VAN VLECK OBSERVATORY 24" PERKIN TELESCOPE

CCD OBSERVING MANUAL

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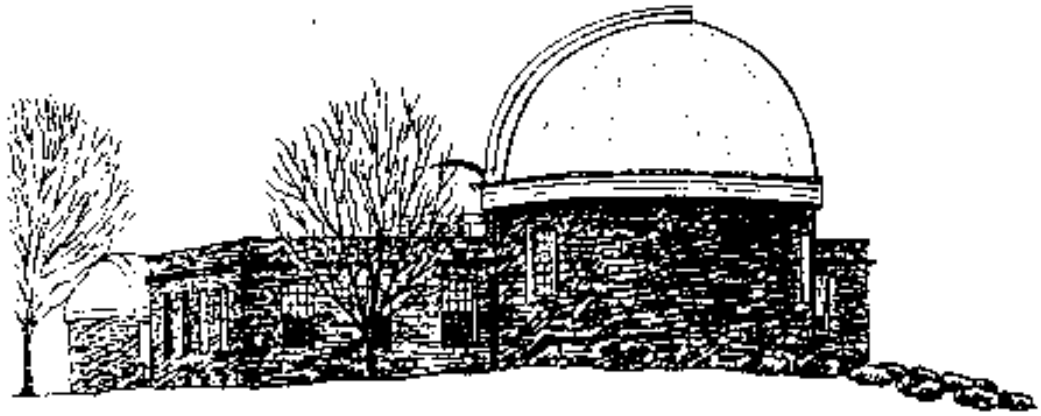

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Chapter 1

Opening Up

Arrive 1 hour prior to sunset. The period between sunset and the end of astronomical twilight is typically the busiest (and in some sense the most important) part of the observing session. Please don't take it lightly! You will need at least an hour in order to get the telescope opened up, to get the camera cooled down, and to take the necessary calibration data.

1.1 In the Dome: Turn on telescope

1. **Make sure the warm cabinet is on (check the light on the power strip and check that the warm cabinet is actually warm) and make sure the computer in the warm cabinet is on (the little green light should be on).** The computer in the warm cabinet is called **astroperkin**.
2. **Remove the cloth cover from the camera/filter wheel assembly.**
3. **Get the key out of the desk drawer and turn on the telescope.**
4. **Plug in the autoguider USB cable**

1.2 In the Warm Room: Start cooling camera

1. On the iMac:

(a) **Log in as observer**. The password is **24Inch!**.

(b) If given the choice of orion or undergrads, **double-click on orion.**

(c) Now you need to remote access astroperkin in the dome. **Click on the remote access icon on the toolbar at the bottom center of the screen (it looks like a satellite dish).** Hit the connect button when it comes up, and then log in as observer with the same password as before.

(d) Once you are logged onto astroperkin, **double-click on the MaxIm DL icon.** This is the program we use to control both the camera and the filter wheel along with the autoguider.

(e) **Click on the Camera Control Window button.** The button is on the top row, seventh from the left; it "kind of" looks like a sideways view of a CCD camera. You can also use the shortcut Ctrl+W, or find it under the drop-down menu under View.

(f) **Under the Setup tab, click on Connect.** You should now be connected to the 24" telescope's CCD camera (Camera 1: "Apogee USB/Net") and autoguider (Camera 2: "SS Autoguider"). NOTE: If you get an error that says it failed to initialize the camera or the filter wheel, refer to the Trouble Shooting Guide (§8.1).

(g) **Turn the cooler on by clicking on the On button in the Coolers section of the window.** Only the 24" telescope's CCD is cooled, the autoguider is not cooled[1].

(h) **Click on the Cooler button in the Camera 1 section of the window and set the temperature to 35 degrees below the given ambient temperature.** The ambient temperature is given as soon as you turn on the camera; it's the Sensor Temperature in the box labeled Camera 1 Information. *NOTE*: If, after reaching the setpoint, the cooler power is using less than 80%, you can decrease the setpoint further. In the opposite case, if, upon reaching the set temperature, the cooler power reads more than 90%, then you'll have to back off on the setpoint. Usually this only takes 1-2 degrees. In short: **the ideal cooler power to be using is 80-90%**; adjust the setpoint accordingly. Also, the

[1] Though it is cool. B–)

cooler can take a fair amount of time cooling to a given temperature or even adjusting temperatures once cooled, so allot plenty of time for this.

