ASTR702 - HW4
September 13, 2024, Due September 20, 2024
2 pt each part

1) At what density is the degenerate pressure greater than the non-degenerate pressure? What radius is this in a star like the Sun?

2) Do the same calculation for when the radiation pressure is greater than the gas pressure.

3) At this point in the semester, we have derived the equations of stellar structure (we'll get to the luminosity equation soon if we haven't already). Although we are lacking in our knowledge of the physics of some terms, we can use this knowledge to create a very basic model star.

You will be computing stellar properties as a function of radius. I suggest at least 100 steps of r, but it's up to you. You will submit the spreadsheet or code over email, and write out any relevant expressions you use on the turned-in assignment. Graphs can be printed out or included in the spreadsheet.

Our four equations are: 1) mass conservation, 2) hydrostatic equilibrium, 3) the "luminosity equation":

$$\frac{dL}{dr} = 4\pi r^2 \epsilon \,, \tag{1}$$

where ϵ is the amount of energy produced per unit volume, and 4) the temperature gradient equation:

$$\frac{dT}{dr} = \frac{3\kappa\rho L}{64\pi r^2 \sigma T^3} \,, \tag{2}$$

where κ is the opacity.

Some parameters that you may need

- If you have to assume a temperature gradient, a good approximation is that the temperature decreases linearly with increasing radius r.
- You can assume the density follows a function, $\rho(r) = \rho_c(1 - r/R_\odot)^{6.69}$, where ρ_c is the central density.

Graph T, ρ, m, P, and the quantity $d\ln P/d\ln T$ as a function of r. For each graph, indicate whether your plot agrees with the one in the text.