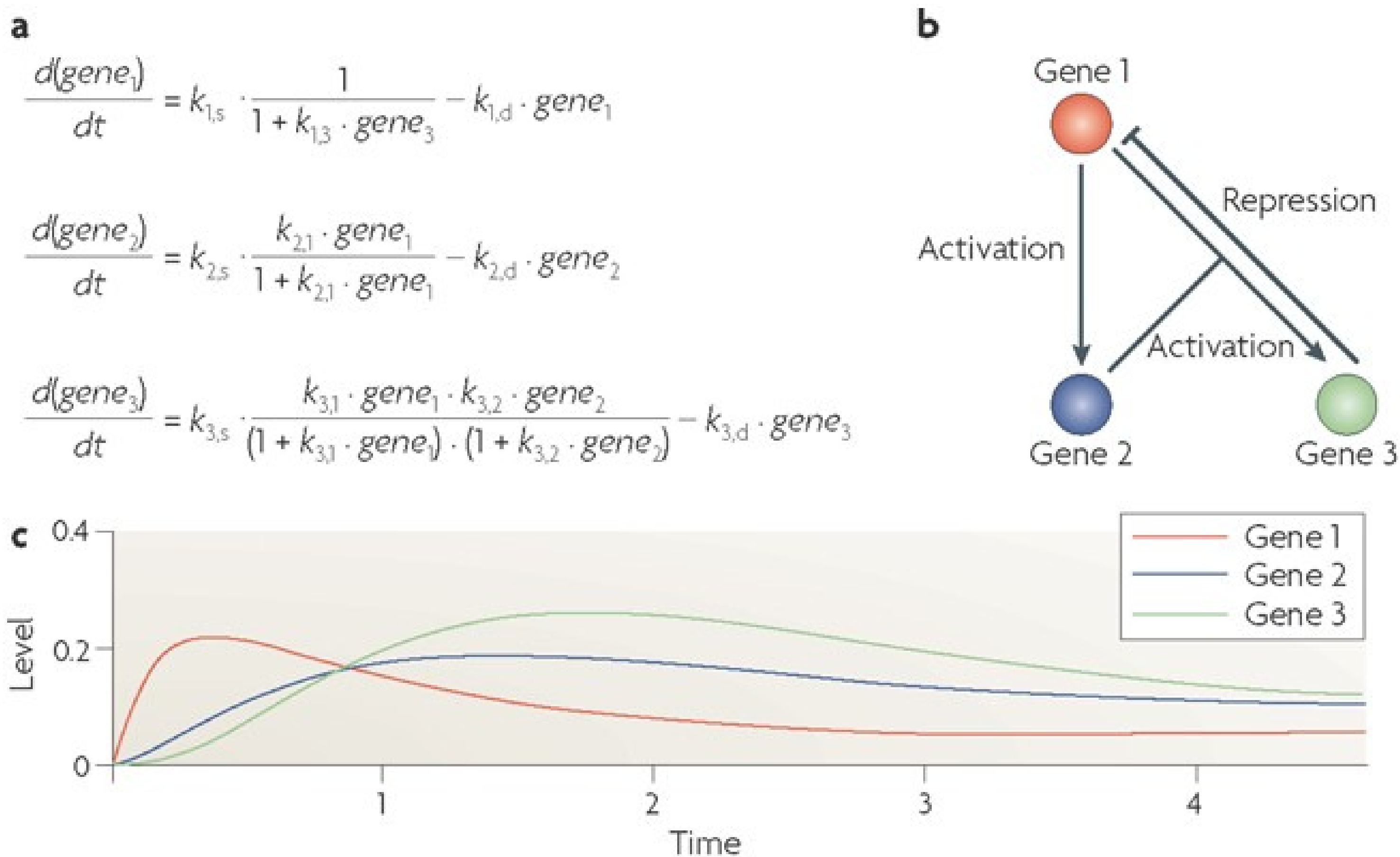
Project List

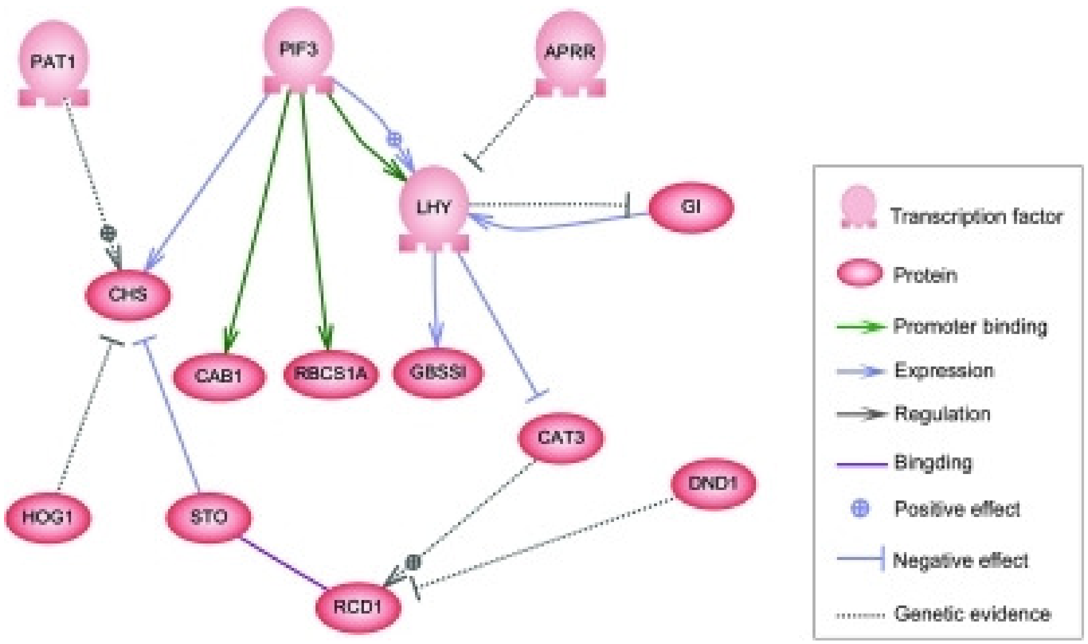
- Modeling Gene Regulatory Networks
- Planetary Orbits and Lightcurves from Transits
- Modeling Supernovae Remnants using Pyro
- Solving nuclear reactions in white dwarf interiors