1.3 In the Dome: Open dome slit

(a) **Start the dome slit motor.** If not already plugged in, the plug should be hanging from the left corner of the slit, just above the door. Pushing the switch to the left opens the slit, pushing it to the right closes the slit, and the center position of the switch is the off position. *NOTE:* To switch directions make sure the slit has come to a complete stop before trying to reverse directions. If it does not come to a full stop the dome will continue in the same direction that it was moving before even if you flip the dome slit motor switch to the opposite direction.

(b) **While the slit is opening, open the bottom part of slit with the hand crank.** Crank it all the way to the stop and then take up slack on the cable. If you are not observing right after taking your calibration fields, you can save opening the lower slit until later. You may need to gently push out on the bottom part of the slit until it can hold itself under its own weight without falling back against the dome. When closing up you should be sure to ease the bottom part in with your hand when it's close enough so that it doesn't bang against the dome.

(c) **While the slit is opening, use the SLEW SPEED on the hand paddle to run the telescope south until you can take off the dust caps on the main telescope, finder and autoguider telescopes.** Don't move the telescope too far horizontally, or it will get stuck at the horizon limit. Stop the telescope at an altitude of 15 - 20 degrees (Dec of -34 to -29) and use the ladder to get the covers off. If the telescope stops moving by itself, or if a loud buzzer goes off and the telescope won't move - you've hit the limit! Hold down the limit override button located near the position dials on the telescope, and at the same time use the hand paddle to move the telescope out of the limit in SET SPEED.

(d) **Slew the telescope back to the vertical position so it's**

pointing out of the slit. NOTE: **Wait until the dome slit has completely opened before moving the telescope**, so any debris that might fall from the dome slit as it opens won't go down the telescope tube.

(e) **When the slit is fully opened, UNPLUG THE SLIT MOTOR POWER CORD and wind it via several loops through the clamp.**

(f) **Check that the telescope controls** (located on the east side of the pier) are set to **'computer control' for 'set/guide'** speeds and **'paddle control' for 'slew/set'** speeds.

(g) **Turn off the dehumidifier.** Unplug it if the power button doesn't work.

(h) **MAKE SURE THE LADDER IS OUT OF THE WAY, ALL LIGHTS (except a few indicator lights) ARE OUT, AND THE DOME SLIT MOTOR IS UNPLUGGED.**

1.4 In the Warm Room: Finish opening up

(a) **Turn on the Telescope Control Box.**

(b) **Turn on the Focus box and press CLR/LOAD.** The Focus box is located on the shelf to the right of the window. The power switch is on the back of the box.

(c) **Turn on the intercom and turn the volume up high enough so you will be able to hear the telescope driving.** If the intercom suddenly gets quiet and you can no longer hear the characteristic sound of the telescope driving, try pressing the speak button a couple times. This should get the intercom to work again.

On the iMac:

(a) **Press the command and tab buttons on the keyboard simultaneously to temporarily exit out of remote access to**

astroperkin. (Simply click back on any of the astroperkin display when you want back in.)

(b) **Open up a terminal.** (it's the little black square in the dock).

(c) **In the xterm that pops up, type**

xgterm -sb &

to open up an xgterm terminal in the background that you will use for IRAF.

(d) **In the xgterm, type**

cd /Volumes/star/24InchData/iraf

and then

cl

to open IRAF.

(e) **In the xgterm, where you are now in IRAF, type**

mkdir nYYMMDD

to make a folder for tonight's images. (Example: n090215)

(f) **Enter the folder you just created by typing**

cd nYYMMDD

You are now in the folder in which you will be depositing the evening's images. This is the IRAF window, where you will be checking your focus later in the night.

Check on the camera temperature. If it is cooler than your setpoint by 1-2 degrees and the power is <80%, go ahead and lower the setpoint to match the temperature the cooler is at (ex: your setpoint is -15, but the cooler is currently reading -17.2, so you change the setpoint to -17). Once the camera has cooled down to the setpoint, power is between 80-90%, and the CCD has stabilized, then you are ready to take your calibration fields (Chapter 2).

IMPORTANT NOTE: As with most CCDs, our detector takes a little while to stabilize after it has reached the set temperature. **YOU MUST WAIT AT LEAST 10 MINUTES AFTER THE CAMERA REACHES THE SETPOINT** before taking any calibrations (flats, darks, or biases) or target images. *Failure to do so could seriously impact our ability to properly reduce the data.* NOTE: You'll know the cooler has settled when it fluctuates $\pm 1^{\circ}$C.

1.5 Quick Checklist

Once you have done this a few times, you will be able to go through the observing procedure much more quickly, and won't need as many explanations. When you get to this point, there are "Quick Checklists" at the end of each chapter that you can use instead of (or in addition to) the more detailed text of each section. **Only use these sections after you consider yourself an expert on the 24"**.

