Computing the Heavens: An Introduction to Computational Astrophysics

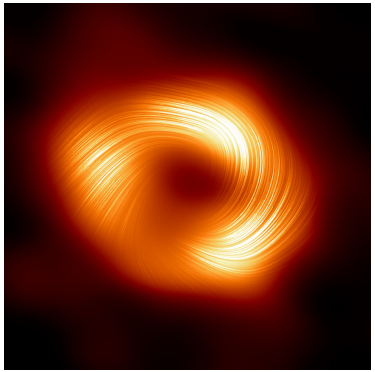
Instructor:
Ian Johnson

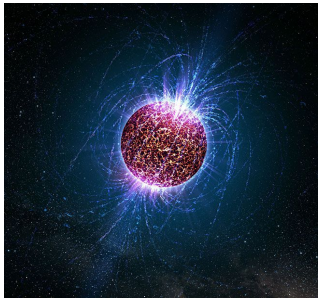
Who am I?

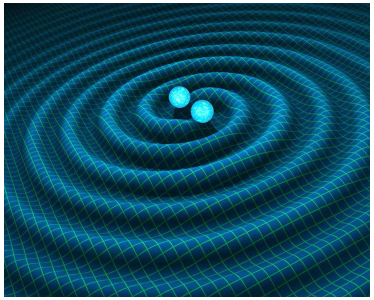

San
Bernardino
Southern
California
Santa Barbara
Ventura
Los
Angeles
Orange
Riverside
Imperial
San Diego

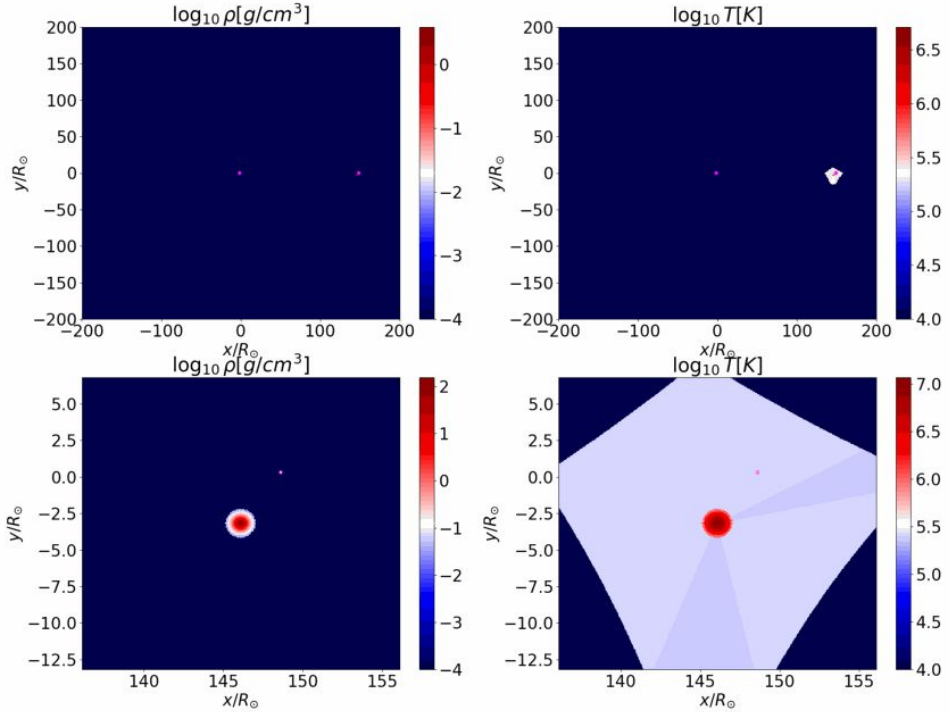

PHYSICS

What Do I Study?

