Class notes for 12 October

Reminders

- Problem Set 4 due Oct. 19 (11.1, 11.2, 11.3, 11.6, 11.8)
- Patten Lectures by Geoff Marcy, Oct. 12 and 14, 7:30 Rawles 100
- Physics/Astronomy Colloquium, Oct. 13, 4 PM, SW119
- Class with Geoff Marcy on Oct. 14 in SW 113

11.1 Solar Interior

Big ideas - Applying the theory of stellar interiors to the Sun

- Atmosphere (optical depth <1, simple approximation of photon diffusion not justified)
- Interior (optical depth >1)
- Basic solar parameters (temperature, composition, mass, radius, luminosity)
- Standard solar model - how do temperature, pressure, density, and composition vary with distance from the center of the Sun?
- Where is the energy produced?
- How is energy transported outward?
- The solar neutrino NON-problem

Problems we will work in class:

1. Estimate the fraction of the Sun’s energy produced by the CNO cycle in the standard solar model

\[ \varepsilon_{\text{CNO}} = \varepsilon_{\text{0,CNO}} \rho X_{\text{CNO}} T_6^{19.9} \]

where \( \varepsilon_{\text{0,CNO}} = 8.24 \times 10^{-24} \text{ erg cm}^3 \text{ g}^{-2} \text{ s}^{-1} \)

\[ \varepsilon_{\text{pp}} = \varepsilon_{\text{0,pp}} \rho X^2 T_6^4 \]

where \( \varepsilon_{\text{0,pp}} = 1.07 \times 10^{-5} \text{ erg cm}^3 \text{ g}^{-2} \text{ s}^{-1} \)

2. Estimate how much the solar constant has changed since complex life emerged on Earth (that is, in the last 600 million years). Assume that the radius has increased about 2% and the surface temperature has increased about 10 degrees (from 5760 to 5770)

3. What fraction of the Sun’s mass is included in the convective zone?
The abundances of $^1\text{H}$, $^3\text{He}$, and $^4\text{He}$ as a function of radius. (Data from Guzik, private communication, 1994.)