Astronomy 211
Fall 2017

Problems for Tutorial Week #9
Non-Optical Astronomy
Some problems from E. Jensen

1. What are the two main sources of background noise in IR observing, and how can they each be mitigated?

2. McLean gives the following estimates for the brightness of a moonless night sky in magnitudes per square arcsecond: 24.0 at 4300Å, 13.5 at 2.2mm, and 0.0 at 10mm.
   Convert these values to brightness ratios:
   a) How many times brighter is the sky at 10mm than at 2.2mm?
   b) How many times brighter is it at 2.2mm than 4300Å?
   c) Finally, how many times brighter is it at 10mm than at 4300Å?

3. Describe the wavelength range probed by the ALMA telescope array and discuss the kinds of astronomical investigations ALMA is especially valuable for.

4. a) Explain what is meant by the "beam pattern" of a radio telescope. Draw the one-dimensional beam pattern of a radio telescope, labeling the main beam and the sidelobes. (What sort of graph is this? What does distance along this graph represent?)

   b) What do the sidelobes represent? What is the optical telescope equivalent? Why don't we generally have to worry about them in the same way we do at radio wavelengths?

5. a) What is meant by the brightness temperature of a source.
   b) What is meant by the antenna temperature detected by a radio telescope.

6. Choose an object that has been observed with Chandra. What new has been learned about it through X-ray observations, and how is that knowledge integrated into a deeper understanding of that specific object and/or that class of object?

7. *Primary source data investigation:*
   Log into one of the Astronomy Department network computers. Mount the astro-server and go to the A211T_F17 folder. Download the folder labeled "ALMA" to your Desktop. Disconnect the astro-server.

   In the ALMA folder is a paper by Bally et al. on OMC1, a molecular cloud core in the Orion Molecular Cloud located just behind the familiar Orion Nebula. These investigators studied "streamers" of CO-emitting gas they conclude are due to an explosion generated by the ejection of two massive stars from OMC1 500 years ago. Also in the folder is a fits file data cube, OMC1.fits.

   Read and absorb as much as you can from the paper, particularly the Introduction (including section 1.2), section 4.1 (The Streamers), and Conclusions.

   Find the *Aladin* application in the Applications folder and open it. In the dropdown "File" menu, click "open local file" and select OMC1.fits. This file contains 300 images of OMC1 covering a range of radial velocities from roughly -120 to +120 km/sec. *Aladin* will play them automatically as a movie (which you can control with the control bar at the top of the window). The velocity of each image is shown in the upper left of the screen in black-outlined yellow numbers. Watch this movie several times to get a feel for it. (Make sure the entire image area is shown – there is a zoom control bar on the right of the main window.)

   a) Describe what is shown in an individual image; what changes from image to image?

Look up what is meant by a "Hubble Law." The most famous example is the cosmological observation involving the recession speeds of galaxies, but the general principle applies in other situations as well.

b) Describe how the Hubble Law applies to this data: looking at the movie of these images, what behavior demonstrates it? (Hint: the movie starts at the most negative velocity and moves through 0 to increasing positive velocities.)