Homework Set 5

Due: April 10, 2014, *before class*

1. **Stellar Model with Thermonuclear Burning**

   Based on the Lane Emden Equation solver developed for Homework Set 3, construct stellar models that include nuclear burning.

   Assume a composition that is a mixture of 70 % hydrogen (^{1}H), 28 % helium (^{4}He) and 2 % of nitrogen (^{14}N), by mass fraction.

   (a) Compute a model with $n = 1.5$ and $M = 1\,\mathrm{M}_\odot$. Assume the star generates its energy according to the pp chains. Use formula 18.63 from Kippenhahn & Weigert (1990). For simplicity, assume $\psi = 1$ and $f_{11} = 2$. Assume the star is in thermal and hydrostatic equilibrium, i.e., nuclear energy generation balances luminosity from the surface.

   Find central density such that the luminosity of star equal the solar luminosity. What is the radius of the star? Why does it deviate from that of the sun?

   (b) Compute a model with $n = 3$ and $M = 100\,\mathrm{M}_\odot$. Assume the star generates its energy according to the CNO cycle. Use formula 18.65 from Kippenhahn & Weigert (1990). Assume the star is in thermal and hydrostatic equilibrium, i.e., nuclear energy generation balances luminosity from the surface.

   What is the luminosity and radius of the star for central temperature of $2 \times 10^7\,\mathrm{K}$**,** $2.5 \times 10^7\,\mathrm{K}$**,** $3 \times 10^7\,\mathrm{K}$**, and** $3.5 \times 10^7\,\mathrm{K}$**?**