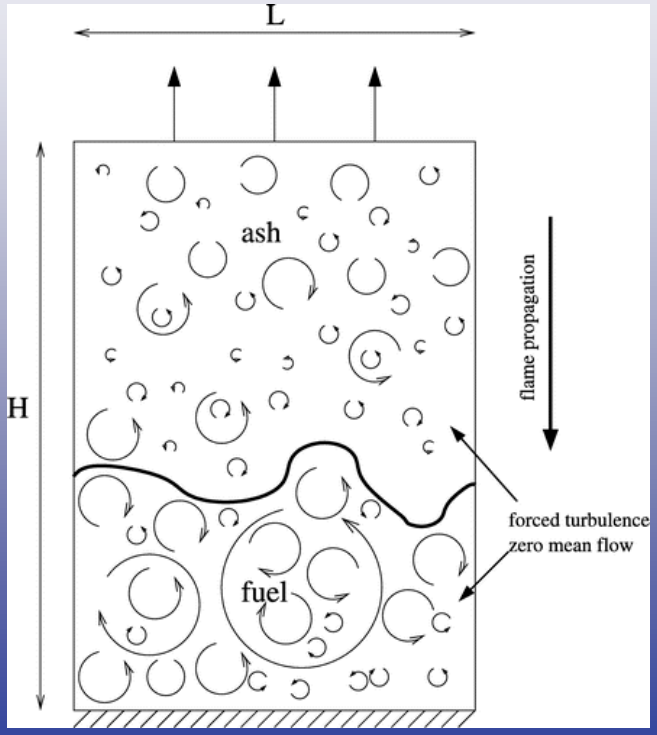
The Structure of Laminar C/O Flames in Type Ia Supernovae at Low Densities

Chris Richardson
Michigan State University

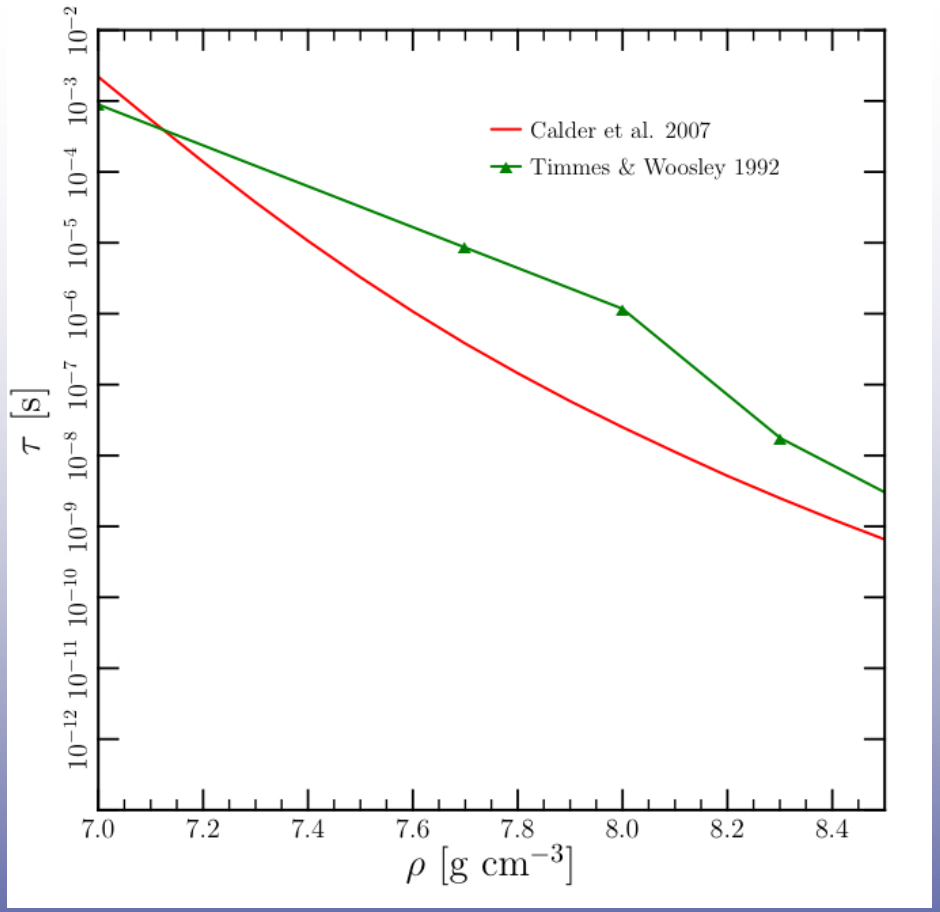
This project is funded by the NSF through grant PHY0822648 and the Universities of JINA.

