Astron 300 Problem Set 8

Due: Wednesday, Nov 17 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: Carroll & Ostlie, Chapter 12

Problem 1 Carroll & Ostlie 12.2

Problem 2 Solar Strömgren Sphere

The Sun emits 5×10^{23} photons per second with $h\nu > 13.6\,\mathrm{eV}$. If the density of hydrogen atoms in interplanetary space is $n = 10^9\,\mathrm{m}^{-3}$, what is the size of the Suns Strömgren sphere? Assume a recombination coefficient $\alpha = 2.6 \times 10^{-19}\,\mathrm{m}^3\,\mathrm{s}^{-1}$.

Problem 3 Cloudy Collision

Suppose that two cold ($T = 100\,\mathrm{K}$) interstellar clouds of $1\,M_\odot$ each collide with a relative velocity $v = 10\,\mathrm{km\,s}^{-1}$, with all the kinetic energy of the collision being converted into heat. What is the temperature of the merged cloud after the collision? You may assume the clouds consist of 100% hydrogen.

Problem 4 Column Density

Column density is the integral of number density along the line of sight. It gives the number of atoms you would find if you had a tube of area $1\,\mathrm{m}^2$ that was infinitely long. For something with uniform number density n_H, the column density $N_H = n_H \times L$, where L is the line-of-sight distance through the cloud.

We observe an interstellar cloud, with temperature $T = 80\,\mathrm{K}$ and neutral hydrogen density $n_H = 10^8\,\mathrm{m}^{-3}$, at a distance $d = 100\,\mathrm{pc}$. Suppose that the cloud is spherical and that the column density of neutral hydrogen atoms through its middle is $N_H = 1.5 \times 10^{24}\,\mathrm{m}^{-2}$.

a. What is the diameter of the cloud?

b. How many neutral hydrogen atoms are in the cloud?

c. What is the mass of the cloud (in units of $M_\odot$)?