

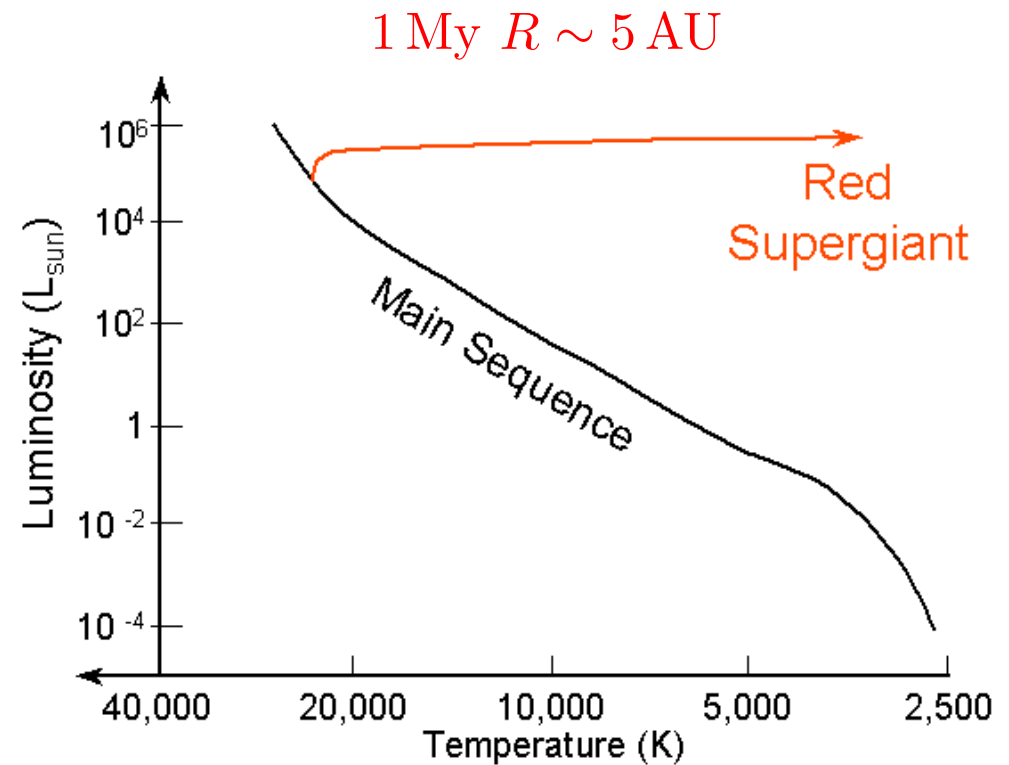
Introductory Astronomy

Week 5: Stellar Evolution

Clip 11: Life in the Fast Lane

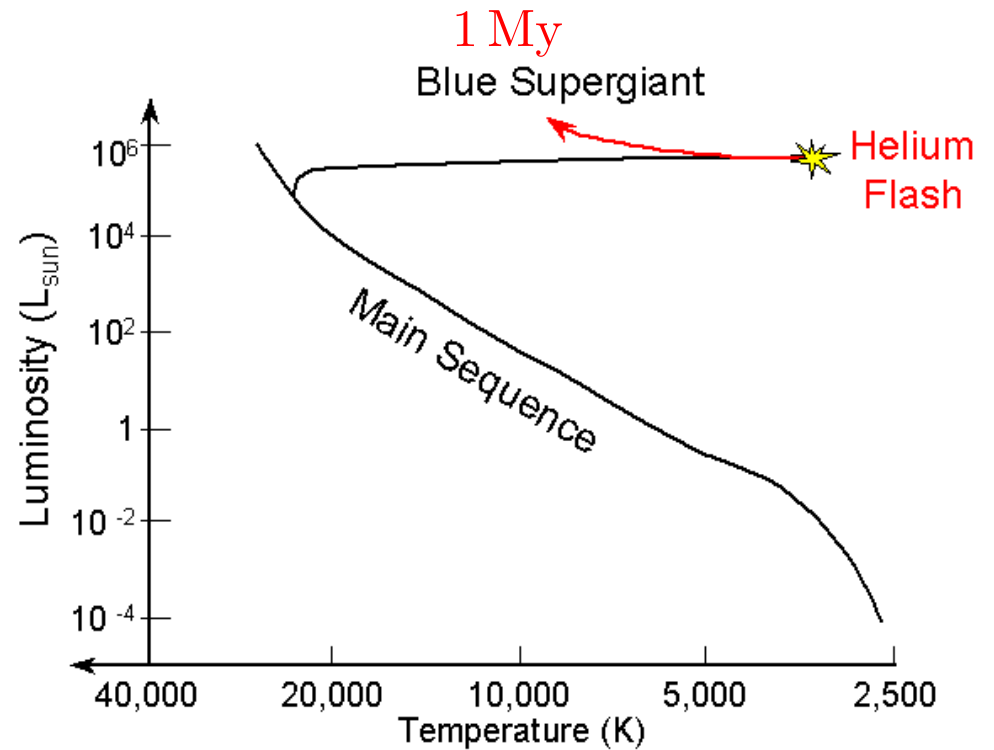
Post-MS Massive Star

- Massive $M > 8M_{\odot}$ stars end Main Sequence life 10 My
- When core Hydrogen fusion ceases core contracts and envelope expands and cools
- Shell Hydrogen fusion: Red Supergiant
- Core does not become degenerate



