Si AND C ISOTOPIC RATIOS IN AGB STARS: SiC GRAIN DATA, MODELS, AND THE GALACTIC EVOLUTION OF THE Si ISOTOPES.

E. Zinner[1], L. R. Nittler[2], R. Gallino[3,7], A. I. Karakas[4], M. Lugaro[5], O. Straniero[6], J. C. Lattanzio[7]. [1]Washington University, St. Louis, MO 63130, USA, ekz@wustl.edu. [2]Carnegie Institution of Washington, NW Washington DC, 20015, USA. [3]Università di Torino, Italy. [4]McMaster University, Hamilton, ON, L8S 4M1, Canada. [5]University of Utrecht, 3508 TA Utrecht, The Netherlands. [6]INAF, Osservatorio Astronomico di Teramo, Italy. [7]Monash University, Victoria 3800, Australia.

Presolar grains of the mainstream, Y and Z type are believed to have an origin in carbon stars. We compared the C and Si isotopic ratios of these grains [1] with the results of theoretical models for the envelope compositions of AGB stars. Two sets of models (FRANEC, Monash) use a range of stellar masses (1.5 to $5M_\odot$), metallicities, different prescriptions for mass loss, and two sets of neutron-capture cross sections for the Si isotopes [2, 3]. They predict that the shifts in Si isotopic ratios and the increase of $^{12}C/^{13}C$ in the envelope during third dredge-up are higher for higher stellar mass, lower metallicity, and lower mass loss rate. The Guber et al. [3] cross sections result in larger shift in the $^{30}Si/^{28}Si$ ratios and smaller shifts in the $^{29}Si/^{28}Si$ ratios than the Bao et al. [2] cross sections. Because the ^{22}Ne neutron source dominates Si nucleosynthesis, the effect of the ^{13}C source is negligible.

Comparison of the model predictions with grain data confirms an AGB origin for mainstream, Y, and Z grains, with the first type coming from stars with solar metallicity [4], the rest from stars with lower-than-solar metallicity [1, 5, 6]. The Si isotopic ratios of the Z grains favor the more recent Guber et al. [3] cross sections. The $^{12}C/^{13}C$ ratios of low-metallicity models are much higher than those found in Z grains and cool bottom processing [7] must be invoked to explain the grains' C isotopic ratios. The high predicted C/O ratios in low-metallicity stars not experiencing this process might have prevented the formation of SiC and led to the condensation of graphite instead [8]. By combining Z grain Si data with the models we determined the evolution of the $^{29}Si/^{28}Si$ ratios in the Galaxy as function of metallicity Z (Fig. 1). At Z<0.01 this ratio rises much faster than current Galactic evolution models [9] predict and suggest an early source of the heavy Si isotopes not considered in these models, which are mainly based on Type II supernova nucleosynthesis.

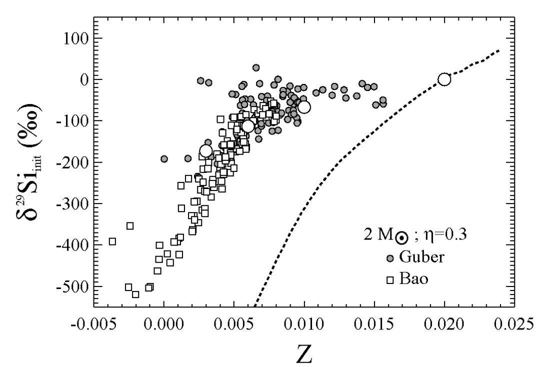

Figure 1. Predicted evolution of $^{29}Si/^{28}Si$ as function of metallicity based on Z grains and the FRANEC models of a $2M_\odot$ star with Reimers mass loss η of 0.3 and two sets of Si cross sections. This evolution is compared with the GCE model of Timmes and Clayton [9] (dotted line). The large open circles are the ratios assumed in our theoretical models.

References: [1] Nittler L. R. and Alexander C. M. O'D. 2003. *GCA* 67, 4961. [2] Bao Z. Y. *et al.* 2000. *Nucl. Data Tables* 76, 70. [3] Guber K. H. *et al.* 2003. *Phys. Rev. C* 67, 062802-1. [4] Hoppe P. and Ott U. 1997. In *Astrophysical Implications of the Laboratory Study of Presolar Materials,* (T. J. Bernatowicz and E. Zinner, eds.) 27. AIP, New York. [5] Hoppe P. *et al.* 1997. *ApJ.* 487, L101. [6] Amari S. *et al.* 2001. *ApJ.* 546, 248. [7] Nollett K. M. *et al.* 2003. *ApJ.* 582, 1036. [8] Jadhav M. *et al.* 2006. *New Astron. Rev.* in press. [9] Timmes F. X. and Clayton D. D. 1996. *Astrophys. J.* 472, 723.