REVIEW OF AGB STARS AS POSSIBLE SOURCES OF SHORT LIVED NUCLEI IN THE EARLY SOLAR SYSTEM. G.J.Wasserburg, Lunatic Asylum, Divn. of Geological & Planetary Science, Pasadena, CA 91125 (gjw@gps.caltech.edu)

Introduction: The evolution of low & intermediate mass stars is reasonably established. In general, their outer envelopes are well mixed so that output from a single zone results in a change of the bulk outer envelope. The only major uncertainty lies in the fundamental understanding of the “carbon pocket” that is responsible for the neutrons required for the s-processes. Observational evidence on stars unambiguously requires their presence (eg 13C/12C). In contrast, the “r-processes” are properly inferred to occur in more massive stars. However, there have not been any proposed mechanism to produce the necessary great abundance of neutrons in a SNe explosion that can be justified physically (the He freeze out & low entropy). A recent breakthrough by Banerjee, Qian & Haxton (1) has shown that a “slow-blow” scenario (10–20 s.) can successfully produce the r-nuclei for [Fe/H]<–3. This appears to be a physically possible process, but no possible solution for more Fe rich domains has been found. No direct observational results on SNe provide information on the presence of the required neutron source. The r-processes must exist, but predictions of their true “r” yields is dependent only on abundance data from stones, observations of the atmospheres of low mass stars at low [Fe/H], and the parametric modeling of neutron flows on target nuclei that is presumed to occur in SNeII. This r-process modeling has been explored extensively by many groups using models with an assumed neutron supply, imbedded in a hypothetical stellar source. In contrast, the direct nuclear products (no super extra neutrons) of a SNe explosion are well understood. The results are somewhat complex if one considers ejecta from different zones in an explosion. The bulk yields are less complex, but are dependent on the stellar mass, as is the case for low mass stars (1.5–2Msol) & intermediate mass stars (3-6Msol). Note that the low mass stars are focused on as they would have time scales long enough to contribute to the ISM at the time the solar system formed. The intermediate mass stars and SNe can contribute both relatively early & late, depending on the local star formation rate. A model that gave firm predictions for more than one short lived species would be an advance over the ad hoc choice of a source for each isotope. The yields of ^{26}Al for core collapse SNe typically give ^{26}Al/^{27}Al ~10^{-3}. Thus, to obtain the canonical value of 5×10^{-5}, about 5% of many stable nuclei derived from a late SNeII event would be required. The only element that exhibits such large effects is oxygen (R.N.Clayton et al 1973). This large oxygen effect does not appear to represent stellar nucleo-synthetic processes, but some other mechanism may be the cause. My focus on AGB sources is simply due to the fact that reliable predictions can be made of their yields. It is with the hope that well defined predictions for AGB stars could provide a basis for testing models of stellar sources of some short lived nuclei. If these simple models fail, then we have actually learned something! So far almost all detailed calculations with s processing have been carried out for low mass stars. The most significant results on intermediate mass stars (without s-processing) have been carried out by Karakas & Lattanzio (2) & Karakas (3). These results will be summarized with particular consideration of ^{60}Fe & ^{26}Al.

References: [1] P. Banerjee, Y.Z. Qian & W. C. Haxton (2011) Physical Review Letters, V106,2011. [2] R. N. Clayton, L Grossman,T.K. Mayeda Science, 182,485 (1973) . [3] A. Karakas & J. Lattanzio , Pub. Of the Astronomical Soc. Of Australia 2007, 24, 103. [4] A. Karakas, MNRAS, V403, Issue 3, 1413.