CCD Imaging Practice
Observational Astronomy

Name: ____

Introduction

This activity continues your use of the 16" telescope and CCD camera. You will determine the plate scale, measure the sky brightness, and attempt to image a galaxy.

These instructions assume you remember the basics of telescope and camera operation from your first use of the telescope. It may help to look back on those instuctions during this activity.

Plate scale

Get the telescope and camera ready for observing. This is a CCD imaging activity, so you will only need to be in the dome when you are moving the telescope. Your first goal is to calculate the plate scale for the telescope. This will allow you to determine the field of view of the CCD.

One way to determine the plate scale is to take an image of an object with a known angular size. Since you know the dimensions of the CCD chip (which you are using instead of actual photographic plates), you can then calculate the plate scale. A double star is a good choice for plate scale determination. It is recommended that you use Albireo.

Move the telescope to Albireo, take a good image, and calibrate it using Maxim's **Process** > **Calibrate** command. You now need to measure the separation of Albireo's components. The most accurate way to do this is with Maxim's Information Window, which you can find under **View** > **Information Window**. Set the **Mode** to Aperture. When you move the cursor over the image, you will see concentric rings instead of the usual pointer. The inner circle is the *aperture*, the inner ring is the *gap*, and the outer ring is the *annulus*. You can control the size of all of these by right-clicking on the image. You should now adjust aperture to contain one of Albireo's components. (If you double-click on the image, the aperture will stay there, and you can then move it with the arrows keys.)

The information in the measurement window that you are currently interested is the **Centroid**. These are the exact coordinates of the center of the star. (It's just a weighted average of the center of brightness). Measure the pixel coordinates of both components of Albireo, and record them below:

Now use the distance formula ($d = \sqrt{x^2 + y^2}$) to calculate the separation in pixels:

Since we know that Albireo's separation is 34 arcseconds, calculate the angular size of one unbinned pixel (you probably used 3-by-3 binning, so you need to divide by 3):

To get the full plate scale (i.e., CCD chip scale), multiply by the dimensions of the CCD, which are 1530 by 1020 pixels. Record the field of view below:

As a final calculation use $F = \frac{20.6 \cdot s}{L}$, where F is the field of view (pixel or chip) in arcseconds, s is the linear size in the focal plane in microns, and F is the telescope's focal length in centimeters. If one (unbinned pixel) is 9 microns, what is the focal length of the telescope?

Sky brightness

Now you will make a measurement of the sky brightness. The method you will use involves calibrating against a star of known brightness. A good faint star that is relatively close to zenith at this time of year is 14 Cygni, which has an apparent magnitude of 5.4.

Move the telescope to 14 Cygni (it should be in ACE's Yale Bright Star Catalogue) and take a good image. Use the **Process** > **Calibrate** command and open the Information Window. Adjust the aperture size to fit around 14 Cygni. You should also adjust the gap and annulus sizes so that the annulus samples an area away from the star.

Now look at the Information Window. You are now interested in **Intensity** and **Bdg Avg**. The intensity is the total number of counts in the aperture region, and the background average is the average number of counts per pixel in the annulus region. Since the annulus is just on the sky, it gives a measure of the sky brightness. Record the values you read here:

You first need to convert counts per pixel to counts per square arcsecond. Using the fact that unbinned pixels are 9-by-9 microns, calculate average counds per square arcsecond:

Now use the relation between magnitudes and intensities ($m_a - m_b = -2.5 \cdot log(\frac{I_a}{I_b})$), and the fact that counts correspond to intensity, to calculate the sky brightness in magnitudes per square arcsecond. Record this below, along with any relevant comments on light pollution and the phase of the moon.

Imaging a galaxy

You will use your remaining observing time to take an image of a galaxy. M102, the Spindle Galaxy, is your most promising target, but if you want to try for another, check with the TA.

Find the Spindle Galaxy in ACE's Messier catalogue. You can follow the same basic procedure as usual for centering, though you will have to increase your exposure times accordingly. Once you've centered the Spindle, try taking a longer exposures (say, five minutes). Save your galaxy image. You should also use **Process** > **Calibrate**, adjust the Screen Stretch, save the image as a JPEG, and print out a copy to hand in with this lab.

If you are the last group using the telescope, be sure to shut the dome and stow the scope properly.