Theoretical Modeling of Massive Stars

Mr. Russell
University of Delaware
Department of Physics and Astronomy
Massive Stars

- **20-100 times the Sun’s mass**
  - Sun has 300,000 Earths in it
  - Massive star has 6,000,000-30,000,000 Earths: Absolutely Huge!

- **Extremely Bright**
  - Blinding if placed next to Sun

- **Short Lifetime—millions of years**
  - Sun lives 10 billion years
  - 10,000 Massive Stars live and die in Sun’s lifetime

- **Produce/distribute almost all elements past H and He in supernova**
Massive Stars

- Light from all galaxies is dominated by massive stars
- Can only resolve massive stars in close galaxies, not small stars
  - All individual stars seen in Whirlpool galaxy are massive stars
- Can only see light from massive stars in distant galaxies
  - All small stars are outshined so light from galaxies shown in Hubble Ultra-Deep Field is all from massive stars
Hubble Ultra-Deep Field (NASA)
Why Make Models?

- Can’t make a star in the laboratory
- Can’t travel to them

- Can observe light from stars
- Can apply physical laws and concepts to learn about stars
  - use computer models to simulate properties of stars
  - match model results to observational data
Thought to be most massive star(s) in our Milky Way Galaxy

10 M\_sun Bipolar Nebula enshrouds star(s) from 1840’s “Giant Eruption”

Very close so lots of data

Data predicts system is actually a binary system with one star \sim 90 M\_sun and the other \sim 30 M\_sun

Think it is in last stages of life before big star undergoes a supernova
**X-Rays of Eta Carinae**

- High energy X-rays penetrate nebula allowing light directly from star(s) to be detected
- Colleague made a model to simulate the two stars
- I analyzed the results to see how the X-ray brightness of the star(s) changed over time
- Excellent comparison between model and observation: suggests Eta Carinae is indeed a binary system