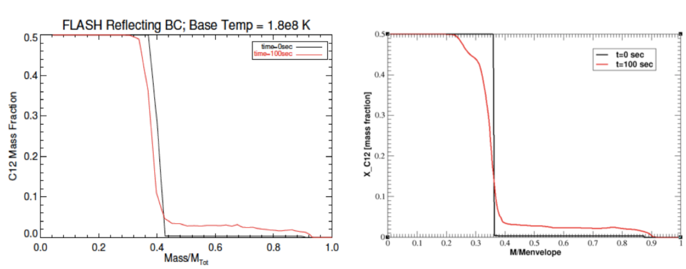
The Joint Institute for Nuclear Astrophysics

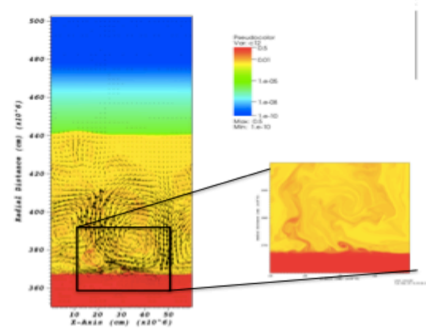
Title: Sub Chandrasekhar He detonations models for SNIa – How to solve the outer composition problem ?

We re-examine the scenario of detonations in helium layers, accreted on carbon-oxygen (CO) sub Chandrasekhar cores as models for SNIa. A major drawback of pure helium detonations is the fact that usually the burning goes all the way to ^{56}Ni, and there is no evidence for intermediate mass elements in the emerging spectrum. A possible way to generate a composition of ejecta dominated by intermediate mass elements is to ignite the detonation in a mixture of helium and carbon (or CO). For the relevant temperatures we obtain, the triple alpha reaction is slow compared to alpha capture on carbon. Therefore, any pre existing ^{12}C will tend to capture the free alpha particles. It follows that, if there are sufficient carbon nuclei present at the onset of burning, the end products can be calculated by a straightforward argument. Carbon enrichment of the helium envelope can take place if there is dredge up mixing at the bottom of the envelope prior to the ignition of the detonation. Preliminary 1D models show that the helium envelope is indeed unstable to convection many days before the runaway. We map a 1D model of 1 solar mass CO core that accreted 0.2 solar masses of helium prior to detonation to multidimensional hydro solvers (FLASH and VULCAN) at several stages prior to the runaway and examine the amount of mixing. The results we have up to now are promising. The predicted amounts of mixing depend strongly on the helium-burning rate. The prediction of both, the FLASH and the VULCAN solver are consistent with each other.

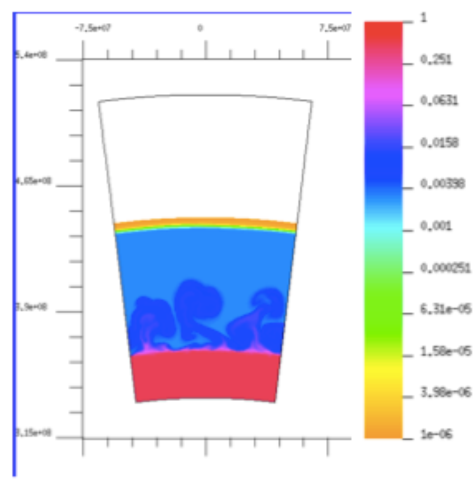


Caption: For the case of an underlying carbon/oxygen white dwarf overlain by an accreted helium shell, we show the resulting level of carbon enrichment of the helium shell achieved by outward mixing from the underlying carbon-oxygen core - as a function of the mass coordinate - at t=100 sec. [left panel – FLASH ; right panel – VULCAN]

FLASH



VULCAN



Caption: The carbon abundances in the envelope 40 seconds after the mapping of the 1D model to the multi-D solvers. The mapping took place when the temperature at the base of the envelope was 1.8×10^{8} Kelvin.

Contact Information:
truran@nova.uchicago.edu

Researchers:
Yeunjin Kim, Ami S. Glasner and James W. Truran,