DDT Pedagogy

Dicloro Diphenyl Tricloroethane

Director's Discretionary Time

Don't Do That

Deflagration to Detonation Transition

The DDT is a phenomenon whose first-principles description remains one of the major challenges of combustion theory.

Chemical experiments on gas phase DDT in tubes are not repeatable; they seem to vary from event to event.

Subtle dynamical effects are involved in DDT; deflagrations, shocks and shock reflections, boundary layers, and their interactions with each other.

A successful model, starting from a 1.38 Msun C+O WD must make

0.1 - 1.0 Msun Ni56	for the light curve
0.2 - 0.4 Msun SiSArCa	for the spectrum
< 0.1 Msun Fe54 + Ni58	for the nucleosynthesis
Not too much O close to Ni56	for the spectrum
Allow for some diversity	for fun

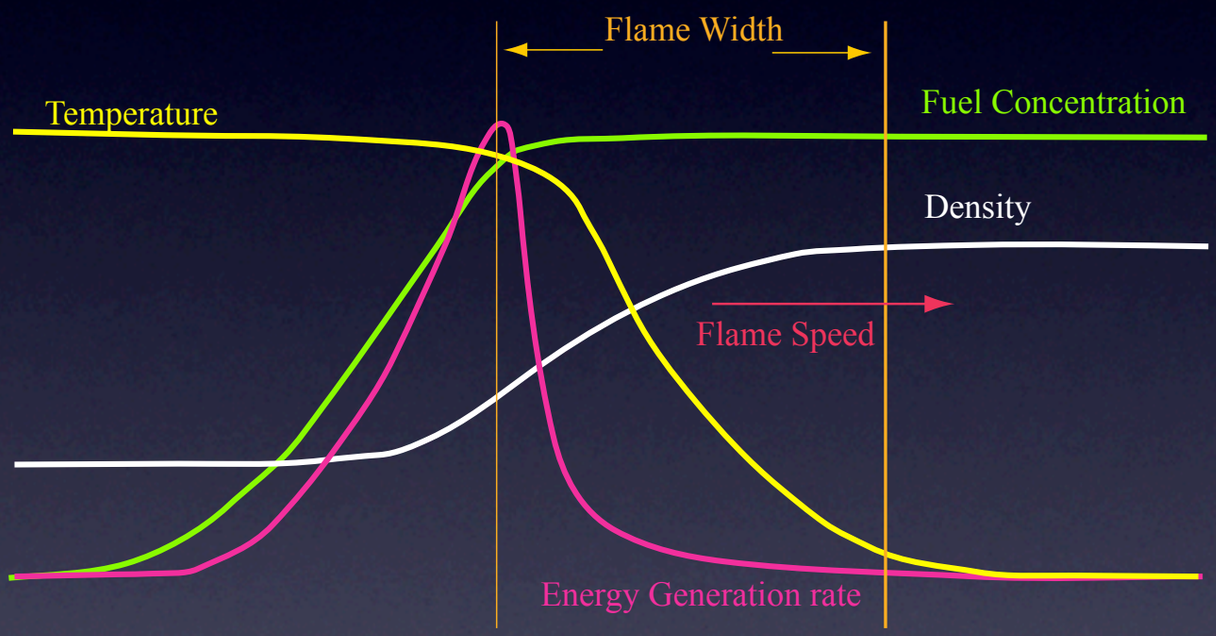
The way to achieve this is with a deflagration that starts slowly, pre-expand the star to avoid too much electron capture, then a move a burning front very rapidly when the density is ~ 10^7 g/cc e.g., W7.

