HEAVY ELEMENT NUCLEOSYNTHESIS IN LOW METALLICITY, LOW MASS AGB STARS. A. M. Davis[1], R. Gallino[2], O. Straniero[3], I. Domínguez[4], M. Lugaro[5], [1]Enrico Fermi Institute and Department of the Geophysical Sciences, The University of Chicago, Chicago, IL 60637 (a-davis@uchicago.edu), [2]Dipartimento di Fisica Generale dell'Universitá di Torino and INFN, Sezione di Torino, Via P. Giuria 1, I-10125 Torino, Italy, [3]Osservatorio Astronomico di Collurania, I-64100 Teramo, Italy, [4]Dpto. de Física Teoríca y del Cosmos, Universidad de Granada, 18071 Granada, Spain, [5]Institute of Astronomy, Cambridge University, Madingley Road, Cambridge CB3 0HA, United Kingdom.

Introduction: The most common type of presolar SiC grains, the mainstream grains, have silicon isotopic compositions that plot on a δ^{29}Si vs. δ^{30}Si diagram along a line of slope 1.3 passing though the origin and extending to δ^{29}Si = 200‰. Grains of Type Y and Z lie to the right of the mainstream array by as much as several hundred ‰. Neutron capture nucleosynthesis in AGB stars tends to enrich silicon isotopic compositions in ^{30}Si, but only by a few tens of ‰ in solar metallicity AGB stars, where mainstream grains are believed to have formed. At low metallicity, ^{30}Si is much more strongly enhanced and it has been suggested that Type Y and Z grains come from low metallicity AGB stars [1,2]. Lugaro et al. [3] have recently summarized predictions from *s*-process nucleosynthesis calculations for solar metallicity AGB stellar models and compared them with measurements on single mainstream presolar SiC grains and SiC aggregates for strontium, zirconium, molybdenum and barium. Here, we have extended these calculations to low metallicity AGB stars in order to predict what isotope anomalies might be found in Type Y and Z SiC grains.

Nucleosynthesis calculations: *s*-Process nucleosynthesis occurs in the helium intershell in low mass AGB stars. There are two neutron sources: (1) ^{13}C(α,n)^{16}O, which provides a large-fluence, low-flux irradiation during the interpulse periods; and (2) ^{22}Ne(α,n)^{25}Mg, which provides a low-fluence, high-flux irradiation during thermal pulses [3]. Freshly produced *s*-process material is dredged up and mixed into the stellar envelope following each thermal pulse. An important difference between solar and low metallicity AGB stars is that in the low metallicity ones, both neutron sources take on increasing importance, since the number of seeds for the *s*-process is decreases with metallicity, but the amount of ^{13}C and most of the ^{22}Ne are independent of metallicity. Following [3] we consider a range of amounts of ^{13}C in the intershell. For each element considered we compare for a 3 solar mass star models of solar (Z=0.02) and one-sixth solar (Z=0.003) metallicity. For each choice of ^{13}C pocket amount, a line connecting results for successive thermal pulses with dredge-up is plotted. Points are plotted along this line when the C/O ratio of the envelope exceeds 1 and SiC can condense.

Strontium. Going from Z=0.02 to Z=0.003 dramatically changes predicted strontium isotopic compositions. In particular, large negative δ^{87}Sr values of –350‰ are predicted, as are large excesses in δ^{88}Sr. The largest excesses of δ^{88}Sr actually occur at intermediate δ^{84}Sr values.

Zirconium. There are a number of interesting differences between the solar and low metallicity cases. At low metallicity, large excesses of ^{96}Zr are made because of the activation of the neutron capture channel at the ^{95}Zr branch [3]. In addition, deficits in ^{90}Zr even larger than those for solar metallicity are predicted, along with large excesses in ^{91}Zr and ^{92}Zr.

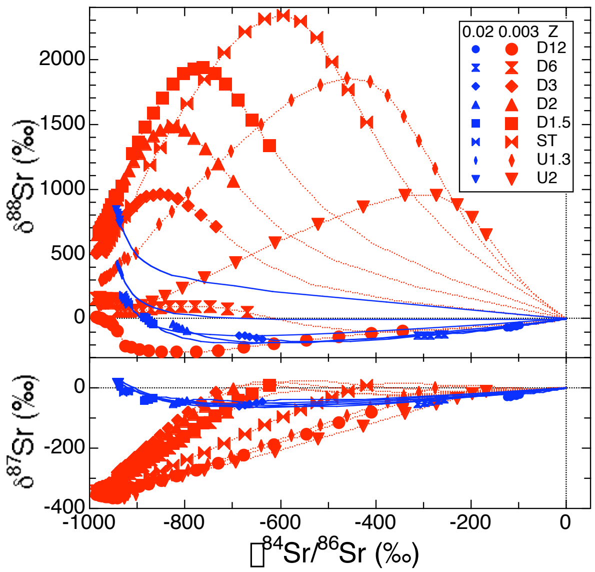
Molybdenum. Molybdenum isotopic compositions are not as strongly affected by branches in the *s*-process path as strontium and molybdenum, so the differences between solar and low metallicity calculations are not so dramatic. Compared to mainstream grains, we would expect SiC grains from low metallicity stars to be somewhat higher in ^{97}Mo and ^{98}Mo.

Barium. Lowering metallicity has dramatic effects on barium isotopic composition. Compared to mainstream grains, SiC grains from low metallicity AGB stars would be predicted to have a slightly wider variation in δ^{134}Ba, much higher δ^{137}Ba and a much wider variation in δ^{138}Ba.

