Astron 211 Problem Set 7

Given: Nov 1. Due: Nov 8 at the beginning of class

Homework Policy: You can consult class notes and books. Always try to solve the problems yourself; if you cannot make progress after some effort, you can discuss with your classmates or ask the instructor. However, you cannot copy other's work: what you turn in must be your own. Make sure you are clear about the process you use to solve the problems: partial credit will be awarded.
Reading: Kutner Chapter 10,11

Problem 1 Kutner 8.3

For a white dwarf with mass $1\,M_\odot$ and radius $5 \times 10^3\,\mathrm{km}$, find the wavelength to which the Hα line (rest wavelength 656.3 nm) will be shifted by the time it is seen by a distant observer.

Problem 2 Kutner 8.6

a. Compute *your* Schwarzschild radius.

b. What would the density be for a black hole with your mass?

Problem 3 Kutner 11.1

Suppose a supernova explosion throws off $5\,M_\odot$ of material at an initial speed of $10^3\,\mathrm{km/s}$.

a. Calculate the initial kinetic energy of the ejected material and the sum of the magnitudes of the momentum of all of the pieces in the shell.

b. Suppose the shell slows down by conservation of momentum in sweeping up interstellar material. How much mass will be swept up before the shell slows to 10 km/s?

c. If the average number density of interstellar material is 10^6 H atoms/m^3, what is the radius of the shell when it reaches 10 km/s?

Problem 4 Lines of Sight and Olber's Paradox

a. Suppose that in Sherwood Forest, the average radius of a tree is $R = 1$ m and the average number of trees per unit area is $\Sigma = 0.005$ m^{-2}. If Robin Hood shoots an arrow in a random direction, how far, on average, will it travel before it strikes a tree? [Hint: Consider the mean free path in Kutner section 6.2]

b. Suppose you are in an infinitely large, infinitely old universe in which the average density of stars is $n_\star = 10^9$ Mpc^{-3} and the average stellar radius is equal to the Sun's radius, $R_\star = R_\odot = 7 \times 10^8$ m. How far, on average, could you see in any direction before your line of sight struck a star? (Assume standard Euclidean geometry holds true in this universe.) If the stars are clumped into galaxies with a density $n_g = 1$ Mpc^{-3} and average radius $R_g = 2000$ pc, how far, on average, could you see in any direction before your line of sight hit a galaxy?