

Astronomy 220
Observing Exercise
Spring 2009

Location of the Leitner Family Observatory: 355 Prospect St., near the Betts House, just north of Edwards St..

There are three parts to the observing exercise lab. You should do each of these parts in groups of 3 or 4 people per telescope. You can do the parts in any order. The entire lab should take about 1.5 to 2 hours.

Part I: Saturn

The 8-inch Reed refractor in the east dome at the observatory will be pointing at the planet Saturn. View Saturn through the telescope and answer these questions.



1. Make a rough sketch of what you see through the telescope eyepiece. Indicate any gaps you notice in the rings as well as shadows and colors (you might see the shadow the rings on the planet). Also indicate any of the moons of Saturn that you can see near the planet.

2. Step outside to the observing deck and find Saturn in the sky with your naked eye. Look around at the constellations, find the Big Dipper, and then find due north (ask for help if you need to). Find due west, and think about where and when the sun sets in late March and early April. Based on where the sun is now and where Saturn is right now, make a sketch showing how the earth, sun and Saturn would be arranged in the Solar System as seen from high above the north pole of the Sun. Your sketch doesn't need to be to scale, but consider the fact that the distance from the sun to Saturn is about 9.5 AU.

If the moon is up on the evening you are at the observatory, there will be a 5-inch telescope set up on a tripod on the observing deck pointed at the moon. Look at the moon and be amazed!

Part II: Imaging

Go into the west dome outside and check out the 0.4 meter Ritchey-Chretien telescope. Climb up the ladder and take a look down the tube at the 0.4 meter (16-inch) mirror. Although we can attach an eyepiece to this telescope for visual observations, we often use this telescope with a digital camera for imaging, and we usually control it from the "warm room" inside the building. Notice the CCD camera attached to the telescope, and then follow the data cable all of the way back into the warm room.

At the controls of the telescope, swing the telescope around to point at the spiral galaxy M81. Take a sequence of short exposures to check the centering and focus of the telescope—an observing assistant will help you with these procedures. Once you have the galaxy in your sights, take 3 x 1 minute exposures through the "Luminance" filter (which is just a clear filter). Then take 9 x 1 minute exposures through the "H-alpha" filter, which only passes the 656 nm wavelength of red light from recombining hydrogen gas. Taking multiple images and combining

them allows you to avoid streaking of the image due to tracking error and it also allows you to filter out cosmic ray hits.

Once you have these images, your observing assistant will show you how to combine the images using a program on the control computer called "MaxIm" and save them as a TIF files so that you can download them and analyze them later. You should end up with a master "luminance" image and a master "H-alpha" image. Save them in subfolders for your group, so that you know which image to download later.

After imaging M81, swing the telescope over to look at M82, which is a very different looking galaxy. Again, take 3 x 1 minute images through the clear filter, and 9 x 1 minute images through the H-alpha filter. Combine and save the images using MaxIm, such that you end up with a single combined "luminance" image and also a single "H-alpha" image.

You will download these images later and answer some questions about them, but even at the telescope controls you might notice and want to discuss some of the differences between the two images for each of the galaxies.

If you have time, try pointing the telescope at a few other galaxies in this part of the sky and taking some images for fun.

Part III: Spectroscopy

The 12-inch Meade Schmidt-Cassegrain telescope will be set up outside on the observing deck with a small CCD camera attached. This CCD camera has a transmission grating in front of it, so that it acts like a slitless spectrograph. Any light passing through the grating will be dispersed, such that the light will be focused onto the CCD chip at a different position depending on the wavelength of the light (See <http://snipurl.com/grating> for information on this grating, especially the box at the very end of the article). Not having a slit in the spectrograph means that images of the object at different wavelengths will overlap.

Working with the observing assistant outside at the telescope, point the telescope at the planetary nebula NGC2392 (also known as the "Eskimo Nebula"). This nebula is just a bit south of a relatively bright star, HIP36370, which has a magnitude of 8.21 and a spectral type of F5 III. (See <http://snipurl.com/n2392> for a picture.) You can make sure that the telescope is pointed correctly and is in focus by checking out the image of HIP36370.

When viewing through the transmission grating, the CCD camera will show "zero order" images of the stars, but off to one side you will see the first-order spectrum. Move the telescope around (and rotate the camera on the telescope if necessary) in order to get a good spectrum of both the star HIP36370 and all of the planetary nebula NGC2392. To avoid streaking of the stars due to tracking errors, it will be best to take many short exposures, which you can then shift and combine to make one master image.

Once you have a good image of the spectrum of NGC2392, save the image as a TIF file in a subfolder for your group, so that you will be able to download the image later for analysis.

Post-Observing Analysis

After your observing session, your data will be uploaded to fop.astro.yale.edu/astro220 in a subfolder for your date of observing and your group.

M81 and M82:

Download the images you took of M81 and M82 and open them up in an image viewer (such as in Preview on a mac or Picasa on a PC). Answer the following questions about these images.

1. Compare the "L" images for M81 and M82. Based on the visible light morphology, what type of galaxies are they?
2. Compare the H-alpha images for each of these galaxies. Astrophysically, what do the H-alpha images for these galaxies show? You should notice that the stars are not nearly as bright in the H-alpha image compared to the L image... why is this? Are there any interesting differences between the two galaxies in H-alpha?
3. Do some research on the M81 and M82 group online and see if you can find an explanation for the morphology of M82 in both the luminance image and also the H-alpha image.
4. Assuming that M81 would appear circular if seen face on, estimate the angle the disk of the galaxy makes to our line of sight.

Spectroscopy:

Download your image of the spectra of NGC2392 and answer the following questions.

5. Since HIP36370 is an F5 star, which spectral lines would you expect to see in the star? Can you see any absorption lines in your image of the spectrum? Do they make sense?
6. Describe and explain the spectrum of NGC2392. Remember that you are using a slitless spectroscope.
7. You may see a continuous line running through the center of the NGC2392 emission features, as if there is a source of continuum emission in the center of the nebula. Check to see if this is in your spectrum, and if so, explain its source.

If you are interested in doing some more advanced work on the raw images from the telescope, we have some copies of MaxIm which you can borrow and install on your own computer (Windows only, unfortunately). For example, you could calibrate the wavelengths of the spectra that you took with the transmission grating and determine the wavelengths of the emission features of NGC2392.