

**Stony Brook University
The Graduate School**

Doctoral Defense Announcement

Abstract

Multidimensional Simulations of Convection Preceding a Type I X-ray Burst

By

Christopher Michael Malone

Type I X-ray bursts are interesting thermonuclear phenomena that can be used to determine the mass and radius of the underlying neutron star and hence help constrain the equation of state for dense matter. Particularly important is our physical understanding of how a localized, subsonic burning front ignites and spreads, the state of the material in which the burning front propagates, and the extent to which heat released from reactions expands the photosphere of the neutron star. Multidimensional simulation of low Mach number astrophysical flows, such as the propagation of a flame or the slow convective turnover, in such systems have been rather restricted in the past; fully compressible hydrodynamics algorithms have a timestep size that is constrained by the propagation of acoustic waves, which can be neglected in low Mach number flows of this type.

This thesis presents results of multidimensional, plane-parallel simulations of the convection preceding ignition in a Type I X-ray burst. I use a low Mach number hydrodynamics code, MAESTRO, based on a low Mach number approximation, which filters acoustic waves from the system allowing for a larger timestep size while retaining the important compressible features, such as expansion from local heating and composition change. This allows for performing long-term evolution of the system and characterizing the effects of convection on the atmosphere. In particular, the simulations presented here suggest that the convection dredges up some of the underlying ^{56}Fe neutron star material into the atmosphere, which may affect any subsequent subsonic burning front as well as the color correction factor used to infer the underlying neutron star's mass and radius.

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