Astronomy 1143 Homework 2

October 21, 2015

1. (a) What is the typical temperature of an O-type star?

   (b) If this star has a radius ten times that of the Sun (remember the Sun's radius is $R_\odot = 7 \times 10^{10}$ cm), then what is the luminosity of this star in erg/s? Hint: The Stefan-Boltzmann constant is $\sigma = 5.67 \times 10^{-5}$ erg/s/cm^2/K^4.

   (c) The Sun's luminosity is $L_\odot = 4 \times 10^{33}$ erg/s. How many times more luminous is this star than the Sun?

2. Two Cepheid variable stars, Star A and Star B, have the same period of fluctuations. Star A is observed to be 100 times brighter than Star B.

   (a) Which star is farther away?

   (b) How much farther?

3. The nearest star, Proxima Centauri, has an apparent V magnitude of 11.13. Its absolute V magnitude is 15.60. Based on these two numbers, what then must be the distance to Proxima Centauri? Remember, show your work!

4. There are 411 cosmic microwave photons per cubic centimeter of the universe. The average energy of a cosmic microwave photon is very small: only $E = 10^{-15}$ erg (1 erg $= 6.242 \times 10^{11}$eV).

   (a) What is the energy density of the Cosmic Microwave Background, in ergs per cubic centimeter?

   (b) Using Einsteins relation, $E = Mc^2$, what is the equivalent mass density, in grams per cubic centimeter (Hint: the speed of light is 3×10^{10} cm/s)?

5. The rest wavelength of the Lyman α emission line is $1215\mathring{A}$. This is in the ultraviolet part of the spectrum, which is not observable with ground-based telescopes. For galaxies at high redshift, however, this emission line can be found in the optical or infrared part of the spectrum, making it a good tool for finding high redshift galaxies. Recently astronomers discovered the farthest known galaxy, which has a redshift of $z = 7.1$.

   (a) What is the observed wavelength of the Lyman α line from this galaxy? Which region of the electromagnetic spectrum (UV, radio, gamma rays, etc.) does this lie in?

   (b) The Universe, due to the expansion of the universe, cools as it gets older. The temperature at a given redshift z is given by $T = T_0(1 + z)$, where T_0 is the CMB background temperature today, about 2.73K. What was the CMB temperature at the redshift of this galaxy?