

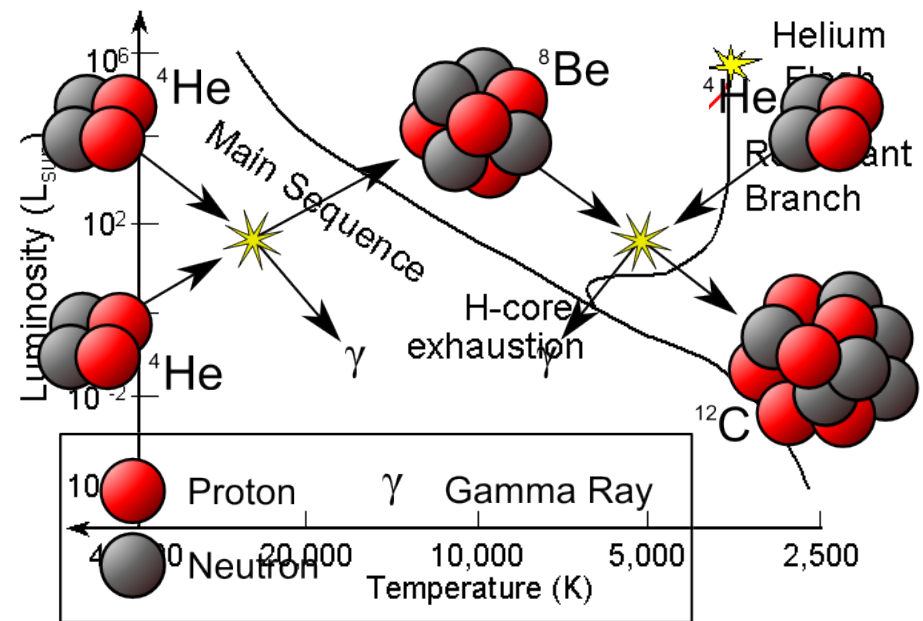
# Introductory Astronomy

Week 5: Stellar Evolution

Clip 5: Post-Main Sequence Sun-II

# Helium Core Flash

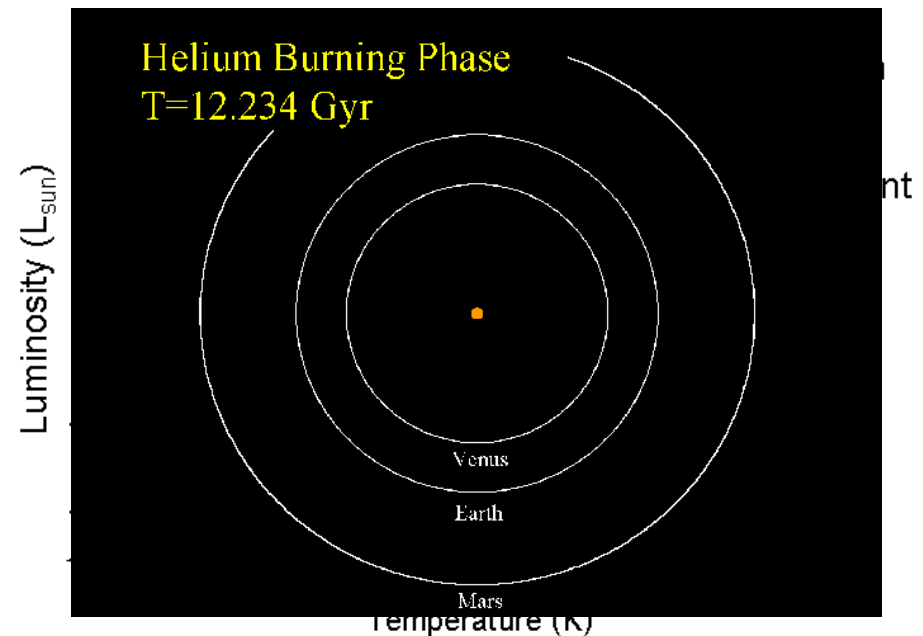
- When core temperature reaches  $10^8\text{K}$  Helium fusion via triple- $\alpha$  process occurs explosively in degenerate core
- For a few seconds produce galactic luminosity absorbed in atmosphere, possibly leading to mass loss
- Expands shell decreasing output
- Envelope contracts and heats



# Horizontal Branch

- Deep convection **rises**
- Convective **core** fusing **Helium** to **Carbon, Oxygen**
- **Shell** fusing **Hydrogen** to **Helium**
- Core **contracts**
- Envelope contracting and **heating**