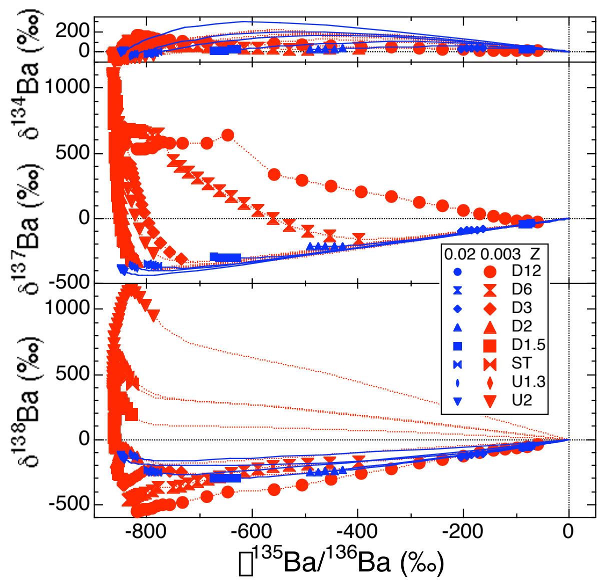
Calcium. The much stronger ^{22}Ne exposure in low metallicity AGB stars leads to a dramatic effect in calcium, in which a large enhancement in ^{46}Ca is produced, by a factor of 100. Despite the low abundance of ^{46}Ca, such a measurement might be feasible, as the ^{46}Ca/^{40}Ca ratio could be as high as 0.005 in a grain from a one-sixth solar metallicity AGB star.

Conclusions: Lowering metallicity has dramatic effects on the predicted isotopic compositions of a number of elements in SiC grains from such stars. The most diagnostic elements for a low-metallicity origin are Zr and Sr.

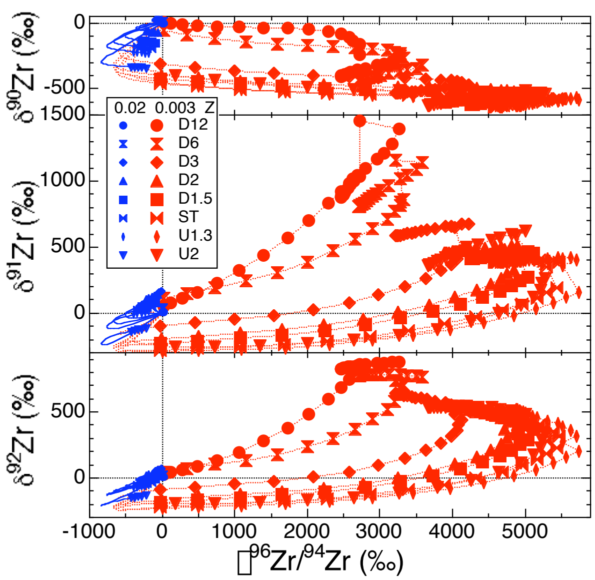
References: [1] Amari S. et al. (2001) *ApJ*, *546*, 248. [2] Hoppe P. et al. (1997) *ApJ*, *487*, L101. [3] Lugaro M. et al. (2003) *ApJ,* in press.



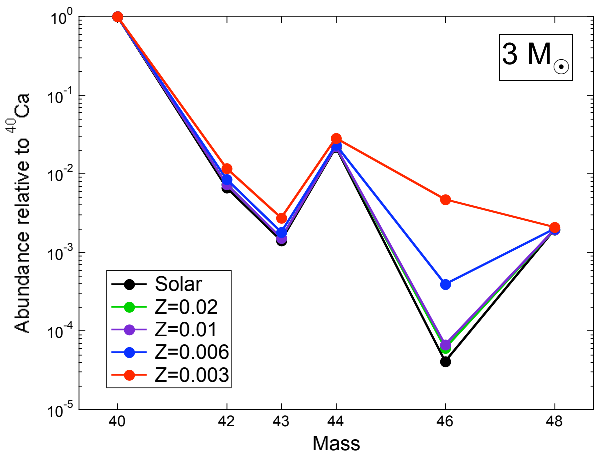
δ88Sr (‰)
δ87Sr (‰)
□84Sr/86Sr (‰)
0.02 0.003 Z
D12
D6
D3
D2
D1.5
ST
U1.3
U2



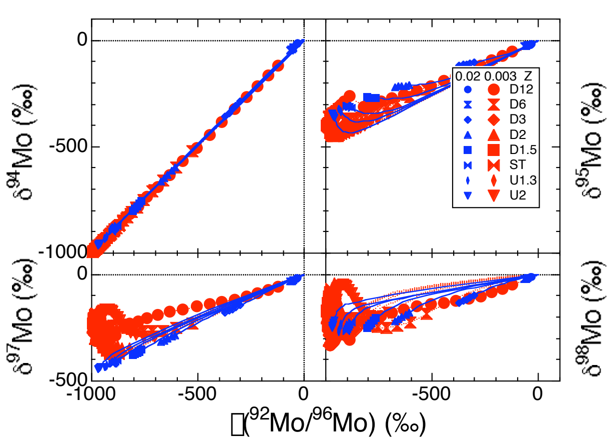
δ134Ba (‰)
δ137Ba (‰)
δ138Ba (‰)
□135Ba/136Ba (‰)
0.02 0.003 Z
D12
D6
D3
D2
D1.5
ST
U1.3
U2



δ90Zr (‰)
δ91Zr (‰)
δ92Zr (‰)
□96Zr/94Zr (‰)
0.02 0.003 Z
D12
D6
D3
D2
D1.5
ST
U1.3
U2



3 M☉
Abundance relative to 40Ca
Mass
Solar
Z=0.02
Z=0.01
Z=0.006
Z=0.003



δ94Mo (‰)
δ95Mo (‰)
δ97Mo (‰)
δ98Mo (‰)
□(92Mo/96Mo) (‰)
0.02 0.003 Z
D12
D6
D3
D2
D1.5
ST
U1.3
U2