Modelling gene regulatory networks



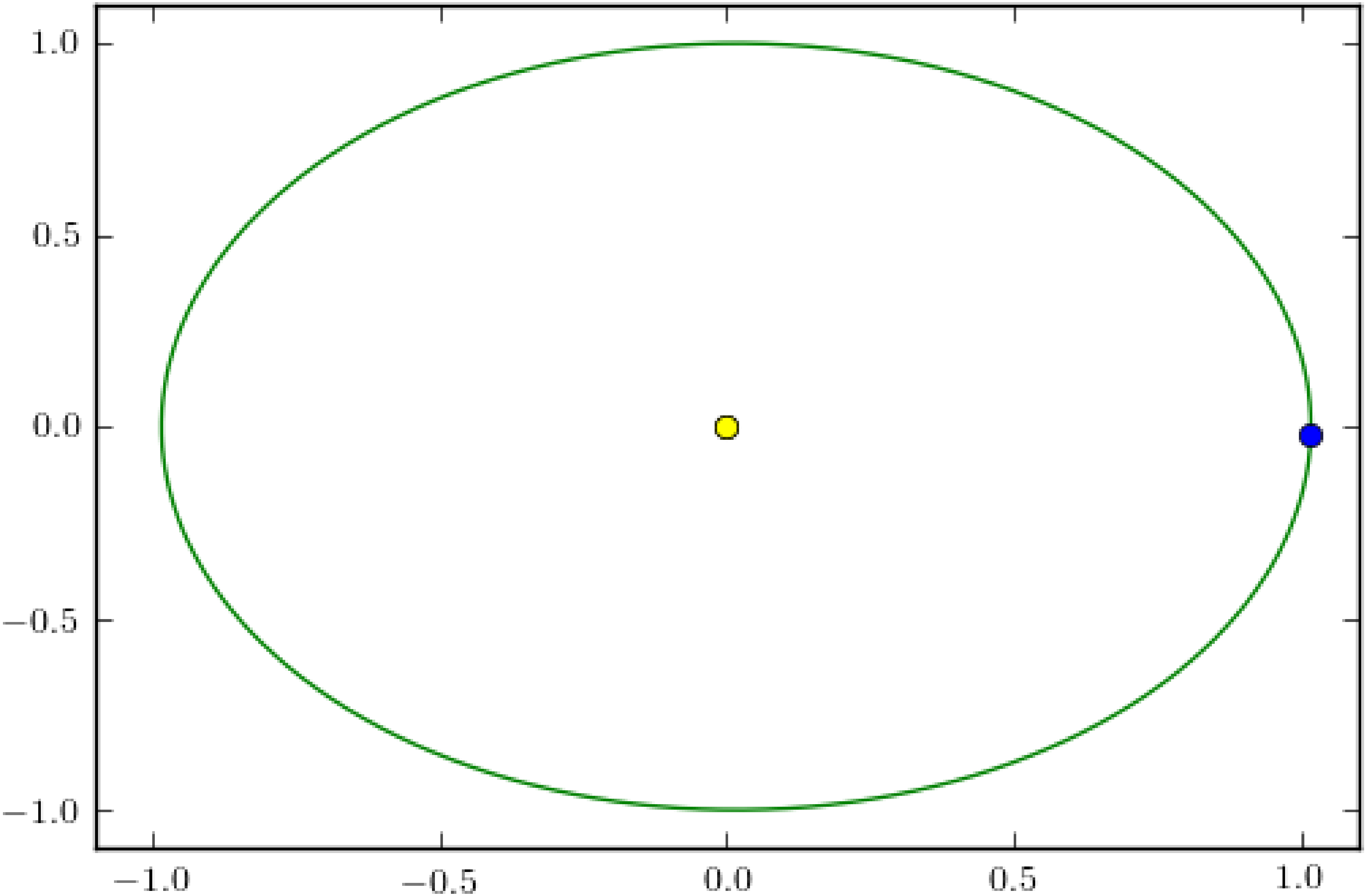
Nature Reviews | Molecular Cell Biology

- Important for understanding biological processes



- Student will build a model of gene regulations by solving ODE to model gene regulations
- Learn how to use gene databases to obtain real information
- Analyze information coming from the model

