

<p style="text-align: center;">CCD Observing Practice Observational Astronomy</p>
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Name: _____

Getting started

This activity is an introduction to using the 16-inch telescope and the CCD camera. The skills you learn here will be important in future activities, so be sure to pay attention to how everything works.

This assumes you're starting with the dome closed and the telescope stowed. Both computers and all the telescope electronics should be powered. (Ask the TA for help if they are not.) Turn the telescope key to the ON position (you should hear humming). Launch the ACE software on the telescope control computer (the widescreen one) and log in with the username and password the TA gives you.

The main ACE window should appear, along with the ACE SoftPad and the SAFETY INTERLOCK windows. The SAFETY INTERLOCK window will pop up whenever people move in the dome; move this window off to the side. The left side of the main window shows the status of the observatory systems. In general, red means no power or stowed, yellow means adjustment in progress, and green means powered or action successfully completed.

The right side of the main window shows detailed information on the telescope's status. The sidereal time in purple refers to the point of right ascension that is directly overhead. Also displayed is where the telescope is currently pointing, with equatorial (i.e., celestial) coordinates in green.

The center of the main window contains the database display and the primary controls. Right click in the black area and select **Open Existing Database**. There are three main databases available: `ACE_BSC5.cat` is the *Yale Bright Star Catalogue (version 5)*, a comprehensive listing of stars down to almost magnitude 8. `ACE_Messier.cat` is the *Messier Catalogue*, a list of star clusters, nebulae, and galaxies first compiled by Charles Messier while hunting for comets. `ACE_NGC.cat` is the *New General Catalogue*, a comprehensive collection of deep sky objects.

Open the Bright Star Catalogue and note the columns showing the catalogue name, right ascension (**R.A.**), declination (**Dec.**), and magnitude (**Vmag**). If you click on a column heading, it will sort the catalogue in ascending or descending order. Sort by magnitude and find the double star Albireo (Beta Cygni), which has a magnitude of 3.08 listed. Double click on this entry, and watch the information appear below the catalogue display.

This is a good point to start up the CCD camera. Make sure the hanging extension cord is plugged in, then go to **Observations > Observer(s)** in the ACE window. In the green **Observer(s)** field,

enter your name(s). In the orange **Directory** field, enter a folder under C:\DATA\. You can enter a new folder, or follow any instructions given by the TA. The yellow fields control how the autosaving of images works. The default setting is the date with a number appended to it. In the future, you may want to change the prefix or suffix settings to indicate the object you're imaging and any filters you may be using. For now, you shouldn't need to change anything here.

Now, click on the **Simple** tab in the **Observations** window. This will launch the MaxIm DL imaging software on the camera computer; the software will automatically connect to the camera. The status of the camera will be displayed in the **MaxIm CCD** window. You can control the temperature setting of the camera by clicking on the **Cooler** button. Make sure it is set at 5°C unless the TA tells you otherwise.

Observing with an eyepiece

(Note – If you need to bring the telescope or dome to a stop at any time, click on the red **STOP** button in the ACE window, or press one of the big red buttons on the wall.)

First, you need to open the dome. If the TA says it's OK, use the **Dome > Open Shutter** command to do this automatically. (Note that you can open both the main shutter and the dropout, or just the main shutter.) Otherwise, the TA will show you how to do it manually.

Next use **Telescope > Mirror Cover Park** to move the telescope to a position where you can remove the covers. Check that the area around the telescope is clear, then click **PARK**. Once the telescope has stopped moving, remove the covers from the main tube and from the 4-inch finderscope.

Beta Cygni should still be selected in the ACE window. (You may need to click from the **H.A.** tab back to the **R.A.** tab.) Click on the big green **GO TO** button. The software will warn you there are people in the dome — click on **Yes**. Another window will appear with the details of the coordinates the telescope is moving to — click on **Move Telescope**. Finally, the software will ask if telescope tracking should be turned on — click **Yes**.

The telescope will move so it is pointing at Albireo. Do not impede its motion in any way. You will know the move is finished when the **GO TO** button reappears. Now, you want the dome to line up with the telescope. Go to **Dome > Auto Dome**, then click on **Yes** to turn dome tracking on. The dome will move to align itself with the telescope. If you need to adjust the alignment, you can try using the switch at the top of the yellow hand paddle, or the **Forward** and **Reverse** buttons on the wall box.

Take a look through the finderscope. You should see Albireo (it will be offset from the crosshairs a little). Next, look to where the camera is mounted. If the 50mm eyepiece isn't already also mounted, ask the TA where it is. Push the little sliding plunger on the camera/eyepiece mount inward. This moves a mirror so you can use the eyepiece. Before you look, go to **Telescope > Focus**. Click on **50mm**, then **Go To Focus** to go to a base focus for this eyepiece.

Now take a look through the eyepiece. If you want to adjust the focus, you have several options. The easiest is to use the two small buttons on the telescope tube. You can also use the yellow hand paddle's **Focus** + and - buttons. These adjust the focus at the slowest speed. Holding down **Set** while pressing the + and - buttons adjusts the focus at an intermediate speed, and holding down **Slew** adjusts the focus at the fastest speed. You can also enter a focus setting in the green field in the **Focus** window, then click **Go To Focus**. The **Jog** + and **JOG** - buttons will adjust the focus by the amount you enter in the yellow field. Finally, the **ACE SoftPad** is a virtual version of the hand paddle. The + and - buttons at the bottom of this window also control the focus, with the speed depending on whether **Fine** or **Coarse** is selected.

