When discovered in carbonaceous meteorites, it was suggested that excess Oxygen-16 “*may represent interstellar dust with a separate history of nucleosynthesis”* [*Science* **182** (1973) p. 485].

The Sun contains over 99.8% of the solar system and is 330 times more massive than the Earth. Thus the “deficit” of Oxygen-16 on Earth might indicate that our planet itself is “alien”, like the interstellar grains imagined to have carried “strange” stellar debris into an otherwise homogeneous cloud of material that was about to form the solar system.

It seems doubtful, however, that either object is “alien”. Oxygen in the Sun and in the Earth is intermediate to that seen in the meteorites that formed at the birth of the solar system, as shown below where the objects are arranged in order of increasing Oxygen-16.

Least Oxygen-16	1. Type L & LL Ordinary Meteorites
More Oxygen-16	2. Type H Ordinary Meteorites
More Oxygen-16	3. Earth, Moon & Differentiated Meteorites
More Oxygen-16	4. Ureilite Meteorites
More Oxygen-16	5. Hydrous Matrix of Carbonaceous Meteorites
More Oxygen-16	6. The Sun
Most Oxygen-16	7. Anhydrous Phase of Carbonaceous Meteorites

The new data on Oxygen-16 in the Sun agree with Manuel and Sabu’s conclusion that poorly mixed supernova debris formed the Sun, the meteorites, and all the planets [*Science***195** (1977) 208-209]. Oxygen in different regions of the supernova contained different amounts of Oxygen-16, an unusually stable nuclear species made by fusing Helium with Carbon. In a similar fashion, rapid neutron-capture generated different levels of Xenon-136 in the Xenon made in various parts of the supernova.

The latest *Nature* paper suggests that unknown reactions produced O-16 in *"the solar accretion disk"*. The authors note that irradiation with ultraviolet light might have increased the level of O-16 in the solar accretion disk. However, this seems unlikely. Irradiation with ultraviolet light does not make atoms of Oxygen-16. It separates Oxygen atoms, making one region rich in Oxygen-16 by depleting Oxygen-16 in another region.

Nuclear fusion reactions in the supernova that gave birth to the solar system [*Science* **195** (1977) 208-209] seem to be a more likely way to produce excess O-16 in the bulk Sun, because:

a) O-16 is characterized by unusually high nuclear stability;
b) O-16 is commonly seen in meteorites with other "strange" elements made by nuclear reactions in the star that gave birth to the solar system,;
c) Levels of O-16 in meteorites bracket those seen in the Earth and the Sun; and
d) Other scientists have recently agreed that "strange" Xenon from stellar nuclear reactions may comprise as much as 8% of the Xenon-136 in the Sun [*Geochim. Cosmochim. Acta* **59** (1995) 4997-5022].

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