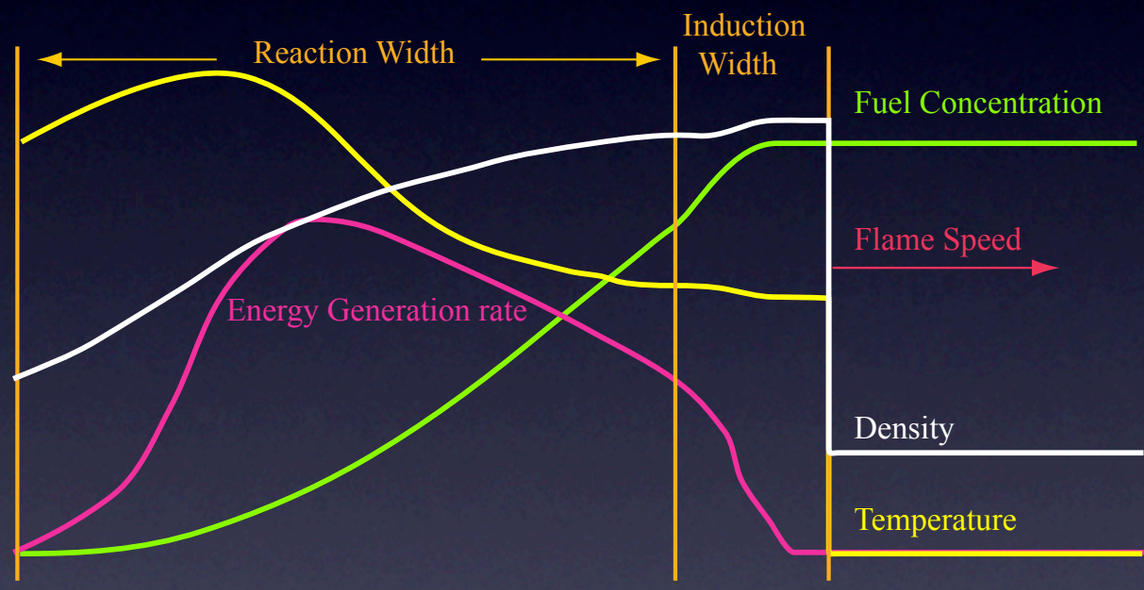
The search for the past ~25 years has been to find the correct physics that describes a little burning at high density and lots of burning at low density.

Rayleigh-Taylor instability, Turbulence, Delayed Detonation, Pulsational Detonation, Off center Ignition

A self-sustained wave of exothermic chemical reaction spreading through a homogeneous combustible mixture is known to occur either as a subsonic deflagration (premixed flame) or supersonic detonation.