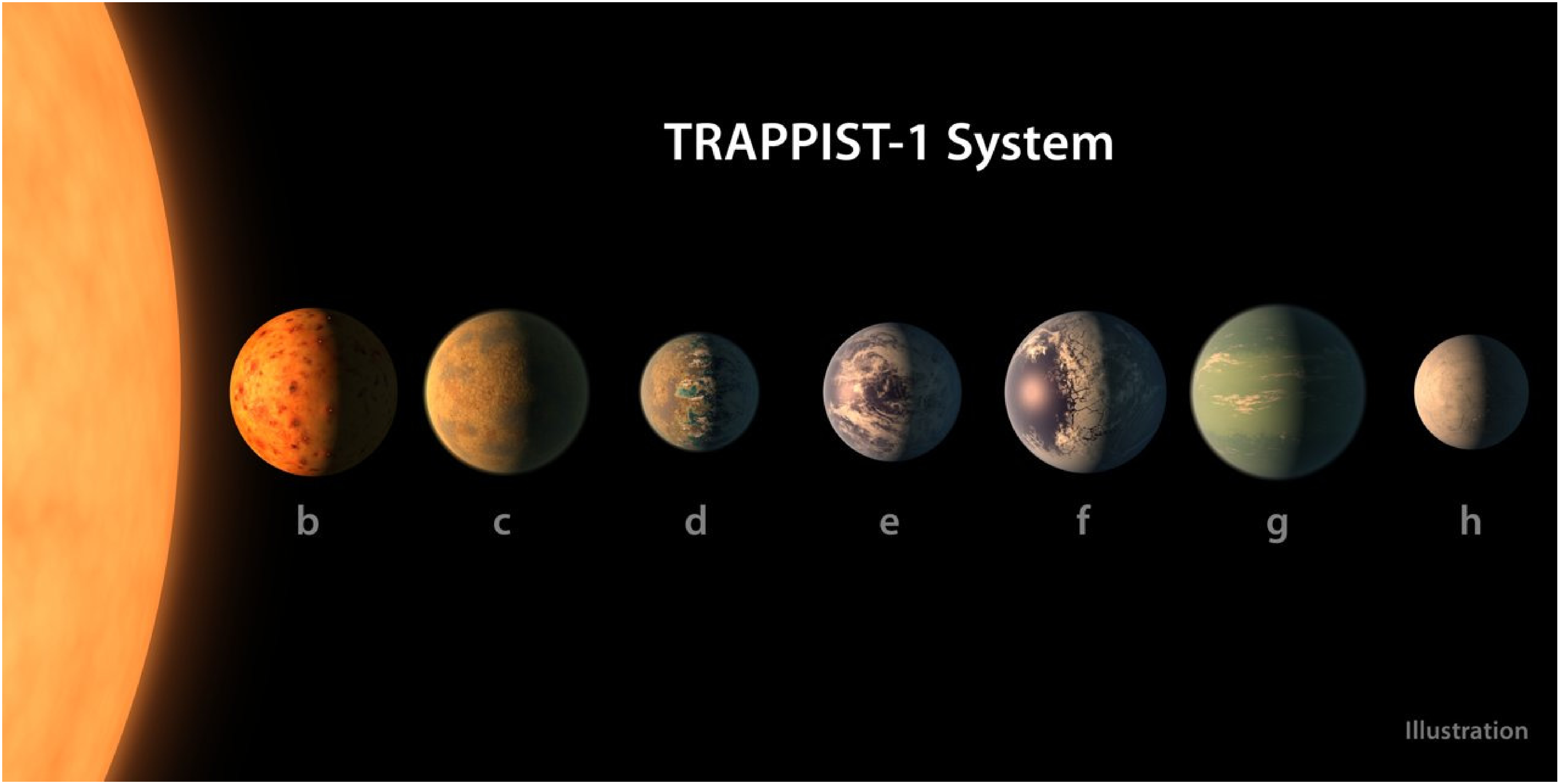
Modelling Planetary Orbits



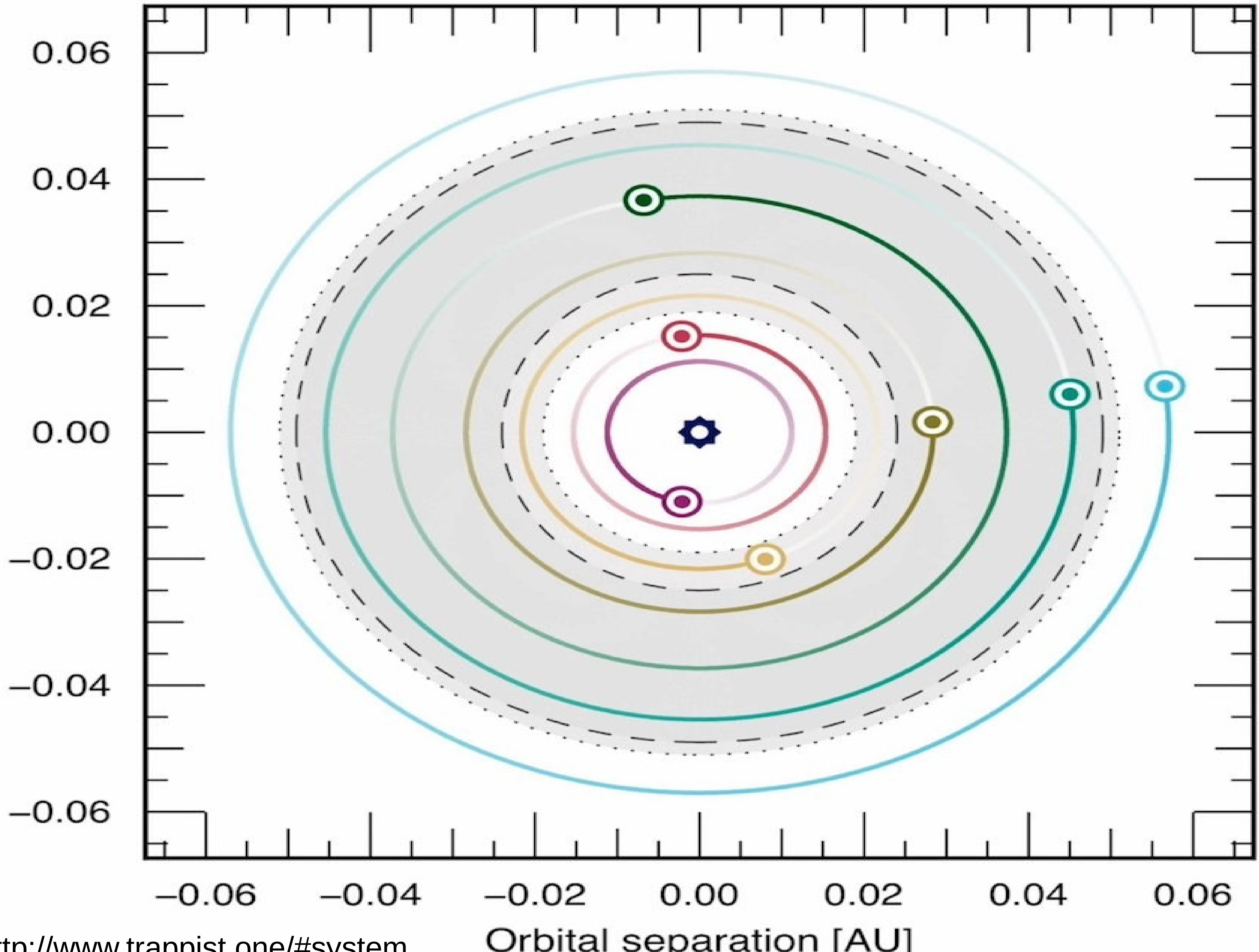
The Earth From Saturn – Cassini

https://saturn.jpl.nasa.gov/resources/5868/

Newly Discovered – Trappist!