The Motivation

- The commonly accepted mechanism is the thermonuclear incineration of a C/O WD due to accretion from a main-sequence companion.
- The light curve is primarily due to the decay of ^{56}Ni, the abundance of which is set during a subsonic deflagration.



Aspden et al. 2008



This project is funded by the NSF through grant PHY0822648 and the Universities of JINA.

Reaction-Diffusion Model

$$\frac{\partial T}{\partial t} = \kappa \frac{\partial^2 T}{\partial x^2} + \frac{1}{c_p}\frac{\partial E}{\partial t}$$

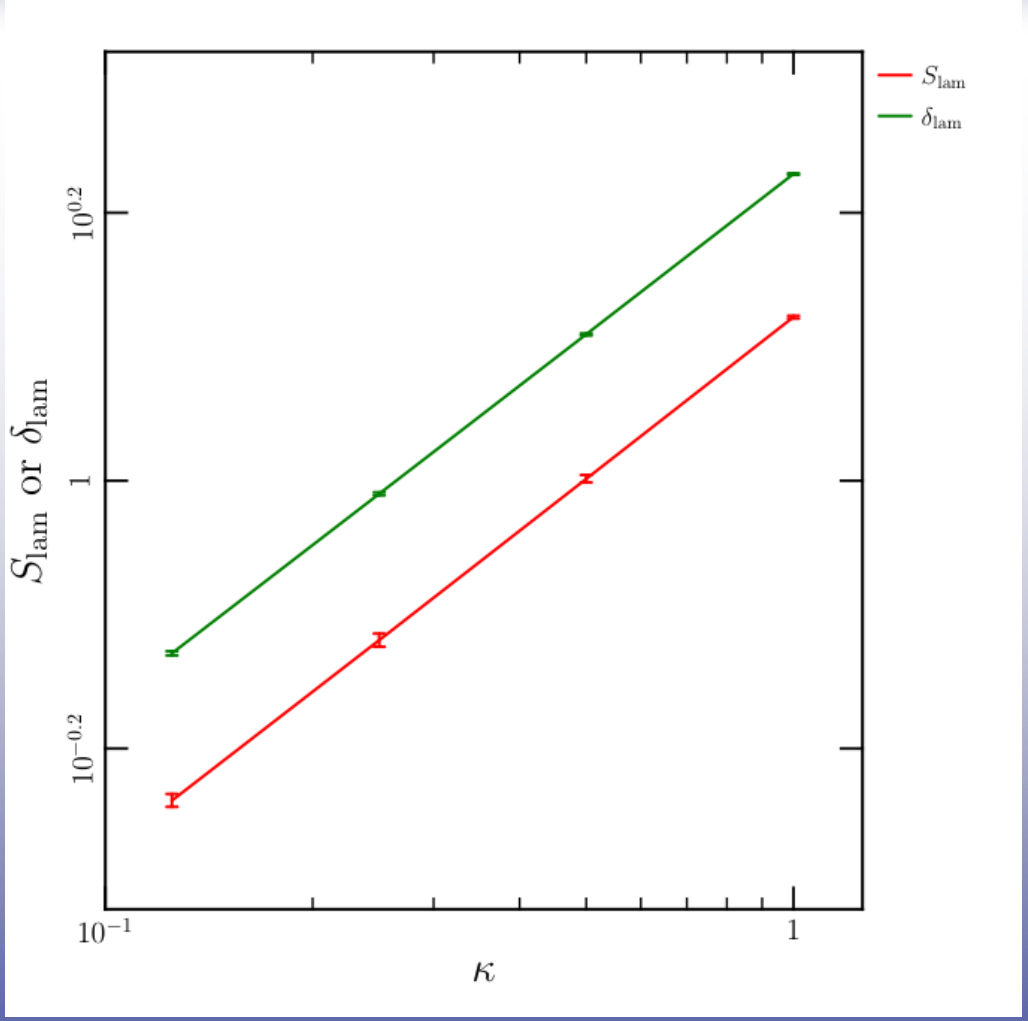
$$\frac{\partial E}{\partial t} = B_1 \frac{\partial \phi_1}{\partial t} + B_2 \frac{\partial \phi_2}{\partial t}$$

