Abstract

Turbulently-Driven Detonation Initiation in Electron-Degenerate Matter with Helium

by Gabriel Casabona

Type Ia supernovae (SNe Ia) are believed to result from the thermonuclear explosions of carbon-oxygen white dwarfs. While important as standardizable candles, and sources of nuclear enrichment and cosmic rays, the stellar progenitors, as well as the mechanism for detonation of SNe Ia are still unknown. In previous collaborative work, I have shown that a turbulently-driven mechanism can give rise to a detonation in carbon-oxygen electron-degenerate fuel in the distributed burning regime. We have now extended this turbulently-driven detonation mechanism to simulate the detonation of carbon in the presence of helium. Using high-resolution local three-dimensional hydrodynamic simulations with the FLASH4 code, I explore a range of parameter space motivated by leading progenitor models of SNe Ia. I show that the helium abundance greatly affects the range of conditions needed to detonate carbon in electron-degenerate matter. These local models can then be used in subgrid models of nuclear burning and detonation initiation in future global simulations of SNe Ia.