http://www.trappist.one/#system

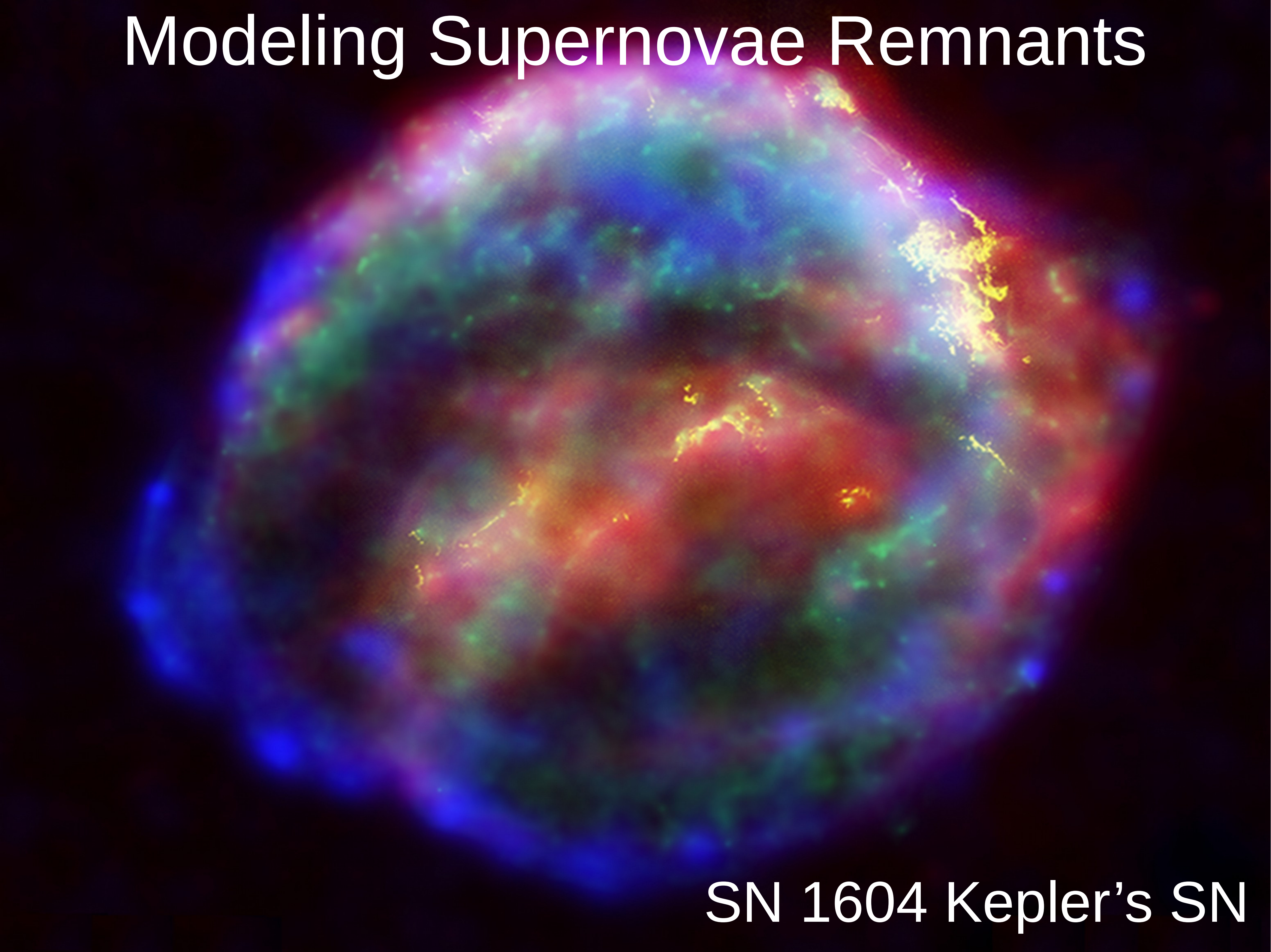


http://www.trappist.one/#system

Project

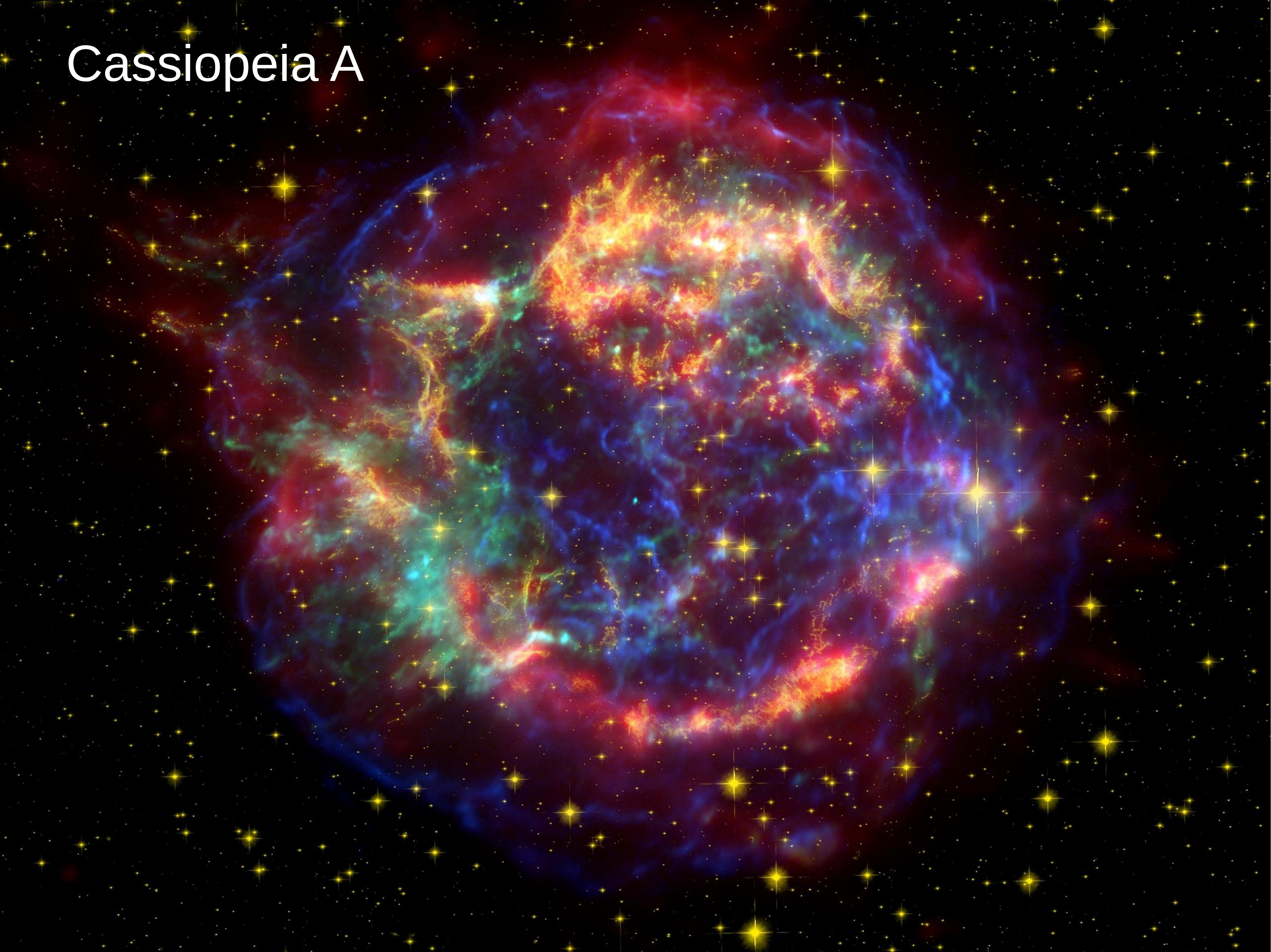
- For either our Solar System or Trappist-1:
  - Model the planetary orbits around the sun, accounting only for the sun’s gravity
  - Study orbital perturbations arising from including gravitation from massive planets (e.g. Jupiter)
  - How would solar transits look for each planet from faraway?

