Name: _____

Problem Set 4

Due Friday, October 19 at 10am

Submit Parts A-B on paper in Class or to Moodle. Submit Part C via Moodle only.

Part A – Conceptual Questions

Answer each of the questions below on a separate sheet of paper. Write legibly or type your answers, which should be in complete sentences and must be in your own words. Each question is worth 3 points.

1. Describe in your own words when the Boltzmann equation is useful, when the Saha equation is useful, and when they are useful in combination.
2. When a star contracts, does is gain or lose gravitational potential energy? Why?
3. What happens to its internal thermal energy as a star contracts? Can you think of any consequences?
4. What forms of energy do we need to consider in examining stars and their structure? Will stars gain, lose, or maintain their total energy over time?
5. A white dwarf has about the same radius as the Earth and about the same mass as the Sun. Compare its bulk density to that of the sun. What are the likely implications of this high density?

Part B – Quantitative Questions

Write out your answers neatly or type them up. Show your work, and make sure all answers have appropriate units. Consider significant figures in reporting final answers.

1. C&O 8.10
2. C&O 8.11
3. C&O 8.13
4. Maoz 3.2
5. Maoz 3.3.

Part C – Computational.

Submit this piece as a Jupyter notebook, including any conceptual questions that are embedded. It requires the supplemental file field_sample.csv, which is available on the course website and on Moodle. It builds directly from In-Class Activity 5, so you may wish to use that activity as a reference.

1. Using In-Class Activity #4 as a model, read in the file field_sample.csv and assign it to a python object called "stars"
2. Make a scatter plot of Teff vs. L for this real sample of stars. Make the y axis logarithmic and reverse the x axis, as you did in In-Class Activity 5. To make a scatter plot, use the command plt.scatter instead of plt.plot. Manipulate the x and y axis limits until your plot looks like a typical H-R diagram

3. Overplot the R=1R$_\odot$ line from In-Class Exercise 5 on your H-R diagram. For what range of temperatures does it overlap the main sequence? Why does this make sense (or not?).
4. estimate the radii of the following types of stars by overplotting stefan-boltzmann relations. In a legend, label each line with its radius value.
    a. A 10,000K star
    b. A 2000K star
    c. A white dwarf
    d. a star near the tip of the giant branch (highest L, lowest T)
    e. What do you take away from