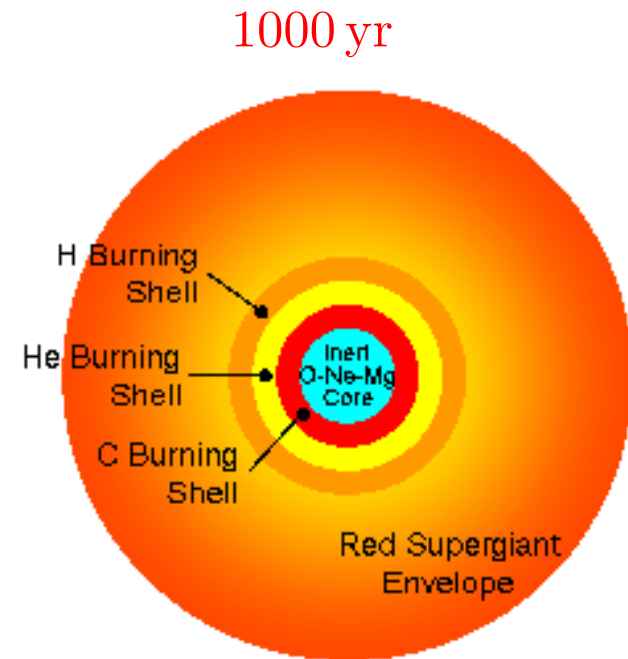
Massive Star HB

- Helium core ignites
- Hydrogen fusion in shell
- Envelope contracts and heats
- Blue Supergiant
- Forming CO core



Massive Star AGB

- CO core **collapses** until
 $T_c > 6 \times 10^8 \text{ K}$
- **Carbon** fusion produces
Mg Ne O
- **Helium** and **Hydrogen**
fusion in **shells**
- Many **neutrinos** carry
energy off
- **Superwind** and **mass loss**

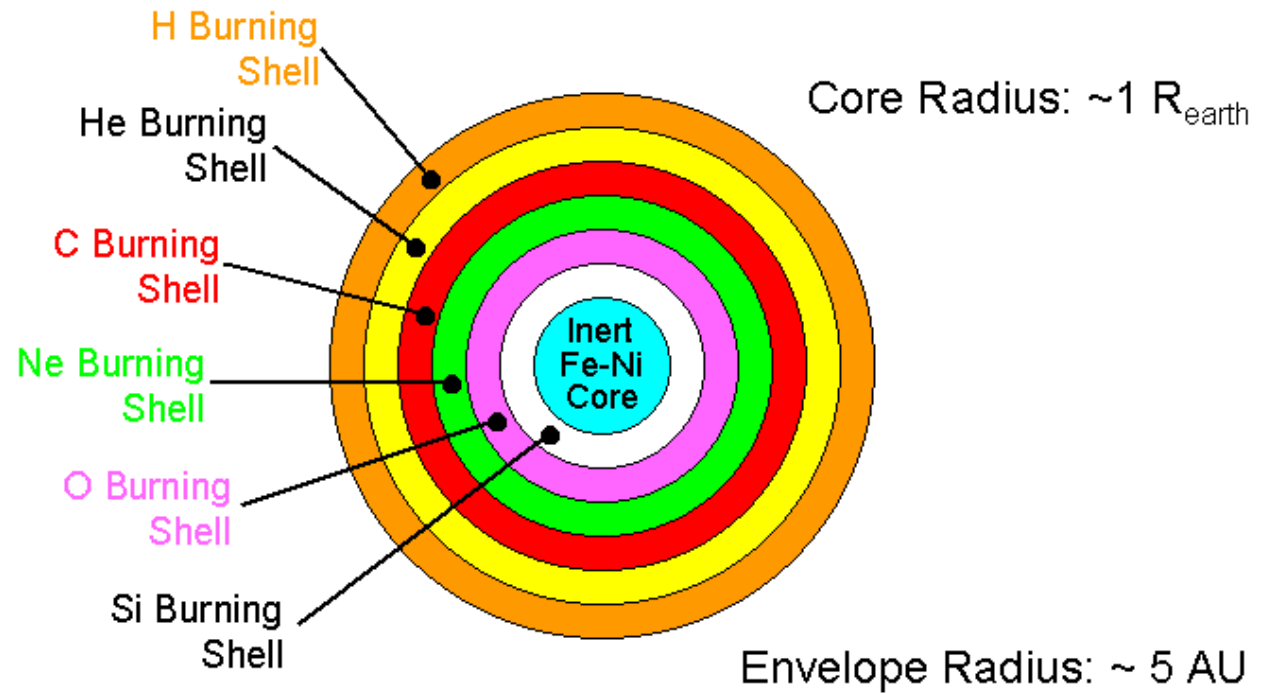


More Onion Shells

- At $T_c \sim 1.5 \times 10^9$ K ignite Neon fusion
 - Produce O Mg...
 - Neutrinos carry off L_\odot
 - Last a few years
- Oxygen fusion $T_c \sim 2.1 \times 10^9$ K
 - Produce Si S P...
 - Neutrinos carry off $10^5 L_\odot$
 - Last about a year
- Si fusion $T_c \sim 3.5 \times 10^9$ K
 - Produce Ni Fe
 - Neutrinos carry off $10^{12} L_\odot$
 - Last about a day
- Build up inert Fe core
- Changes rapid. Envelope never responds
- s-process nucleosynthesis produces heavier elements

End of the (Si) Day

- Inert Fe core
 $T_c \sim 3.5 \times 10^9 \text{ K}$
- $\rho_c \sim 10^{11} \text{ kg/m}^3$
High T photons cause photodisintegration destroying heavy nuclei and absorbing energy
- Fe is the end: no more nuclear energy. What next?



Credits

- Figures and HR Diagrams: R. Pogge (with permission)

<http://www.astronomy.ohio-state.edu/~pogge/Ast162/Unit2/himass.html>