Homework Set 8

Due Date Thursday, December 2nd, 1999, at the beginning of class.

1 Leave it to Beaver

Two beavers build dams in the river. Each beaver claimed to have the better dam, so they went to war. The beaver who won ended up having a distinguised career serving in the U.S. House of Representatives for 22 years. The beaver who lost lived a life of ignominy and seclusion until he died in a tragic stapler accident in 1992. Please do Shu Problem # 2.3.

2 Resolution and Light Gathering Power of Telescopes

1. Let's say you are an astronomer living on a planet orbiting Alpha Centauri, 4.3 light years away, and you want to build a telescope with which to study Earth at optical wavelengths. You want to be able to observe the planet Earth in fine detail. How big would your telescope need to be in order to resolve an object on Earth, say the size of a goat? Name an object of comparable size to the telescope. (Feel free to make reasonable estimates of certain quantities in this problem.)

2. Now suppose you want to observe Earth with radio telescopes in the same detail. What size telescope would you need to resolve goats who emit radio waves at 1 GHz?

3. Now let's come back to observing the Universe from Earth. What are the advantages of the Hubble Space Telescope over ground-based telescopes? What are the disadvantages? Describe a scenario in which you, as an astronomer, would want to use HST over all available ground-based telescopes. Now describe a scenario in which the Keck Telescope in Hawaii would be the better choice.

3 Purple Rays

Consider a glass prism whose cross-section is an equilateral triangle. A ray of purple light is incident on the prism from the left, travelling parallel to its base. What is the angular displacement of the red and blue rays that emerge from the right-hand side of the prism? Does the red ray emerge above the blue ray, or vice versa? The refractive indices of red and blue light in glass are 1.513 and 1.528 respectively.

4 CCD Detectors

A CCD detector is mounted at the focus of an $f/14$ reflecting telescope with a 40-cm-diameter mirror. The CCD chip contains 500 by 500 pixels, with each pixel being 20 μm square.

1. What is the angular size (in arcseconds) of the sky which is imaged on each pixel?
2. What is the angular field (in arcminutes) of the CCD chip?

From Zeilik and Gregory, pg. 199, # 14