ASTR121 Homework #10 – (Hamilton)
due Thursday May 1 (15 Points)

Finishing reading Chapter 23. These first three problems are from that chapter.

30. The disk of the Galaxy is about 50 kpc in diameter and 600 pc thick. (a) Find the volume of the disk in cubic parsecs. (b) Find the volume (in cubic parsecs) of a sphere 300 pc in radius centered on the Sun. (c) If supernovae occur randomly throughout the volume of the Galaxy, what is the probability that a given supernova will occur within 300 pc of the Sun? If there are about three supernovae each century in our Galaxy, how often, on average, should we expect to see one within 300 pc of the Sun?

39. According to the Galaxy's rotation curve in Figure 23-18, a star 16 kpc from the galactic center has an orbital speed of about 270 km/s. Calculate the mass within that star's orbit.

*41. Show that the form of Kepler's third law stated in Box 23-2, $P^2 = 4\pi^2 a^3/G(M + M_\odot)$, is equivalent to $M = rv^2/G$, provided the orbit is a circle. (Hint: The mass of the Sun ($M_\odot$) is much less than the mass of the Galaxy inside the Sun's orbit (M).)

Finishing reading Chapter 24. These next three problems are from that chapter.

34. As Figure 19-19 shows, there are two types of Cepheid variables. Type I Cepheids are metal-rich stars of Population I, while Type II Cepheids are metal-poor stars of Population II. (a) Which type of Cepheid variables would you expect to be found in globular clusters? Which type would you expect to be found in the disk of a spiral galaxy? Explain your reasoning. (b) When Hubble discovered Cepheid variables in M31, the distinction between Type I and Type II Cepheids was not yet known. Hence, Hubble thought that the Cepheids seen in the disk of M31 were identical to those seen in globular clusters in our own Galaxy. As a result, his calculations of the distance to M31 were in error. Using Figure 19-19, explain whether Hubble's calculated distance was too small or too large.

42. It is estimated that the Coma cluster (see Figure 24-21) contains about $10^{13} M_\odot$ of intracluster gas. (a) Assuming that this gas is made of hydrogen atoms, calculate the total number of intracluster gas atoms in the Coma cluster. (b) The Coma cluster is roughly spherical in shape, with a radius of about 3 Mpc. Calculate the number of intracluster gas atoms per cubic centimeter in the Coma cluster. Assume that the gas fills the cluster uniformly. (c) Compare the intracluster gas in the Coma cluster with the gas in our atmosphere (3×10^{19} molecules per cubic centimeter, temperature 300 K); a typical gas cloud within our own Galaxy (a few hundred molecules per cubic centimeter, temperature 50 K or less); and the corona of the Sun (10^5 atoms per cubic centimeter, temperature 10^6 K).

48. According to Figure 24-34c, elliptical galaxies continue to form stars for about a billion years after they form. Give an argument why we might expect to find some Population I stars in an elliptical galaxy. (Hint: Table 19-1 gives the main-sequence lifetimes for stars of different masses.)