$$\frac{\partial \phi_1}{\partial t} = \begin{cases} -\lambda_1 T^{\alpha_1}\phi_1 & T > T_1 \\ 0 & T \leq T_1 \end{cases}$$

$$\frac{\partial \phi_2}{\partial t} = \lambda_1 T^{\alpha_1}\phi_1 - \lambda_2 T^{\alpha_2}\phi_2$$

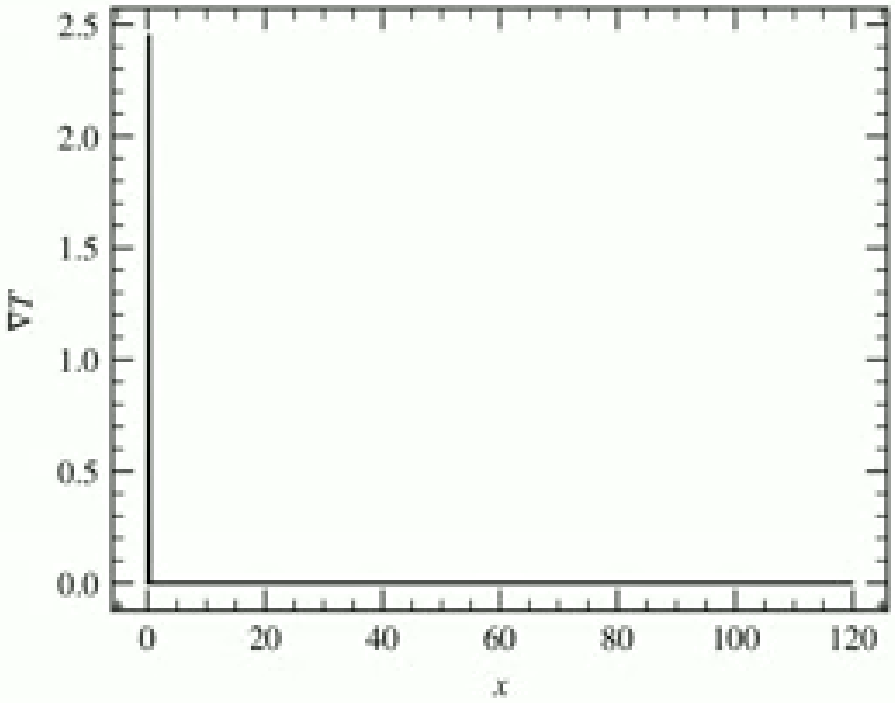
$$S_{\rm lam} \propto \sqrt{\kappa\tau} \qquad \delta_{\rm lam} \propto \sqrt{\kappa/\tau}$$

