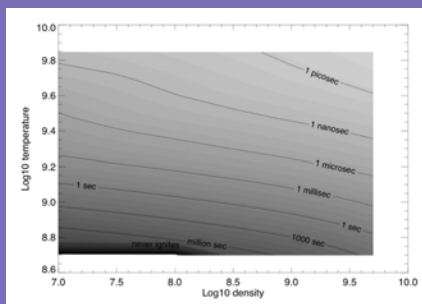
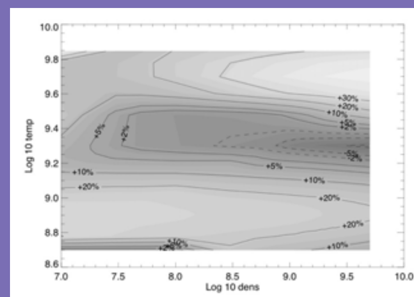
The Joint Institute for Nuclear Astrophysics

New Results on the Ignition Physics in C+O White Dwarfs





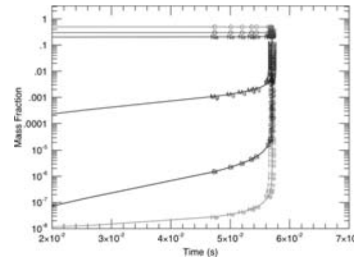


Figure 1

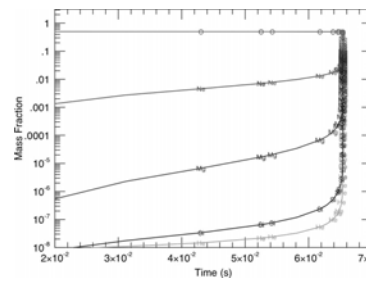


Figure 2

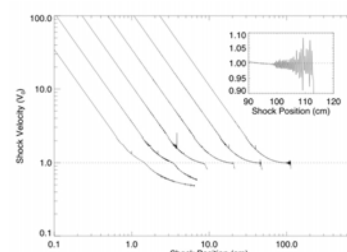


Figure 3

The details of ignition of Type Ia supernovae remain fuzzy, despite the importance of this input for any large-scale model of the final explosion. Jonathan Dursi (CITA) and Frank Timmes (LANL) have begun a process of understanding the ignition of these hotspots by examining the burning of one zone of material, and then investigate the ignition of a detonation due to rapid heating at single point. They numerically measure the ignition delay time for onset of burning in mixtures of degenerate material and provide fitting formula for conditions of relevance in the Type Ia problem. Using the neon abundance as a proxy for the white dwarf progenitors metallicity, they then find that ignition times can decrease by ~ 20% with addition of even 5% of neon by mass. When temperature fluctuations that successfully kindle a region are very rare, such a reduction in ignition time can increase the probability of ignition by orders of magnitude. If the neon comes largely at the expense of carbon, a similar decrease in the ignition time can occur. They then consider the ignition of a detonation by an explosive energy input in one localized zone, e.g. a Sedov blast wave leading to a shock-ignited detonation. Building on previous work on curved detonations, they confirm that surprisingly large inputs of energy are required to successfully launch a detonation, leading to required matchheads of ~4500 detonation thicknesses - tens of centimeters to hundreds of meters - which is orders of magnitude larger than naïve considerations might suggest. This is a very difficult constraint to meet for some pictures of a deflagration-to-detonation transition, such as a Zel'dovich gradient mechanism ignition in the distributed burning regime.

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