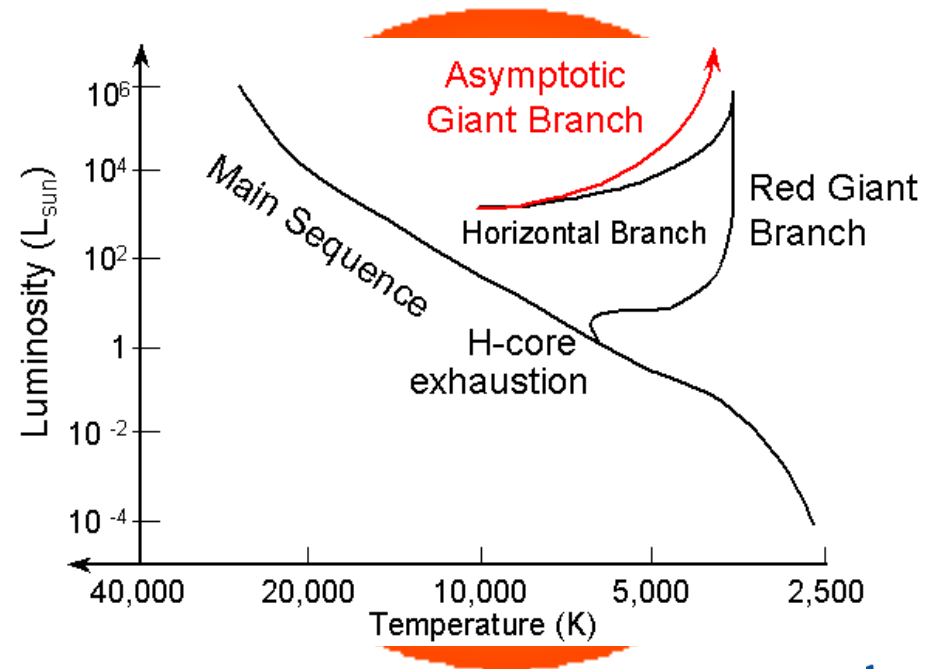
$$T \sim 12.234 \text{Gyr} \quad R \sim 10R_{\odot} \quad L \sim 41L_{\odot}$$



# Early Asymptotic Giant Branch

- Inert **CO core** collapses to degeneracy
- **Helium** fusion in **shell**
- **Hydrogen** shell nearly inactive
- Envelope **expands** and **cools**
- **Convective** envelope deepens: **second dredge-up**
- **Mass loss** in outer layer

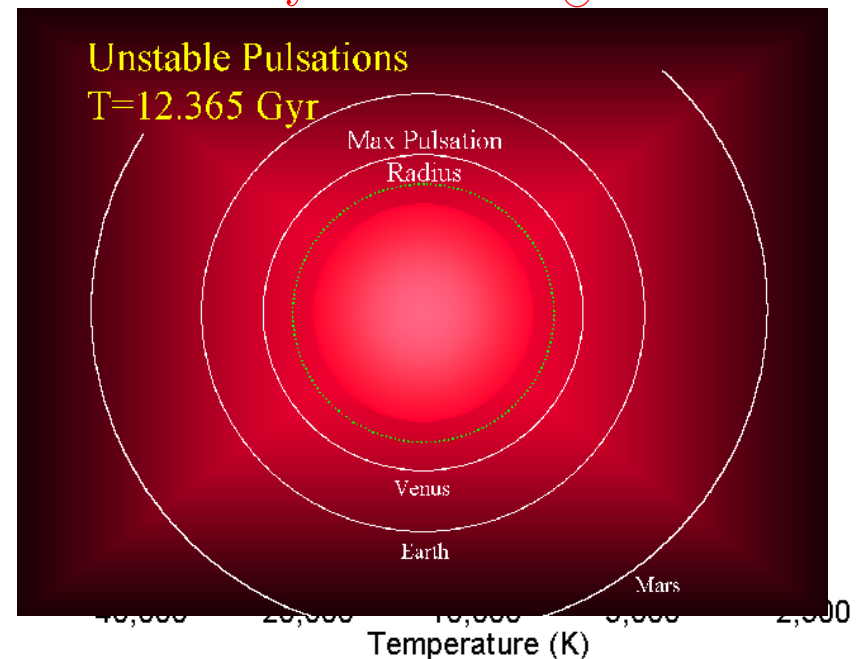
$$T \sim 12.365 \text{ Gy} \quad R \sim 180 R_{\odot} \quad L \sim 3000 L_{\odot}$$



# Thermal Pulse AGB

- Hydrogen shell reignites
- Helium shell flashes intermittently
- Flash expands Hydrogen shell, luminosity drops and envelope contracts heats
- Hydrogen reignition increases luminosity envelope expands cools
- Convection between shells and deep convective envelope: third dredge-up and Carbon stars
- Rapid mass loss to superwind
- s-process neutron capture nucleosynthesis produces heavier elements

$$T \sim 12.365 \text{ Gy} \quad R \sim 213 R_{\odot} \quad L \sim 5200 L_{\odot}$$



# Credits

- Stellar Evolution Figures: R. Pogge, OSU (with permission)  
<http://www.astronomy.ohio-state.edu/~pogge/Lectures/vistas97.html>  
<http://www.astronomy.ohio-state.edu/~pogge/Ast162/Unit2/lowmass.html>
- Triple- $\alpha$  process: Wikimedia/Borb  
[http://en.wikipedia.org/wiki/File:Triple-Alpha\\_Process.png](http://en.wikipedia.org/wiki/File:Triple-Alpha_Process.png)