$$\tau = \frac{1}{\lambda T^{\alpha}}$$



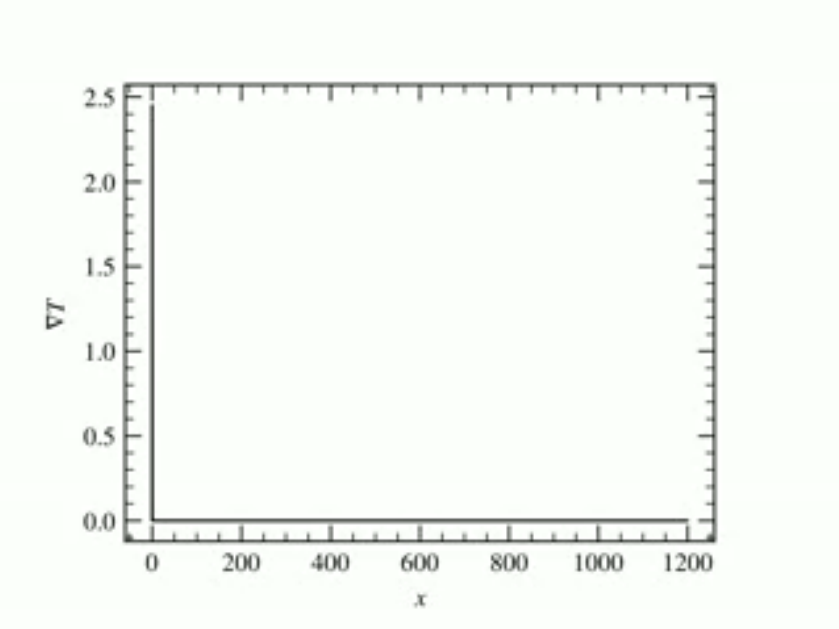
This project is funded by the NSF through grant PHY0822648 and the Universities of JINA.

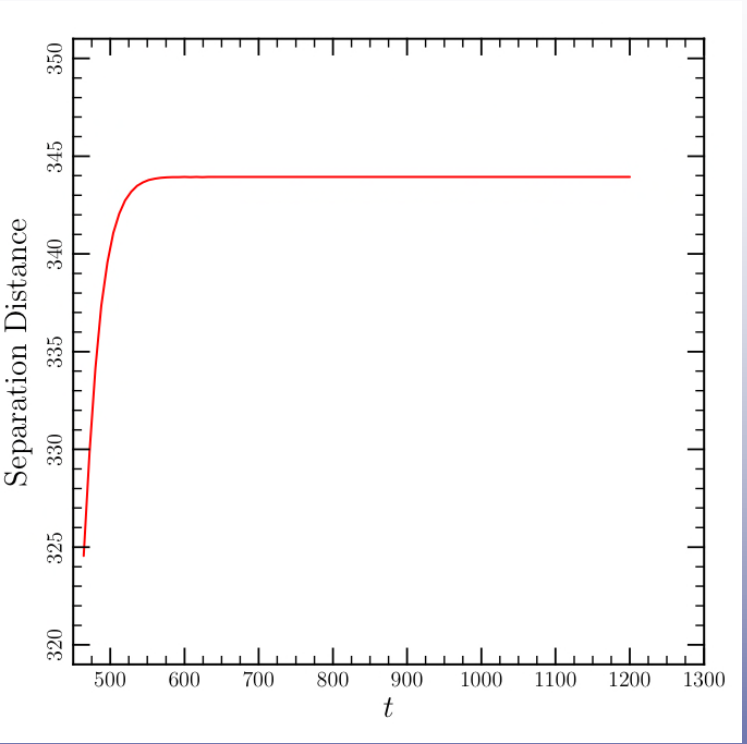
Results



This project is funded by the NSF through grant PHY0822648 and the Universities of JINA.