Modeling Supernovae Remnants

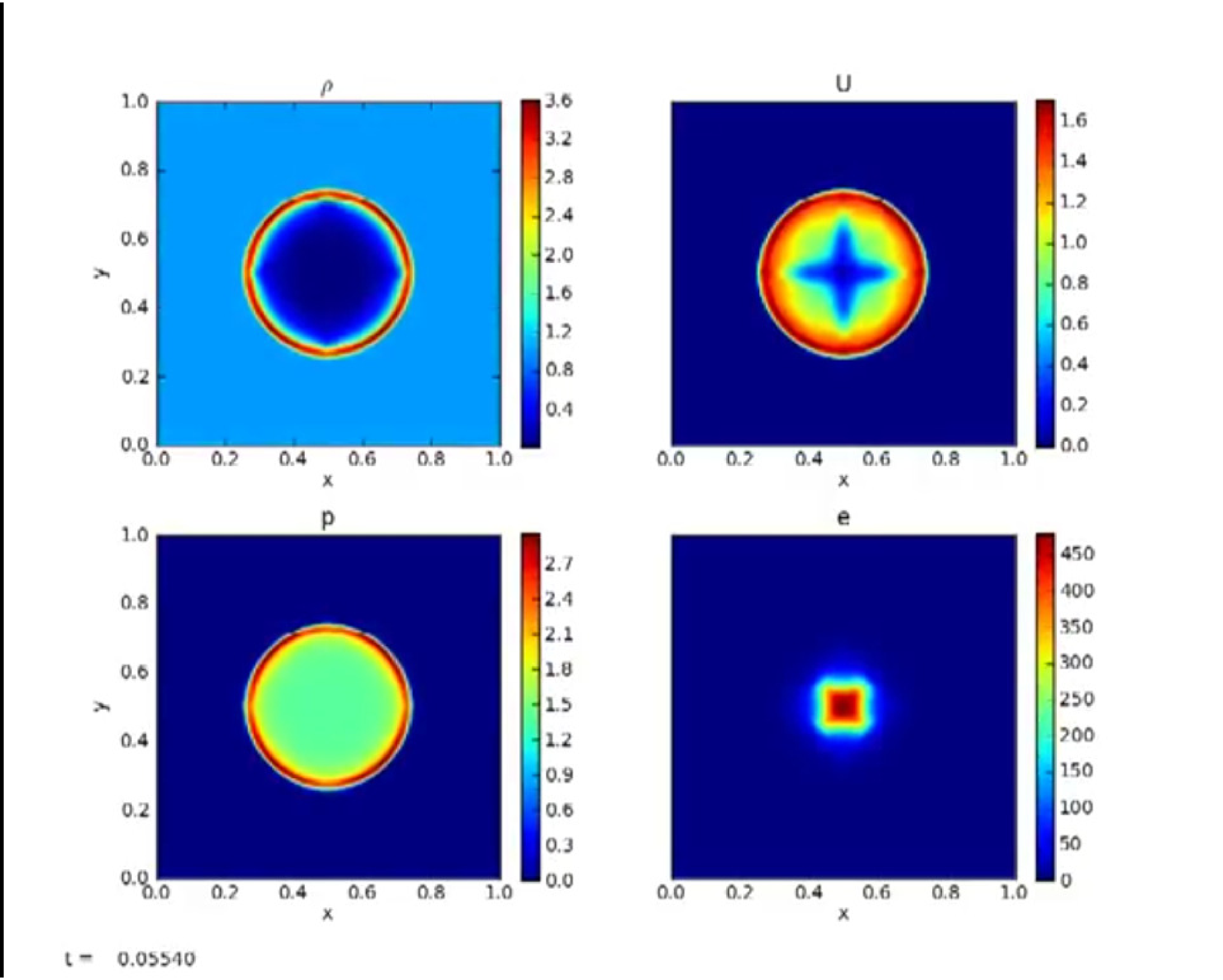


SN 1604 Kepler’s SN

Cassiopeia A



Pyro – The Sedov Explosion

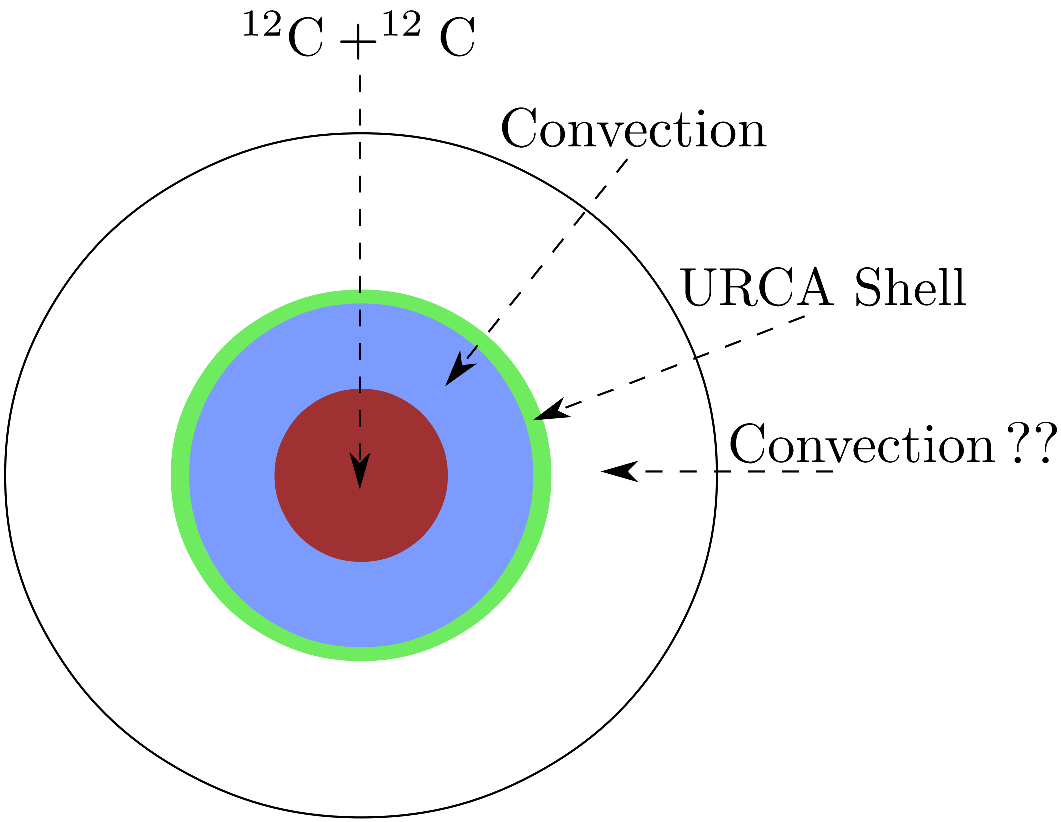


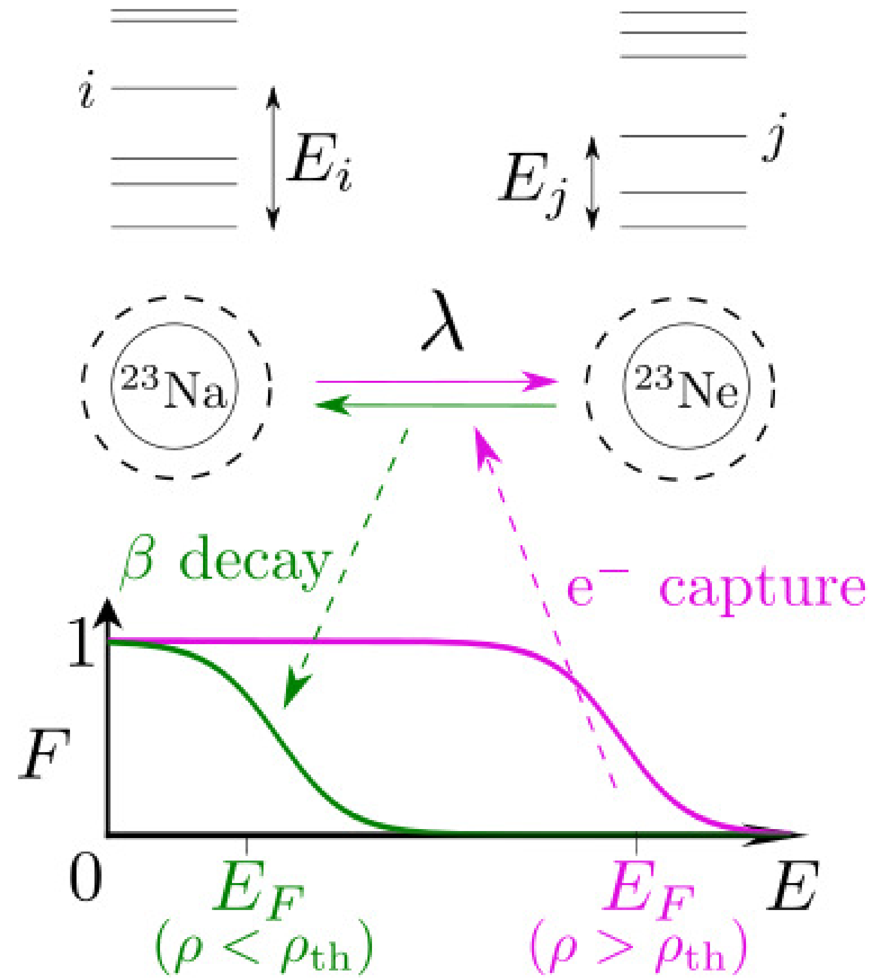
https://zingale.github.io/pyro2/

Project

- Assess which supernovae remnants we can model in the Sedov-Taylor adiabatic expansion phase.
- Experiment with Pyro using different blast initial conditions to determine how best to model various supernova remnants.