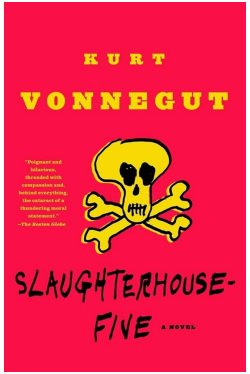


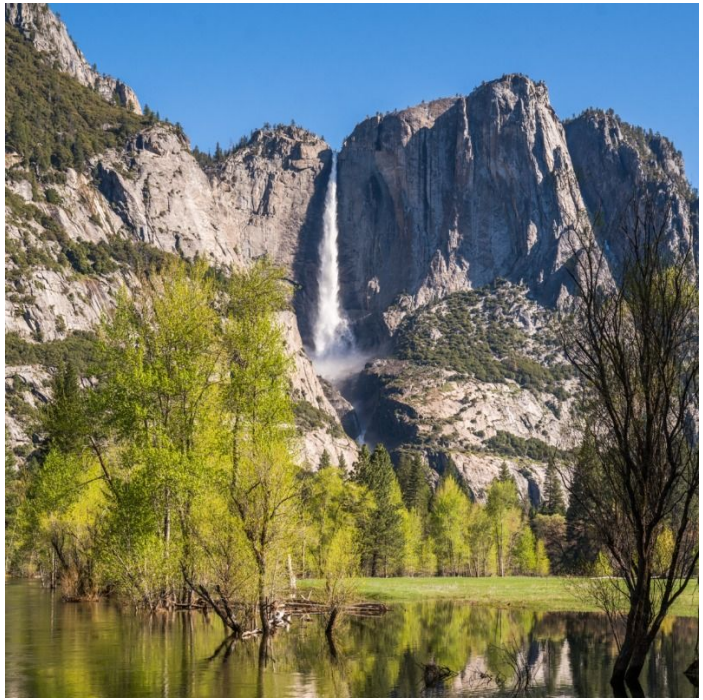


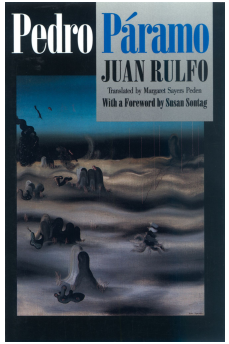




Outside of Work...







Now, About You!

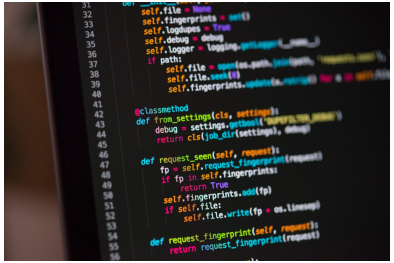
Activity: Make a rough circle

- Name/Pronouns
- School/Year
- Sport/Hobby you do
- Favorite Astro Object
- Name of Previous Students

What is Computational Astrophysics?

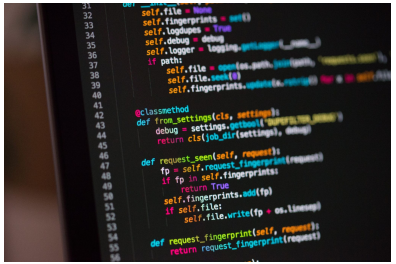
What is Computational Astrophysics?

- Physics
- Astronomy
- Software



What is Computational Astrophysics?

- Physics
  - Math
  - Model Design
- Astronomy
  - Chemistry
  - Optics
- Software
  - Coding
  - Hardware



$$f'(x)=\lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$$

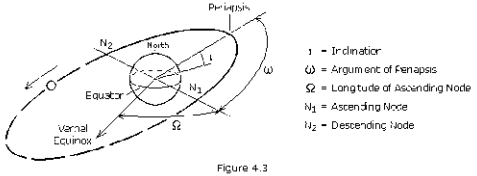
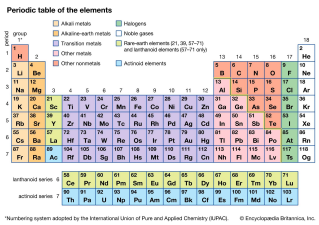
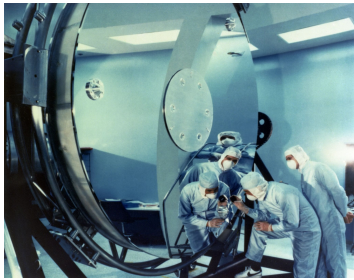


Figure 4.3





And More!

Some Topics

- Simulating the Big Bang
- Simulating black holes merging
- Modeling the chemistry of Exoplanets

Sometimes theory MUST be tested on computers

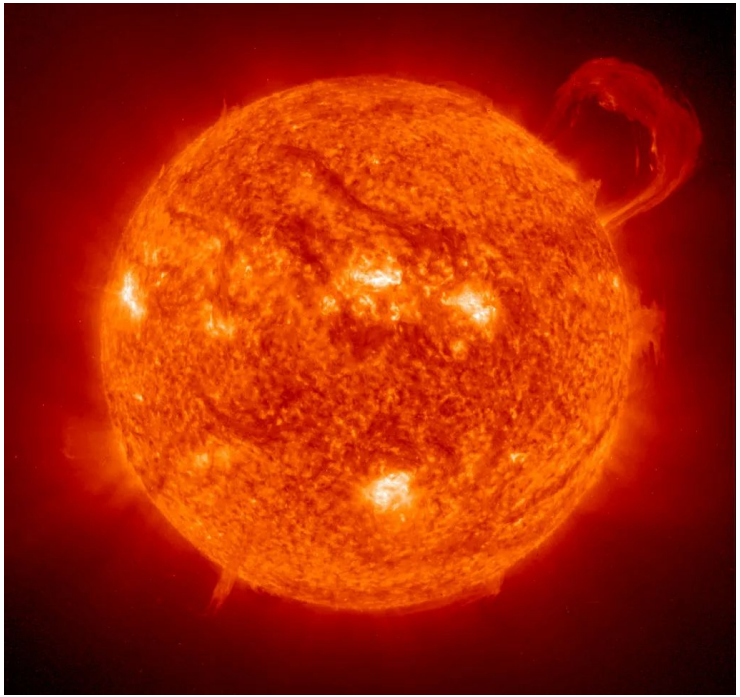
Why?

