The Joint Institute for Nuclear Astrophysics

New Examination of ^{44}Ti and ^{56}Ni from Core-collapse Sn

Aimee Hungerford, Chris Fryer, and Frank Timmes (all at LANL) have recently investigated the production of radioactive ^{44}Ti and ^{56}Ni from core-collapse supernovae models. Radioactive ^{44}Ti, an observable diagnostic of core-collapse supernovae, is an isotope of extraordinary astrophysical significance. Its primary observable effects are (1) the relatively large abundance of ^{44}Ca -- it is the second most abundant calcium isotope and the 44th most abundant species overall in solar system material--is overwhelmingly due to its synthesis as ^{44}Ti parent; (2) gamma rays from radioactive decay from young core collapse supernovae are visible in several Galactic remnants. Since the ^{44}Ti yield probes the dynamics of core collapse supernova nucleosynthesis, and in particular, the location of the proverbial "mass cut", the pre-supernova composition inside ~ 2 Msun, and the maximum temperature and density reached during the passage of the shock wave in the ejecta, this detection has generated great enthusiasm for; (3) ^{44}Ca-enriched silicon-carbide particles extracted from meteorites have been identified as presolar particles that condensed within supernova ejecta during their first few years of expansion, while ^{44}Ti was still at its initial value.

These grains may be of enormous value in probing the dynamics and make up of supernova ejecta. The presence of explosion asymmetries in supernovae alters both the extent of the hydrodynamically mixed regions, as well as the conditions for burning within the supernova shock. This serves to change both the distribution and abundance of the ejected elements. In these preliminary efforts, the trends in burning processes for a range of physical conditions which exist in core-collapse supernova simulations are examined with a detail parametertized nuclear reaction network. Additional intuition built up from 1D explosion simulations are then compared against preliminary results from 3D explosion simulations.

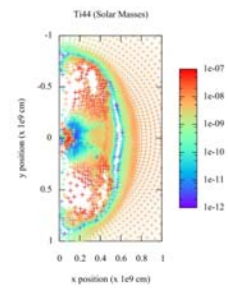

Figure 1

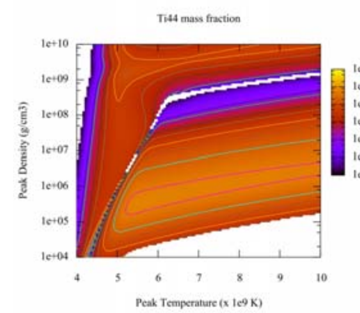

Figure 2

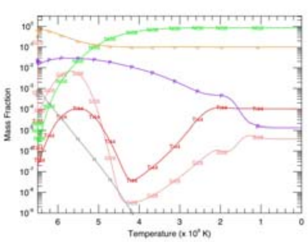

Figure 3

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