- Determine how shock speed and temperature depend on initial conditions.

Urca Process In White Dwarfs





$$^{23}\mathrm{Na} + e^- \rightarrow \nu_e + ^{23}\mathrm{Ne}$$

$$^{23}\mathrm{Ne} \rightarrow e^- + \overline{\nu}_e + ^{23}\mathrm{Na}$$

$$Q = 4.37590\ \mathrm{MeV}$$

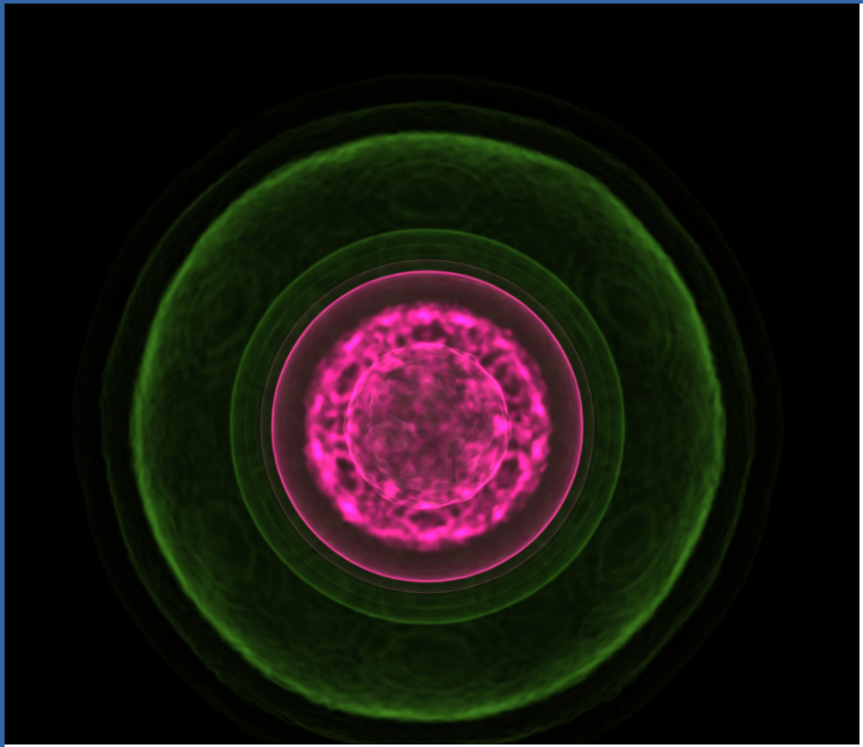
$$\mathrm{Log}_{10}(\rho Y_e) = 8.92$$

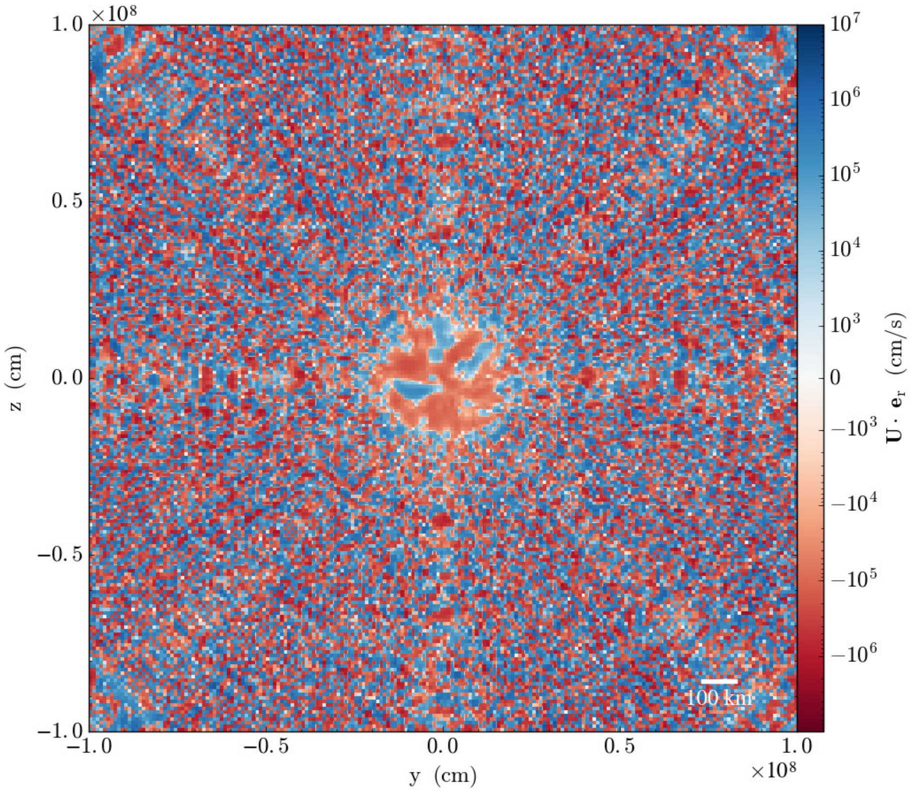
(Toki,Suzuki,Nomoto,Jones & Hirschi 2013)