Stars:

The Building Blocks of Astronomy

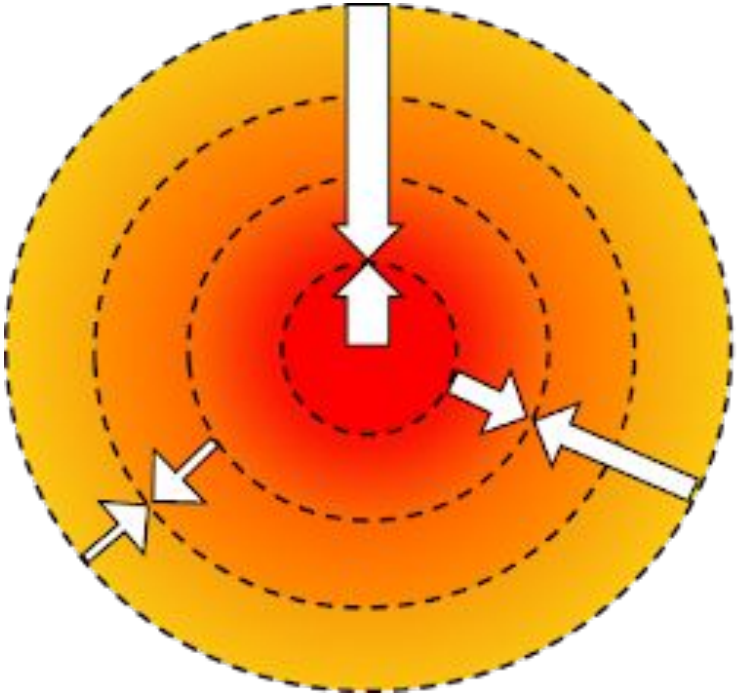
What Are Stars Made of?

- 75% Hydrogen
- 25% Helium
- Trace other elements
- Plasma and a bit of gas



Our Sun—the basis of most stellar astrophysics

Hydrostatic Equilibrium



Hydrostatic equation

$$\rho_r \frac{d^2 r}{dt^2} = -\frac{dP_r}{dr} - G\frac{M_r \rho_r}{r^2}$$

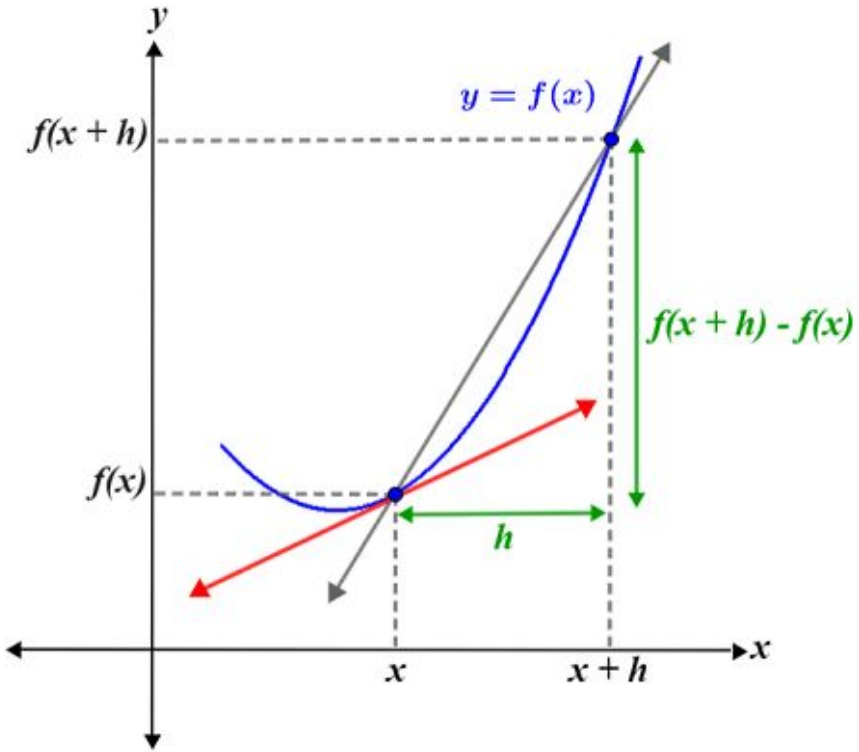
Hydrostatic equilibrium

$$\frac{dP_r}{dr} = -G\frac{M_r \rho_r}{r^2}$$

Derivatives

Notation for the Derivative

$$f'(x) \qquad y' \qquad \frac{dy}{dx} \qquad \Bigg\} \quad \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$



How Can We Use Computers to Calculate a Derivative?

Computers Make Complex Math Trivial

Topics We (may) Cover

- Stars
- Galaxies
- Cosmology
- Coding Essentials
- Guest Tour + Guest Speaker
- **Main Project: Gravitational Waves of Merging Black Holes**