

Evolution of Flame Geometry in Buoyancy-Driven Thermonuclear Combustion in Type Ia Supernovae

George C. Jordan¹, Christopher S. Daley¹, Dongwook Lee¹, Don Q. Lamb¹

¹*Center for Astrophysical Thermonuclear Flashes, University of Chicago, Chicago, IL 60637, gjordan@flash.uchicago.edu*

Type Ia supernovae play a central role in the study of dark energy because their properties are remarkably homogeneous, and they can therefore be made calibrated "standard candles." However, the mechanism responsible for the explosion is not fully understood.

In the gravitationally confined detonation (GCD) model of Type Ia supernovae, ignition at one or more points in the core of the star produces hot, burning "bubbles" that grow and rise due to buoyancy-driven thermonuclear combustion. When the burning bubbles break through the surface of the star, the hot material in them spreads rapidly over stellar surface, and collides at the opposite point, initiating a detonation.

We have conducted a verification study of this "deflagration phase" of the GCD model using the FLASH code. In these simulations, we choose a hydrostatic background in a constant gravitational field. We initiate each simulation with small spherical ignition volume and specify a laminar flame speed. As the simulation evolves, the initial flame bubble grows and rises. It quickly distorts due to fluid instabilities resulting from its rise velocity and the rapid fluid motion flowing past it, and to the Rayleigh-Taylor instability. We describe the results of a series of 3D numerical simulations as a function of spatial resolution and for different laminar flame speeds.