ASTR 498N Homework #3 due in class Th 28 Feb

R Please read O&C Ch. 9, Sec. 2 and Ch. 10, Secs. 3 and 4.

P Estimate the central temperature of a star in which the dominant source of hydrostatic support is radiation pressure. Is radiation pressure more important for high or low-mass stars?

P Calculate the Jeans mass for interstellar neutral hydrogen characterized by T = 100 K and $\rho = 10^{-19}$ kg m^{-3}, and also for a cloud of molecular hydrogen characterized by T = 20 K and $\rho = 10^{-22}$ kg m^{-3}. Comparing these Jeans mass with the typical masses of stars, speculate on how star-sized condensations form.

P Define the interface between a stellar core and its envelope as the surface across which the chemical composition changes. In equilibrium, pressure and temperature will be constant across this surface. Show that a density discontinuity must result. If the core is pure He and the envelope pure H, by what fraction must the density change?

P Consider a particle near the center of the Sun. Compare its kinetic energy with its Coulomb interaction energy (O&C §5.3) with the typical nearest particle. Is gas at the center of the Sun a perfect gas to good approximation?

P Show that $P_{gas} = 2\, u_{gas} / 3$ for a perfect gas of non-relativistic particles and $P_{gas} = u_{gas} / 3$ for ultra-relativistic particles, where u_{gas} is the kinetic energy density.

P Use the normalization condition $n = \int_0^\infty f(p)\, g(p)\, dp$ to derive an expression for the chemical potential ψ of a classical gas of non-relativistic particles and show that the condition for a classical gas demands that the average separation of gas particles is large compared with their typical de Broglie wavelength.

P O&C problems:

9.11
10.4, 10.5