$$\frac{1}{\tau_r} = \frac{1}{\tau_r} \; B \exp\left(E/kT\right)$$



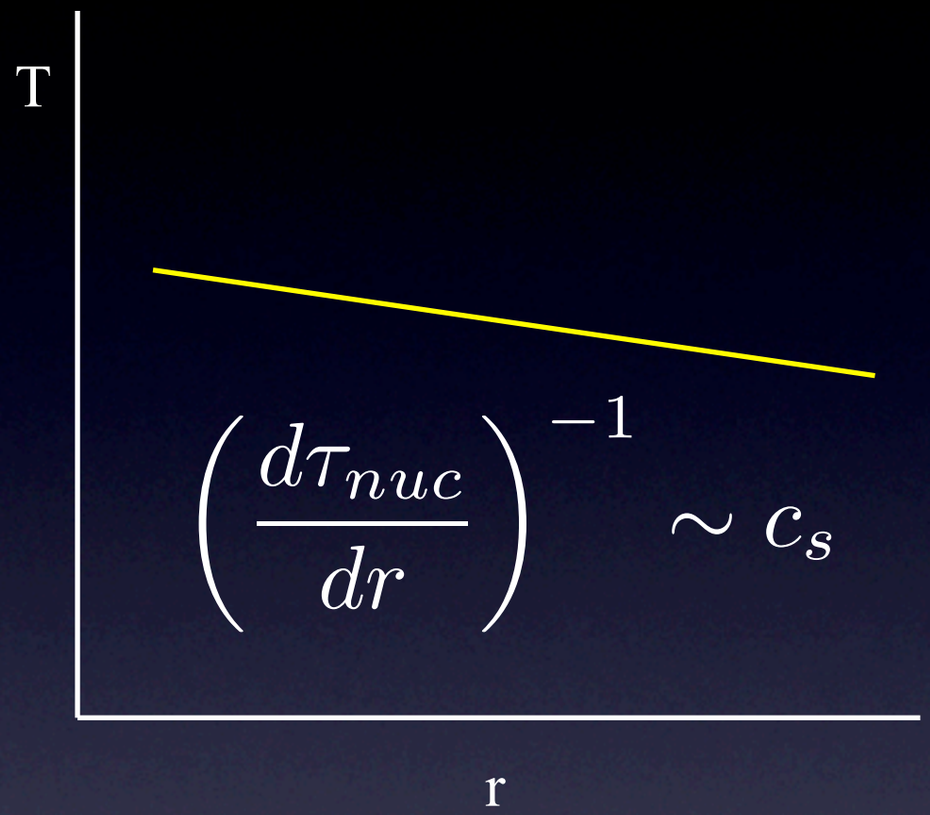


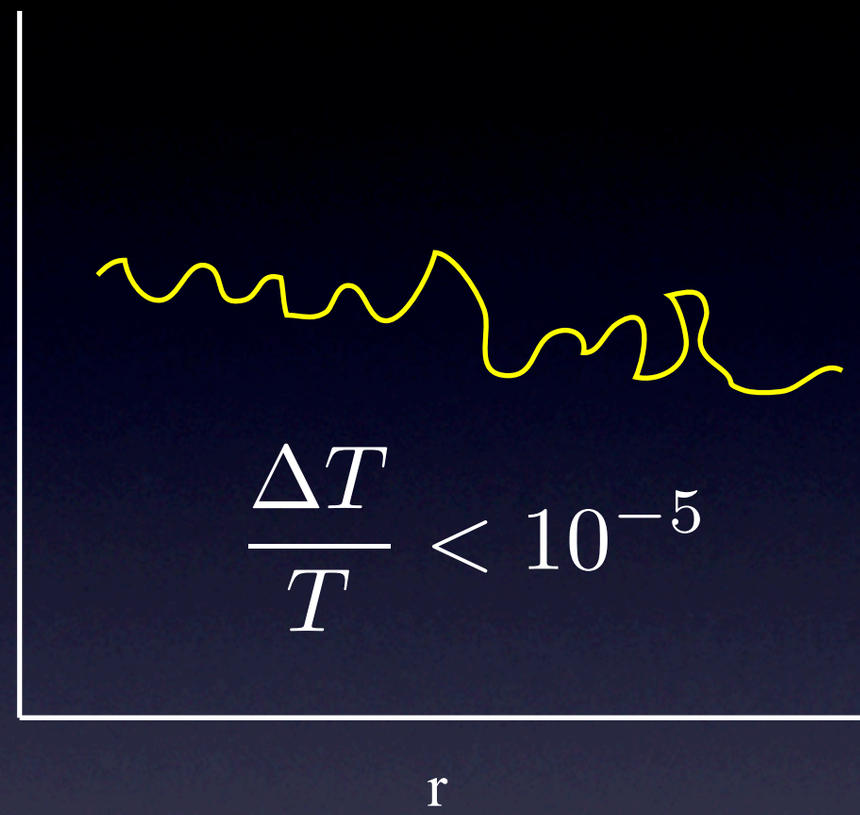
$$\tau_{diff} = \frac{\delta}{\lambda c} \qquad \tau_{burn} = \frac{E}{\dot{S}}$$

$$M_{det} = 1.5 \; - \; 10$$

$$v_{laminar} = \sqrt{\frac{\lambda c \dot{S}}{E}}$$

Deflagrations are initiated by a mild energy discharge, e.g. by a spark, while detonations (DDT) are provoked by shock waves and/or a region running away as a unit in approximately a sound crossing time.





In the presence of obstacles (tube walls, wire screens, porous medium matrix, solid particles) an initially formed deflagration can undergo an acceleration abruptly ending up as a detonation.

Can a turbulent deflagration in a white dwarf produce a sufficiently large, nearly isothermal region that burns in a sound crossing time?
Let the arguments begin...