

Astronomy 3
Lab 2: Stars and Galaxies
Due Feb. 19

In this lab you'll use the telescope to look at a few different types of objects. You'll also look at the sky without the telescope to locate a few objects and draw a star map of their locations. You might find it useful to look at a star chart...an interactive chart can be found on the web at: <http://www.fourmilab.ch/yoursky/>

1 Binary Stars

Something like half the stars in the Universe are thought to be in binary systems, where two stars orbit each other. In this part of the lab, you'll look at two different binary star systems.

Sirius is the brightest star in the sky and is in fact a binary star. Its companion, Sirius B, is not a main sequence star but rather a white dwarf, the first ever discovered. At the end of its life, our Sun will become a white dwarf.

The star h3945 CMa is in the constellation Canis Major. In this binary system, both stars are on the main sequence. The brighter star has an apparent magnitude of 4.8 while the other has an apparent magnitude of 6.8.

Recall that magnitude is a logarithmic scale which describes how bright a star is, and that a lower magnitude corresponds to a brighter star. Apparent magnitude expresses how bright a star appears in the sky (i.e. its *apparent* brightness) and absolute magnitude describes how bright a star is intrinsically (i.e. its luminosity). Apparent magnitude (m) can be converted to apparent brightness using the not-so-pretty formula

$$\text{apparent brightness} = 10^{-4(4.76-m)}(3.196 \times 10^{-10} \text{ W/m}^2)$$

- a. Stepping outside the observatory, identify Sirius in the sky without the telescope and sketch its location with respect to the constellation Orion. Now try to see Sirius B through the telescope. It might be hard to see since Sirius is so much brighter. Why is Sirius B so dim?
- b. Make a sketch of the h3945 CMa system as you see it through the telescope, labeling each star's color and which one is brighter. Make your sketch inside one of the circles on the sketching paper provided, and let the circle represent the edge of the telescope's viewing area. Pay particular attention to the spacing of the stars relative to the size of the viewing area. If you have trouble determining the colors of the stars, ask your TA for help.
- c. Use your observations and your general knowledge about stars to answer the following questions about h3945 CMa. You'll find helpful information in Chapter 12 of the textbook.

1. Which star has the largest absolute magnitude?
2. Which star is more luminous?
3. From the colors, estimate the spectral class of each star (this can be a very rough estimate!).
4. Estimate the distance to the system by following these steps:
 - Use the spectral types to estimate the luminosity of each star.
 - Given the apparent magnitudes, calculate the apparent brightness of each star.
 - Compare the apparent brightness to the luminosity and use the inverse square law to get the distance.
5. The Shattuck telescope has a field of view with an angular diameter of 32.75 arcminutes. Using this, estimate the angular separation between the stars. Assuming the line connecting the stars is perpendicular to the line of sight, use trigonometry to calculate the physical distance between the stars (the last part of Appendix 1 in the textbook may be helpful).

2 Star Clusters

In this part, you will look at two types star clusters: open clusters and globular clusters. The globular cluster you will see is M79; it is approximately 42,000 light-years from earth. The open cluster is the Pleiades; it is only about 400 light-years away.

- a. Make a sketch of each cluster you see and label the type of cluster.
- b. Make a sketch of what you'd expect the H-R diagram to look like in each case. Which cluster is older?
- c. Which cluster do you expect to have a higher abundance of elements more complex than Helium? Why?
- d. Knowing the angular diameter of the telescope field-of-view, estimate the angular diameter of the globular cluster. Use this to determine its physical size.

3 Galaxies

- a. Make a sketch of the Andromeda galaxy and its companions.
- b. Estimate the angular size of Andromeda. You will probably only be able to see the innermost, brightest part of the galaxy with the telescope you're using.
- c. The Andromeda galaxy is about 2,900,000 light-years away. Using this, calculate the physical size of Andromeda from your estimated angular size.
- d. Draw a star map showing the location of the Andromeda galaxy, labeling the two nearest constellations.