Astronomy 120 "Galaxies and the Universe" Summer 2018
Homework Assignment #8 DUE: Friday June 22, 2018

HOMEWORK PROBLEMS:

1. (20 points) Figure 24-9 (in 10th edition; Fig 25-9 in 8th+9th edition) shows the radio galaxy Centaurus A, which does not exhibit apparent superluminal motion as viewed from earth. Is it possible that somewhere in the universe there is an alien astronomer who observes apparent superluminal motion in the AGN jets of Centaurus A? Explain your answer with a labeled drawing showing the relative positions of the Earth, the alien astronomers, and Centaurus A, and the jet axis.
[HINT: Draw a diagram showing the "unified AGN model", NOT a diagram of superluminal motion!]

2. (30 points) This problem attempts to demonstrate how jets from active galactic nuclei can have apparent superluminal motion. Suppose the distance from point A to point B in Figure 24-11a (in 10th edition; Fig 25-14a in 8th+9th edition) is 13 light years, and the blob moves at 13/15 of the speed of light. As the blob moves from A to B, it moves 12 light-years toward the earth and 5 light years in a transverse direction.

a.) How long does it take the blob to travel from A to B (in years)?

b.) If the light from the blob at A reaches earth in 2014, in what year does the light from B reach Earth?

c.) As seen from earth, at what speed does the blob appear to move across the sky?

SHOW A DIAGRAM WITH LABELS FOR THIS PROBLEM! YOU MUST SHOW YOUR WORK!

3. (30 points) Notice that once you have measured a numerical value for $H_o$, you can use Hubble's Law to obtain the distance of an extragalactic object for which you know only its redshift. Suppose the spiral galaxy Arp122 has a redshift $z = v/c = 0.0444$.

a.) At what wavelength is the radio HI line (rest wavelength 21.12 cm) observed?

b.) What is the distance to Arp122 (in both Mpc and lightyears), given the measured value of the Hubble "constant" of $H_o = 73.0$ km $s^{-1}$ $Mpc^{-1}$?

c.) How many years ago were the photons that we now detect emitted from this galaxy?

4. (20 points) Suppose you were not held together by electromagnetic forces. How long would it take you to grow 2 centimeters because of the expansion of the universe?
[HINT: Apply Hubble's Law to your head as seen by your feet. Calculate the velocity in cm/sec between your feet and head, using v=Hd, where H is the Hubble "constant", and d is your height. With this "expansion" or "growth" velocity, figure out how long it will take you to grow an additional 2cm.]
[ANOTHER HINT: Take care with units!]