Introductory Astronomy

Week 4: Stars

Clip 15: Main-Sequence Stars

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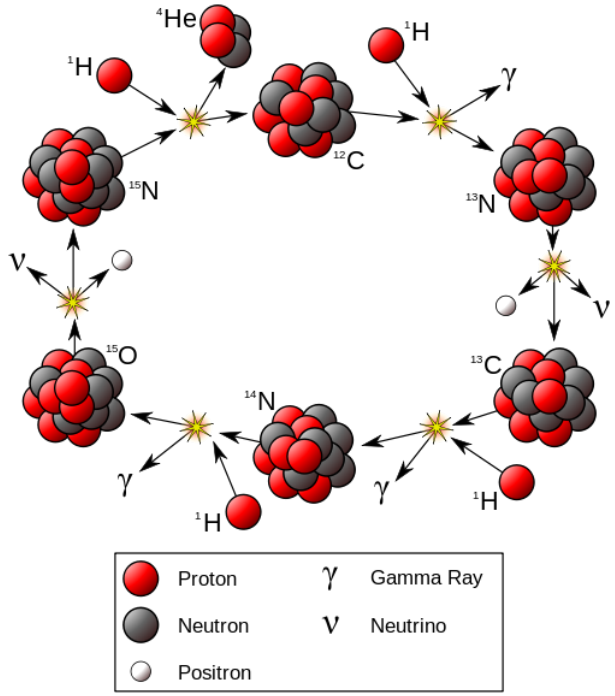
Basics

- Stellar modeling matched to data tells us about how stars work
- Main-Sequence stars fuse Hydrogen to Helium in core
- Hydrostatic Equilibrium determines rate of fusion and density profile from mass

CNO Chain

- In large stars $M > 1.5M_{\odot}$ core hot and CNO chain dominates fusion
- Rate rises rapidly with temperature



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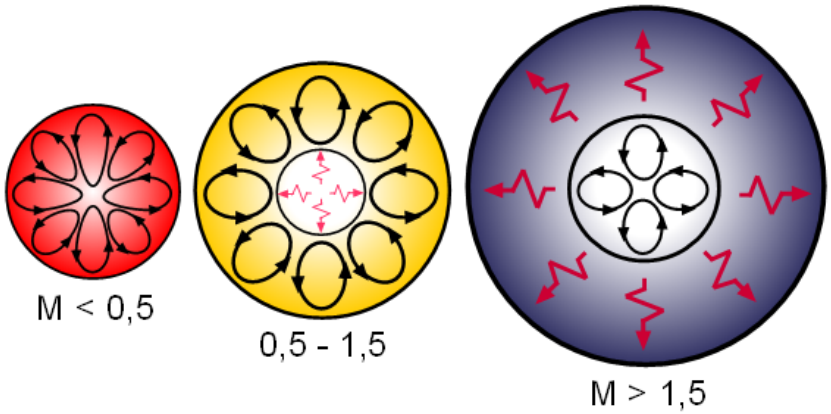
Size Matters

- Mechanisms of heat transfer depend on mass
- In small stars, entire volume convective so all available to fuse in core
- In large stars, radiation and convection zones inverted



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Expansion by Contraction

- As a main sequence star ages core enriched in Helium
- Rate of fusion decreases – temperature and radiation pressure decrease
- Number of particles decreases – thermodynamic pressure decreases
- Core contracts and heats
- Fusing region grows
- Luminosity increases
- Envelope expands

- Sun now 25% brighter than when it formed
- Core now 60% Helium
- Continues to brighten – heating Earth
- In 1-3Gy could be uninhabitable?
- Orbit stable out to 1Gy?

Summary

- For 90% of stars we have a good understanding of how they work
- This comes from careful observation and detailed modeling
- Where do the rest come from?
- What happens when core is all Helium??

Credits

- Stellar Structure: Wikimedia/Xenoforme/GPDL http://en.wikipedia.org/wiki/File:Estrellatipos.png
- CNO Cycle Animation: UNL Atronomy Group http://astro.unl.edu/classaction/animations/sunsolarenergy/fusion02.html
- CNO Cycle: Wikimedia/Borb/GPDL http://en.wikipedia.org/wiki/File:CNO_Cycle.svg
- HR Diagram: ESO http://www.eso.org/public/images/eso0728c/