ISOTOPIC IMPRINTS OF SUPER-AGB STARS AND THEIR SUPERNOVAE IN THE SOLAR SYSTEM.

L. R. Nittler, Dept. of Terrestrial Magnetism, Carnegie Institution of Washington, 5241 Broad Branch Rd NW,
Washington DC 20015, USA (lnittler@ciw.edu)

Introduction: In studies of the origin of presolar grains and bulk nucleosynthetic isotopic anomalies in meteorites, little attention has been paid to the potential importance of stars in the mass range of ~8-10 solar masses. These stars lie in a middle-ground between low- and intermediate mass asymptotic giant branch (AGB) stars that end their lives as white dwarfs and massive stars whose cores burn all the way to Fe before collapsing and exploding as supernovae (SNII), leaving behind neutron stars or black holes. They evolve through a "super-AGB" phase, undergoing thousands of thermal pulses and losing most of their mass in strong winds [1]. However, their final fates (*e.g.,* as white dwarfs versus neutron stars following core-collapse supernovae) depend on highly uncertain physics and diagnostic observable signatures of both super-AGB stars and their possible supernovae are controversial [1, 2]. Here we discuss possible ways super-AGB stars and their supernovae may have left nucleosynthetic imprints in the solar system.

Super-AGB stars: Although most presolar SiC, silicate and oxide stardust grains are inferred to have originated in AGB stars [3], the isotopic signatures largely point to relatively low-mass (~1-3 $M_\odot$) progenitors. Until recently, intermediate-mass (4-8$M_\odot$) AGB stars have largely been ruled out as parent stars because their predicted O isotopic ratios are not observed. However, re-measurement of a key reaction rate has made such an origin plausible for Group 2 (^{18}O-depleted) presolar grains [4], albeit with the requirement of some mixing of the pure AGB component with isotopically normal material, perhaps from a binary companion. More recently, large ^{25}Mg excesses have been found in some Group 1 presolar silicates [5, 6], inconsistent with the low-mass AGB origin implied by these grains' O isotopes. Leitner and Hoppe [5] favored an origin for these grains in SNII undergoing explosive H-burning. However, hot bottom burning in super-AGB stars, especially those of lower-than-solar metallicity, also produces large ^{25}Mg/^{24}Mg ratios [7] and mixing of their ejecta with more normal material from a binary companion can quantitatively explain the isotopic data for such grains, similar to that proposed for Group 2 grains, providing an alternative possible origin.

Electron Capture Supernovae: ECSN may occur when the electron-degenerate ONeMg white dwarf core of a super-AGB star reaches a Chandrasekhar mass, and undergoes electron-captures on ^{20}Ne that lead ultimately to a thermonuclear runaway. Most studies have found that the nuclear burning results in the WD core collapsing to a neutron star, while ejecting newly synthesized neutron-rich isotopes. Several studies of nucleosynthesis in such core collapse (cc-)ECSN have found that n-rich isotopes of relevance to meteorite studies, including ^{48}Ca, ^{50}Ti, ^{54}Cr, ^{60}Fe, and light r-process isotopes may be produced [8-11]. Nittler et al. [12] suggested either high-density Type Ia supernovae [13] or ccECSN as a source of extreme ^{54}Cr and ^{50}Ti-enriched nano-sized presolar oxide grains from the Orgueil meteorite, as well as of the putative presolar carriers of ^{48}Ca anomalies. More recent studies have begun to investigate the possible existence of thermonuclear (t-)ECSN in which the nuclear energy generation occurs rapidly enough for the entire core to explode [2]. Jones et al. [14] recently showed that nucleosynthesis in a tECSN is similar to that previously found for high-density Type Ia SNe [13] and in fact, this work suggested that tECSN *are* the hypothesized high-density SNIa, for which hitherto there has been no astrophysical origin identified. The calculated tECSN nucleosynthesis provides an excellent match to the most extreme ^{54}Cr-rich grain of [12], as well as producing many other n-rich isotopes and important short-lived nuclides like ^{26}Al, ^{53}Mn, and ^{60}Fe. One advantage of tECSN over ccECSN for explaining the meteoritic data is they eject copious amounts of ^{16}O, facilitating the formation of oxide dust without requiring mixing with unburnt core material [15]. In any case, the lifetimes of super-AGB stars (15-25 Myr) is comparable to that of molecular clouds, suggesting the possibility of direct interaction between the ejecta of such stars (both during super-AGB winds and/or ECSN explosions) and the forming solar system, with potentially important implications for understanding the isotopic diversity of meteoritic materials and early solar system evolution.

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