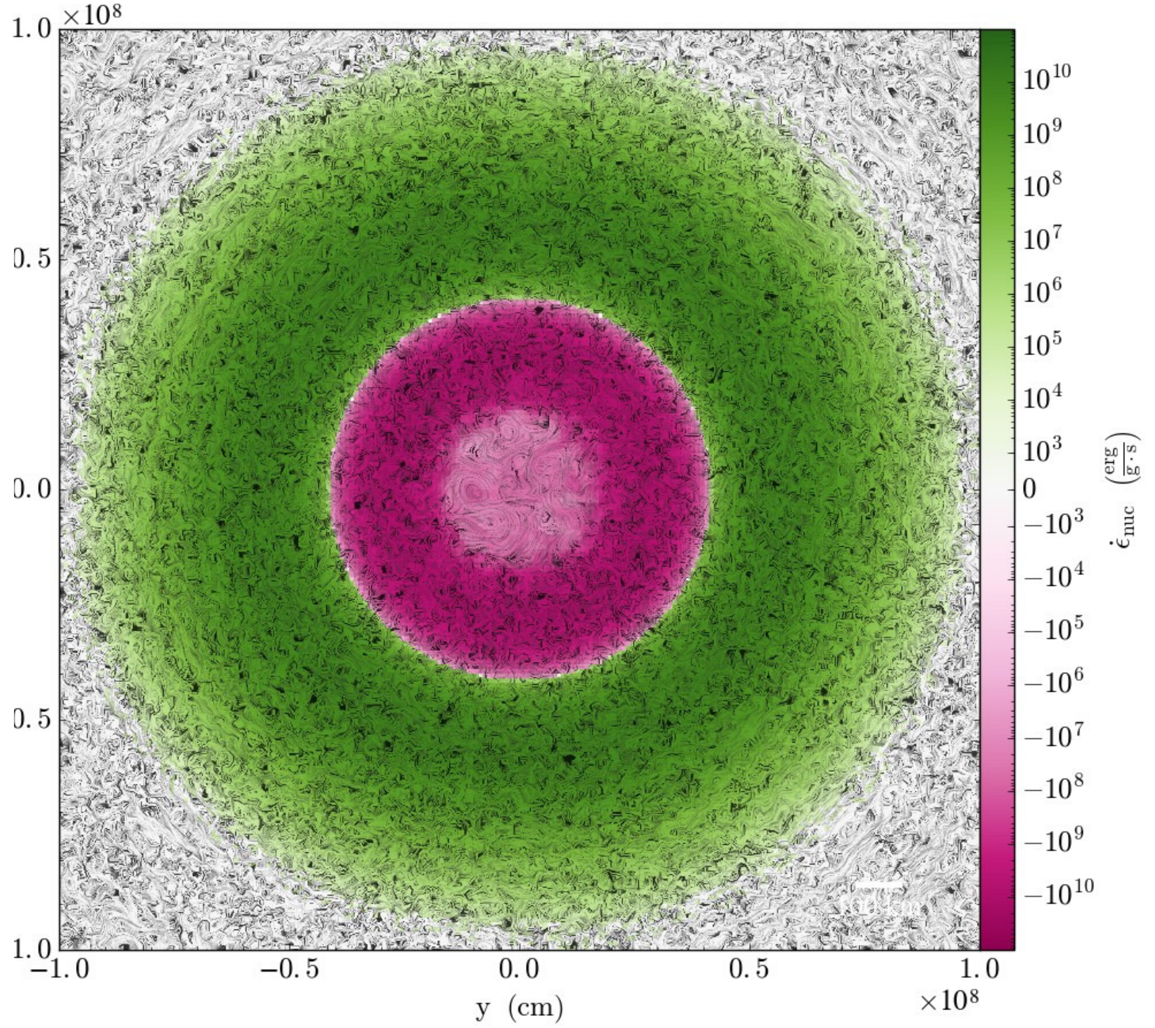
White Dwarf Urca Process

$$\rho_c = 4.5 \times 10^9 \ \mathrm{g \cdot cm^{-3}}$$

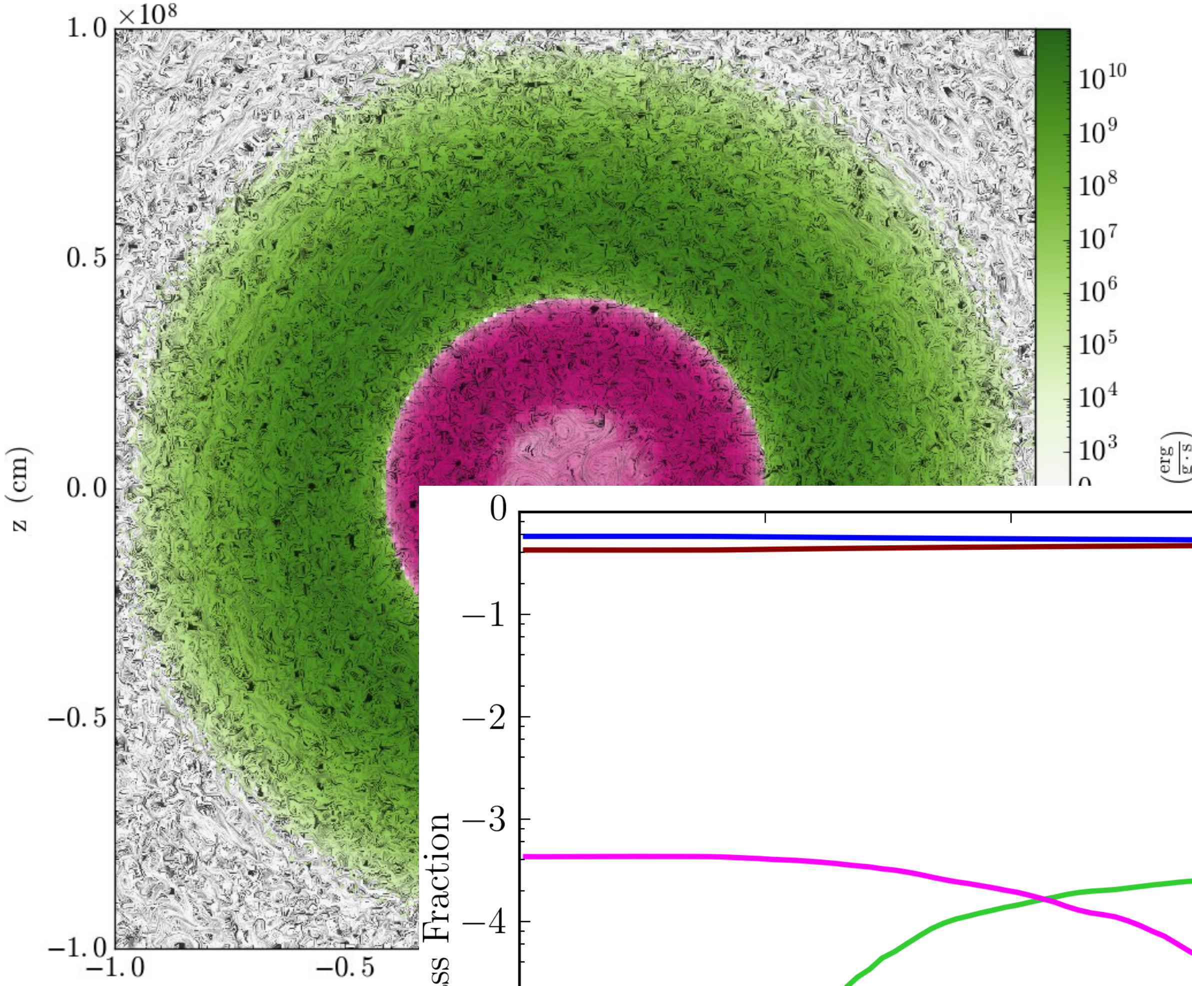
$$\mathrm{T_c} = 3.0 \times 10^8 \ \mathrm{K}$$

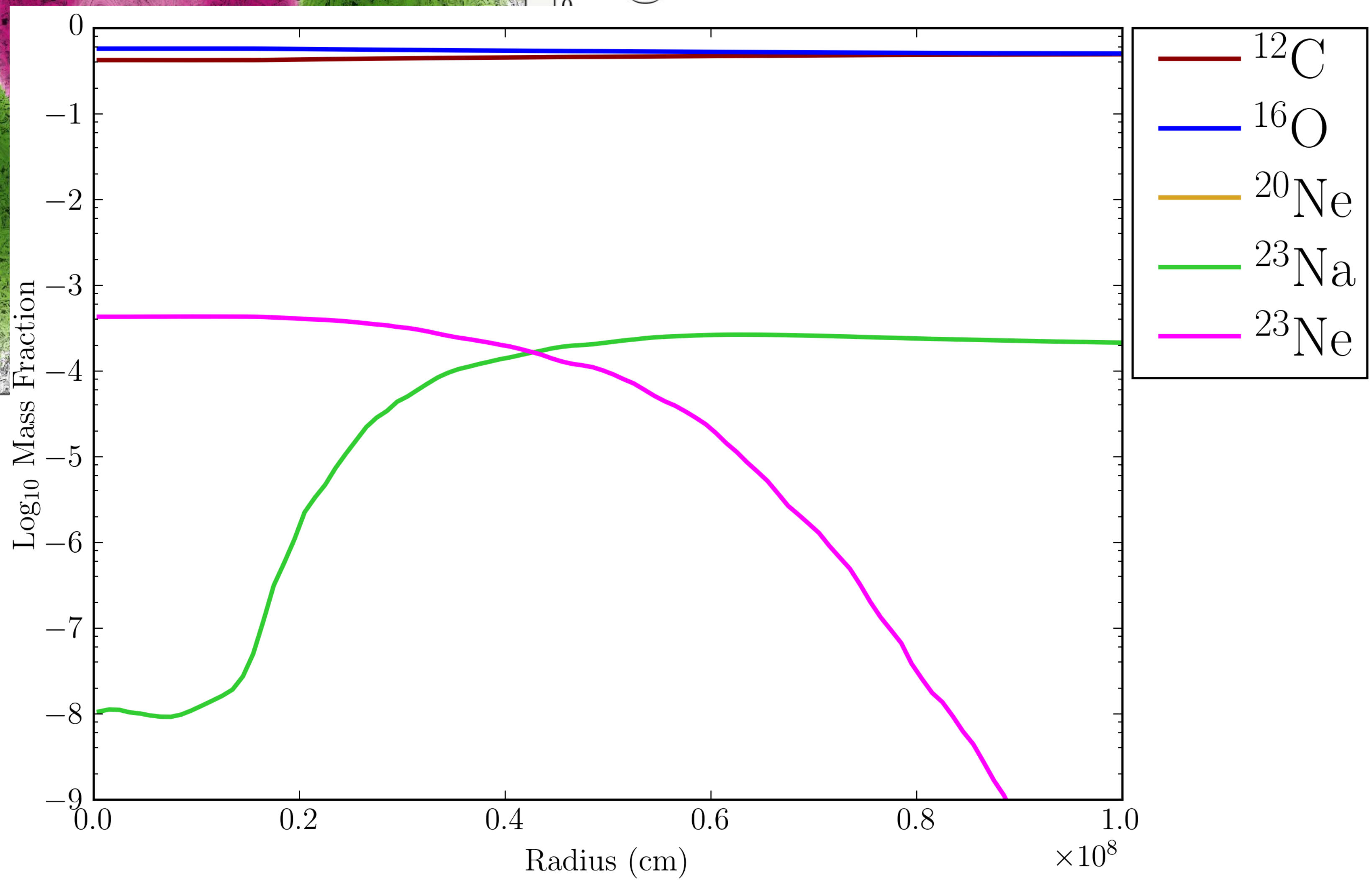






White Dwarf Urca Abundances





Project

- Use pyreaclib to construct a reaction network that links the nuclides that have a role in carbon fusion, electron capture, and beta decay.
- Determine the nucleosynthesis properties of the system and assess the dependence on:
  - Density
  - Temperature
  - Composition