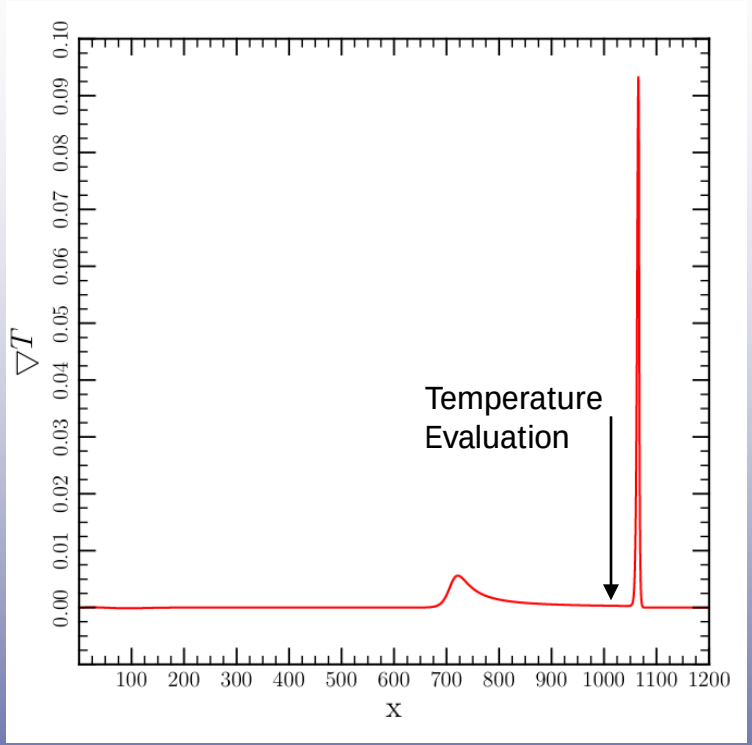
The Two Stage Flame

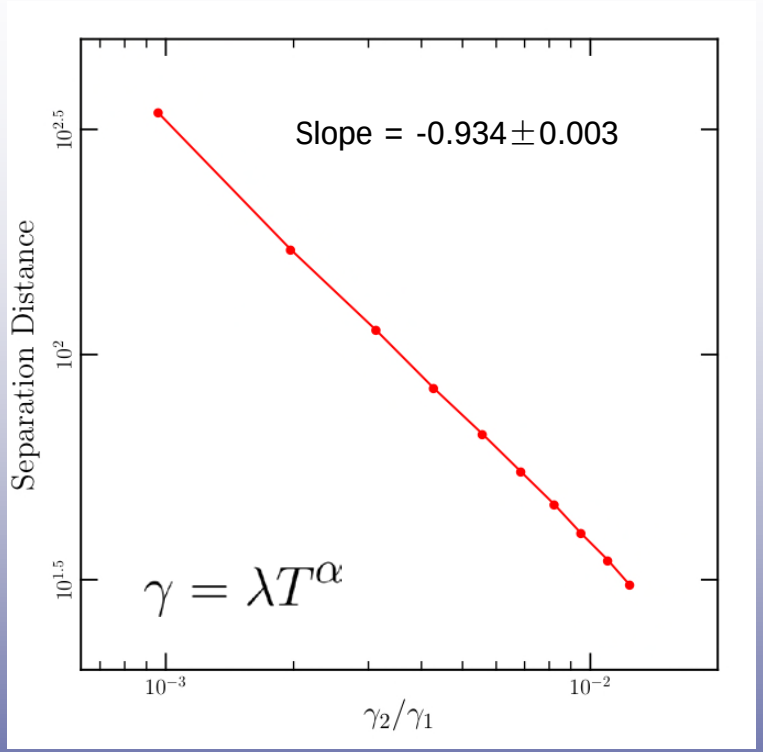




This project is funded by the NSF through grant PHY0822648 and the Universities of JINA.

Separation Distance





This project is funded by the NSF through grant PHY0822648 and the Universities of JINA.

