Joint Institute for Nuclear Astrophysics

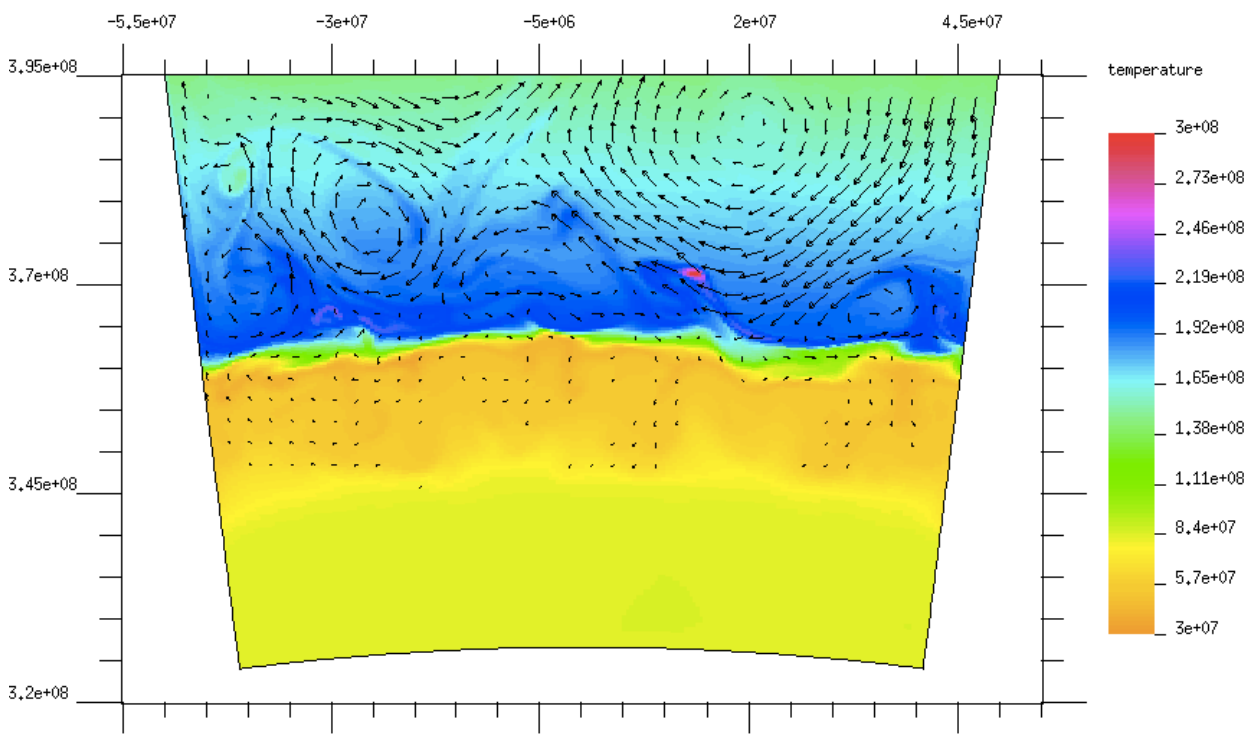
Sub Chandrasekhar Models for Supernovae

We re-examine the possibility that burning initiated in the thick helium shell of an accreting carbon–oxygen white dwarf will lead to a supernova-like runaway. In the early 1980s, it was realized that, for a range of accretion rates around 10^{-8} M_o/yr, a thick helium layer would accumulate and ignite. In some cases, the helium runaway ignited as a single detonation, producing a faint supernova and leaving behind an intact white dwarf. In others, the helium detonation led to a secondary explosion of the CO core as well, and the star was completely disrupted.

For the relevant timescales, the ignition takes place locally and therefore the exact ignition mechanism should be studied using multidimensional models. 1D models show that the helium envelope, prior to the runaway, is unstable to convection on timescales of days. In this research, we re-examine the problem of ignition in a convective region using 2D hydrodynamic models. The main issues we explore are:

a) What is the exact mechanism for the ignition of detonation in convectively unstable flow.

b) What are the effects of pre-mixing of the accreted helium envelope with carbon and oxygen from the underlying white dwarf on the post-runaway abundances.



Caption: Temperature fluctuations in the convectively unstable, reactive, helium envelope (note the large red fluctuation).

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