v. 7, May 2024

**Astro 103/104 lab Name: _____ Date: ___/__/200_ Sec. __**

# The Paramount Lab

This lab is preparation for actual image taking with the instrument in the little dome of Kennon Observatory. It must be done, and turned in, only a few days before your actual observation (barring a sudden weather change), and the students must receive an acceptable grade on it before they may proceed to the work in the little dome.

## 1. Reading

Read Sect. 6 ("*LEARN HOW TO USE THE CAMERA*") in the CCD booklet, and review Secs. 1, 2, and 5.

Answer the following questions and turn in the answers. Use a separate sheet.

1. Why do you need to cool the camera, and what is an acceptably cold temperature for the chip?
2. Explain what happens to stars whose pixel reading goes beyond 40,000 on an image.
3. What is the image depth of a decent astronomical CCD, and of a regular digital camera? How does this difference show up in the number of shades of gray that can be contained in an image?
4. What happens if (by mistake) you flat field an image before dark subtraction?
5. What does the tracking chip do?
6. How precisely (in millimeters) do you have to focus the telescope?
7. What is the expected star size, and what is the size of a pixel?
8. What does the "focusing" utility do in CCDops?
9. What does "dual CCD view do in CCDops?
10. Why do you need to use self-guide for longer-than-a-minute exposures?
11. How long is an acceptable guiding exposure?

*Each student must answer these questions individually. Do not work them in groups; it is not appropriate to accept help for these. During your observation the instructor will evaluate how well you understand your own answers.*

## 2: Computer work

Start up TheSky 6 on a Windows computer (you have access to the computers in Lewis Hall and the Kennon Observatory astro labs).

Open the settings file called *ParamountLab.sky*.

1. On the time panel (DATA→TIME…) check that the date is Sept. 12, 2007, 8:10 pm, and the clock is not going.
2. Click on Pluto to bring up the information panel. Find some of Pluto's data:
   RA: ___ DEC: ___ Brightness: ___ Altitude: _____
   Airmass: ____ Transit time: _____ Hour angle: _____

Notice that the hour angle indicates how many hours Pluto is after transit. You want to take all your images as close to transit as you can, but you cannot take images during transit (you'll work either before transit or after transit).

3. Notice the red vertical dashed line towards the South (the *meridian*). An object that is just crossing is called *transiting*. Click on an object close to the meridian. What is its hour angle? _____.
4. Set the time at 10 pm. Which way (E, W, S, N) did the sky turn? _____ Read off Pluto's hour angle now (click on it again): _____.
5. Use find (hit letter F) to find M27, and center it using the object panel's bottom left "center" icon. Change the view to "telescope view" (hit CTRL-T). Notice that you must select the sky; if the object panel is selected, CTRL-T won't work. Scroll the mouse to zoom so that the field all fits on the screen.

On the SE from the nebula, inside the donut between the two concentric red circles, there is a reasonably bright star (SAO 88047). Turn the FOVI position angle towards that star, so it ends up inside the rectangle that represents the guide chip. (Click the red lines to reveal the turning orange handle of the FOVI indicator). You find the position angle of this star at _____ degrees, and its brightness is ____. You can use it as a guide star (any star brighter than 9-10$^{mg}$ will do).

6. Now turn the whole field so that the picture is horizontal, and the guide chip is up. Use the ROTATE TOOL on the toolbar (in the shape of a circular arrow). Read off the position angle of the sky (this is the way the camera needs to be oriented). It is in red letters in the middle of the field, but you'll see it only if you zoom out strongly by scrolling. You find the position angle: _____. Now zoom back by CTRL-T again.
7. On the time panel, set TheSky to use the computer's clock (hit the little yellow clock icon.) Read off M27's data. Date&time now: _____, RA: _____ DEC: _____ Brightness_____, Altitude: _____ Size: _____ Hour angle: _____. Based on these data, if it were dark now, would it be possible to take images of it now? Explain your yes/barely/no answer in a sentence or two: _____ _____.
8. Zoom back out by CTRL-B ("binocular view"). Then, hit "*ZENITH UP*" (the little icon on the toolbar with a Z in it) and scroll and use the green up-down-left-right arrows to move around a bit. Stop the clock and set the time to 10:30 pm tonight. Record the date: _____. Navigate to looking just over the horizon line in the south, then move up and find a Messier object (such as M113). Click on it, center, and zoom in. Find the brightest guide star around it, set the guide chip in its direction, and turn the field upside up as you did in part 5. Read off the camera orientation (*not the FOVI position!*)

Your object is ____; Altitude ___, Hour angle ___, brightness: _____, guide star's name: _____, brightness: ___, camera orientation needed:_____.

# The paramount lab – instructor's guide

During their first observation session, about one hour long, the students are supposed to:

1. Go up to the little dome with the lights on (so that they can see the equipment), explained the safety issues (hole in the floor; hitting the telescope with their backs in the dark; kicking the telescope pier and cause shaking). Explain that at most two students can work in a group.
2. Explain what the fans do and why. Show ice-water cooling, and the water thermometer. Make sure the students know what cooling does (7 degrees of cooling cuts the noise in half, exponential dependence). Start cooling.
3. Explain that the telescope is controlled by TheSky6. Show the meridian, and explain why the telescope cannot track through transit. Explain that imaging must be done in the 3 hours just before transit or in the 3 hours just after transit. Have students find an object in the sky and slew the telescope to it.
4. Explain that the camera is controlled by CCDops. Show camera setup and temperature control. The thermostat should not run at more than 90% power, 70% is ideal. Use (if at all possible) -30°C. The water temperature should be colder than 12°C, otherwise more ice is needed.
5. Show the focusing procedure.
6. Show system of folders to save data.
7. Slew to an object, and show how to run Dual CCD imaging. Use Motion Controls to get a guide star on the guide chip. (Use green filter, an 8-10 mg star will do, tracking exposure no more than 2 sec, shorter is better.)
8. Take 2-3 minute guided exposures of the object with R, G, B filters, one each.
9. Have the students fill out the Notes.xls files. They should do it right after the observation downstairs in the transit room. Have them email the notes file to ttorma@phy.olemiss.edu when finished.
10. Tell the students that they should process (not very carefully) the three images. They need to turn it in within 7 days of the observation.
11. Circumstances permitting, have them take a picture of the Moon. Use a narrowband filter (one color is enough). Make sure two panels cover the whole Moon. Take 5 images of each, using Autograb. Tell the students they need to process the Moon images within 3 weeks, and have their progress checked out in 2 weeks.
12. Make a paper record of the names of the students, what object, and all of the deadlines the students were given. Make sure the students also record their deadlines.

Have the students do as much of the computer work as possible; and make sure both students do their share of it. Have them swap several times.