Future Work

Future Work

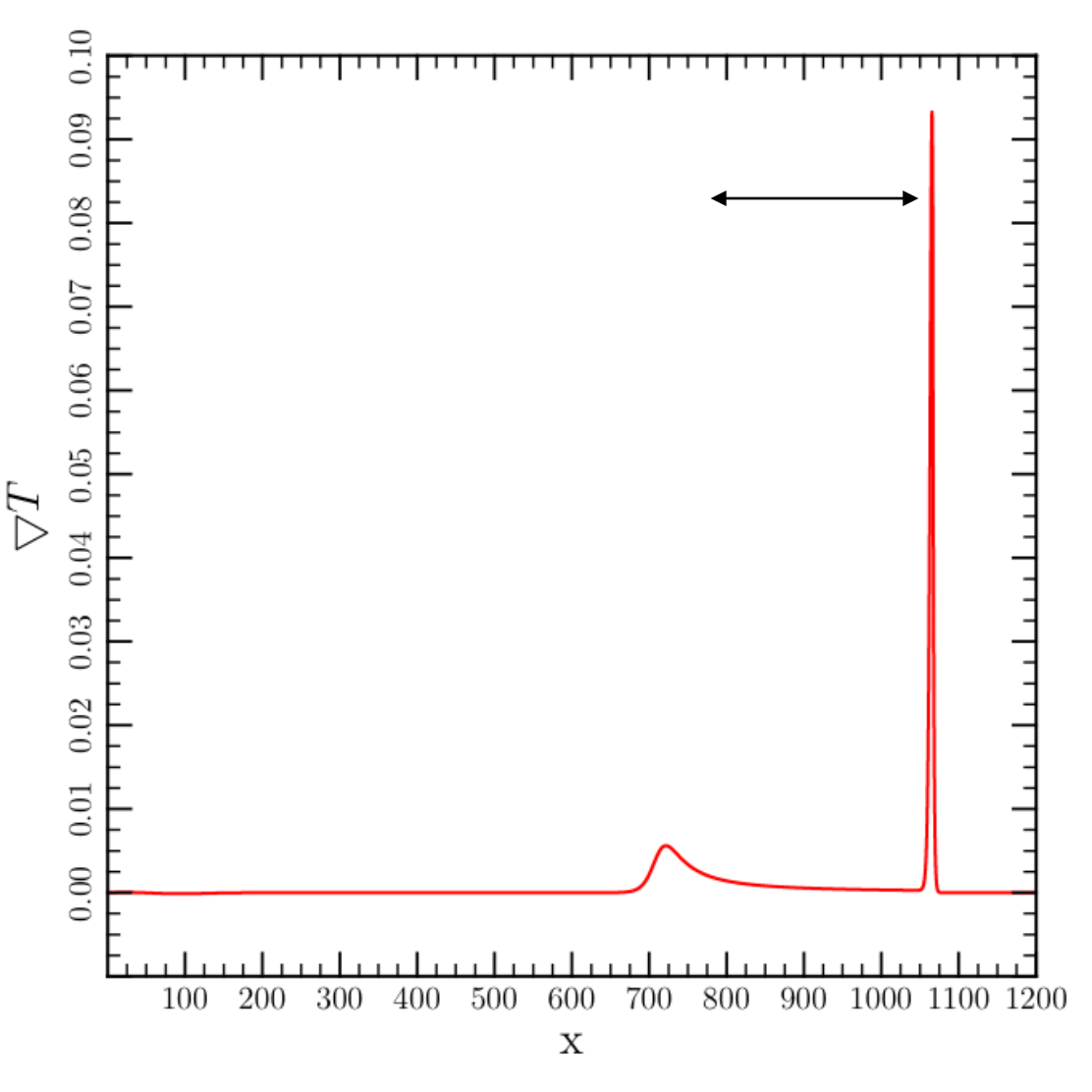
- We will extend flame models to lower densities using a full set of hydrodynamical equations and by using a nuclear reaction network.