Alibireo is probably not quite centered. To move the telescope, you again have several options. The hand paddle's **N**, **E**, **S**, and **W** buttons move the telescope at the slowest speed. As with focusing, holding down **Set** moves the telescope at an intermediate speed, and **Slew** is the highest speed. The gray buttons on the **ACE SoftPad** also move the telescope, as do the intermediate **NE**, **SE**, **SW**, and **NW** buttons. The speed depends on whether **Guide** or **Set** is selected. Finally, you can enter offsets in right ascension and declination in the ACE **Offset** tab, then click **GO TO**.

1. Draw what you see in the eyepiece, making notes if you can discern any color:

Using the CCD

Now it is time to begin observing with the CCD. Pull out the mirror plunger so light can reach the camera. Also remove the eyepiece and replace it with the red cap. Since you want to avoid light leaks in the camera, you will be moving into the warm room for this part of the activity. Make sure the camera's power and data cables are not caught anywhere, then turn off the computer screens and dome lights. Move into the warm room, where the two computers should be on. Use the *VNC Viewer* and the password supplied by the TA to remotely access the telescope and camera computers. The telescope computer's IP address is 128.113.8.4, and the camera computer's IP address is 128.113.8.138. Once the viewer is launched, press F8 to see a menu allowing you to close it.

To take images, you will use the controls under the **Simple** tab of the ACE **Observations** window. Check that the **Binning** field is set to **3** and that the **Full** box is checked. (This tells the software to read out the full CCD chip while grouping 3 by 3 blocks of pixels together.) The green **Time** field

controls the length of the exposure, with 0.12 seconds being the shortest. The red **Sets** field controls how many exposures are made; keep this set at **1**. The **Image Type** buttons allow you to switch from taking normal images to taking calibration images; keep this set to **Light**. Finally, if **AUTOSAVE** is checked, any images you take will be automatically saved using the names and folder you specified earlier in the **Setup Observing** tab. The autosave settings can be changed at any time.

Before you take an image, the focus needs to be adjusted. In the ACE **Focus** window, click on **CCD**, then **Go To Focus**. Now set the exposure time to 0.5 seconds and click **START OBSERVATION**. The status of your observation will be displayed in the box under the controls. When the exposure is finished and the image is read out, it should appear in MaxIm DL (on the camera computer).

You will want to change the display settings in the **Screen Stretch** window to adjust contrast. The histogram shows the frequency of pixel intensities in the image, with intensity on the horizontal axis and frequency on the vertical axis. The red marker sets the black point for the image, while the green marker sets the white point for the image. You can either drag these marker with the mouse, or use the presets in the drop-down menu. Try the **Low**, **Medium**, and **High** settings.

If Albireo isn't centered in the image, there is an easy way to center it. In MaxIm, place the cursor over the point you want centered and note its pixel coordinates in the status bar at the bottom of the screen. In ACE, go to **Telescope > Center CCD** and enter these pixel coordinates in the window that appears. When you click on **Center Star**, an offset is calculated and placed in the **Offset** tab. Click **GO TO** to use this offset.

2. Draw what you see on the computer screen. How does it look different from what you saw in the eyepiece? What effect does changing the **Screen Stretch** settings have?

3. How could you get a quantitative measurement of the brightness of a star from the CCD image?

4. How could you get a quantitative measurement of the position of a star from the CCD image?

Using the filter wheel

Now you will take images of Albireo through different color filters, which only let through light in a specific wavelength range. Attached to the camera is an SBIG CFW-8A filter wheel. This is a rotating wheel that holds up to five filters. Generally, the first position on the wheel is left blank to allow for unfiltered imaging. This is the default setting unless you tell the software differently. ACE uses this position automatically when you use the **Observations** window.

Since you now want to use filters, you must use MaxIm DL's **CCD Control Window**. Under the **Expose** tab is a box that should read **None**. Use the pull-down arrow to reveal your other options. There should be clearly labeled **Red**, **Green**, and **Blue** filters available. Switch to the red filter.

Now, use the controls in this tab to take a 5 second light exposure of Albireo. Save the image, making sure it is clearly marked as taken through a red filter (e.g., **albireo-r.FITS**). Take 5 second exposures using the green and blue filters and save them in a similar manner. You will combine these into a color image in a later activity.

Your own image

Choose another object to image; something from the Messier Catalogue is probably a good idea. (When you move the telescope, be sure someone is in the dome watching it.) Try to take a good image of your chosen object, using your own judgement on exposure lengths and filters. You'll go over calibration in more depth in another activity, but for now just use the **Process > Calibrate** command to clean up

your image. Remember to adjust the **Screen Stretch** settings.

Once you're satisfied with how your image looks, go to **File > Save As**. Set the **File Filter** to **JPEG**. A warning will appear telling you the JPEG format cannot handle the range of pixel values. Check **Auto Stretch**, which will produce an image based on the current **Screen Stretch** settings. **Save** your image in your folder.

5. Print out your image using the printer in the warm room, which is connected to the computer on the left. The camera computer's `C:\DATA\` directory should be mapped as a network drive, giving you access to your image. Label what object it is and hand the printout in to the TA.

Shutting down

When you're finished observing, click on **Warm Up** in the **MaxIm CCD** window. This will warm up the CCD chip. Next, use **Telescope > Mirror Cover Park** and replace the primary and finder covers. Then go to **Telescope > Zenith Park** and click **OK** to stow the telescope with tracking turned off. When the telescope has finished moving, turn the key to the OFF position. The dome is normally parked facing west: use the switch on the hand paddle or the buttons on the wall box to do this. If the TA says it's OK, close the dome using the **Dome > Close Shutter** command. Otherwise the TA will show you how to close the dome.

When you're done, go to **User > Logoff** and click **Yes**. This will close down both ACE and MaxIm DL. If no one else is using the observatory tonight, turn off the lights and computer monitors.