Thank you

- Ed Brown
- Andrew Steiner
- Alex Deibel

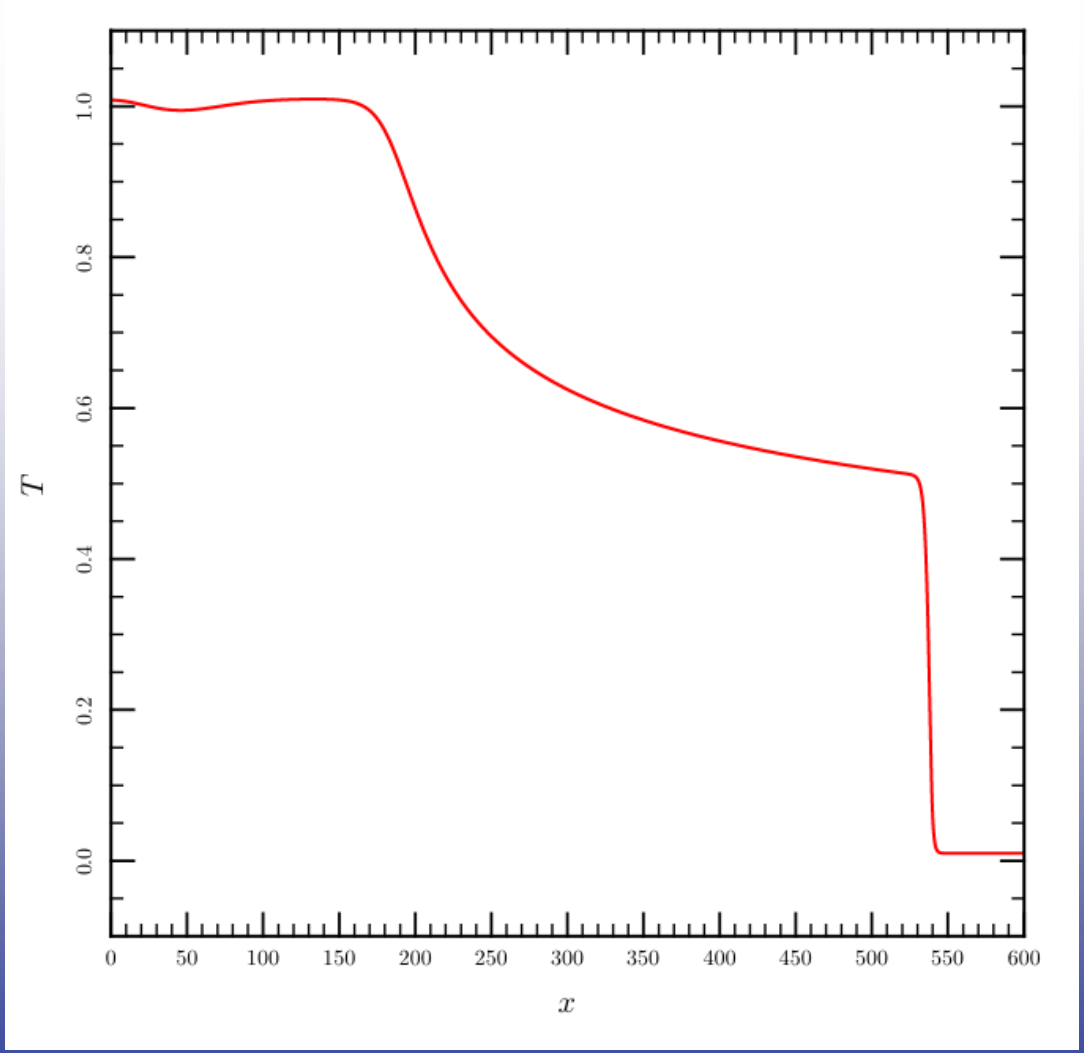
This project is funded by the NSF through grant PHY0822648 and the Universities of JINA.

Extras



This project is funded by the NSF through grant PHY0822648 and the Universities of JINA.

Extras



This project is funded by the NSF through grant PHY0822648 and the Universities of JINA.

Extras

This project is funded by the NSF through grant PHY0822648 and the Universities of JINA.