1. **In the Dome**:
   (a) Remove cover from camera, plug in autoguider, and turn on telescope
2. **In the Warm Room**:
   (a) Log in to iMac
   (b) Log in to astroperkin
   (c) Start MaxIm DL
   (d) In Camera Control Window, under the Setup tab, click Connect
   (e) Turn on cooler
   (f) Set cooler temperature to 35 degrees C below ambient temperature
3. In the Dome:
   (a) Open the dome slit (top and bottom)
   (b) Take the cover off the telescopes
   (c) **After the dome slit is fully open**, point the telescope straight up, out of the slit
   (d) **Unplug the slit motor power cord**
   (e) Check telescope controls: slew/set = paddle ; set/guide = computer
   (f) Turn off dehumidifier
   (g) **MAKE SURE: ladder is out of the way, lights are off, slit motor is unplugged**
4. **In the Warm Room**:

(a) Turn on the Telescope Control Box, Focus box, and intercom

5. On the iMac:

   (a) In an xgterm, cd /Volumes/star/24InchData/iraf, then start IRAF

   (b) Make a directory for tonight's data called nYYMMDD, and enter the folder

Chapter 2

Calibration Data and Telescope Initialization

In order to properly reduce the observational data obtained with the CCD, one needs to also acquire a series of calibration frames. These fall into three categories: flat field images, dark images, and bias (zero) images. Here is a summary of calibration fields you need to take:

1. Flats: set of 5 for each filter you are using; dither telescope between each image.
2. Darks: set of 5, no filter requirement, 120 secs each.
3. Biases: set of 15, no filter requirement.

See examples at the end of the observing manual. Under normal conditions, all of these data should be obtained after opening up the telescope, **just before or at sunset**. The sections below describe how to take the necessary images.

2.1 Taking Sky Flats

(*NOTE:* Sky flats can be taken at either dusk or dawn).

1. **Point the telescope near the zenith.** *Make sure the dome slit is NOT in the way.* If you know there is a significant amount of time before it is dark enough for flats, then you can point the telescope a

certain amount east in hour angle so that when it is dark enough for flats the telescope is near vertical. For example, if it is known that the sky will be dark enough for flats in about an hour then the telescope can be set about one hour east in hour angle.

2. **Order for multiple filters:** If using more than one filter for the night, take your flats for each filter using the priority of starting first with U, HaN, HaB, B, V, R, I, and Unfiltered. If no filter options are seen, make sure you have the proper camera selected (Camera 1: "Apogee USB/Net").

3. **Take a test exposure for your first flat.**

   (a) **On astroperkin, in Maxim DL, in the Camera Control Window, click on the Expose tab.**

   (b) **Select Flat under Frame Type.**

   (c) **Set the amount of time for the exposure.** A good starting point is 4 seconds.

   (d) **Select your filter in the pull-down menu.**

   (e) **Make sure that Single is selected.**

   (f) **Click on Start.**

   (g) **Evaluate the image to estimate an ideal exposure length.**

      i. **Click on the Information button.** This is the button adjacent to the Camera Control button on the left; it looks like an aperture with cross-hairs. You can also use the shortcut Ctrl+I or find it under the View menu.

      ii. **Check that the mode is set to Area, and the area described at the top of the Information window reads off the area of the image: (0,0)-(2047,2047).**

      iii. **Check the Average value given.** You should aim to have an average of around 10,000-30,000 counts and an exposure time between 4 and 10 seconds. If you're getting too many counts, shorten your exposure, until you've reached the limit of 4 seconds. If you're still getting too many counts, then you just have to wait until it gets darker. Keep checking, though, because it gets dark fast! If you're getting too few counts,

then you need to increase your exposure length. You can go longer than 10 seconds, but if you go much longer than that, you run the risk of spending too much time on one filter, and it being too dark for your subsequent filters. Rule of thumb: If you're on your last filter, and need to take longer exposures to get enough counts, go ahead; if you've still got more filters to do, then just do the best you can with exposures no longer than about 20 seconds.

4. **Once the correct exposure time has been determined, take a series of sky flats:** NOTE: you may have to change exposure times even while taking flats of the same filter, since it will be getting darker.

   (a) **You will need to save EACH flat individually.** Otherwise, you will write over your previous image and will have to retake the flat, wasting valuable time. To save the images:

      i. Click on the **File** button in the upper left-hand corner, and select **Save As.** Shortcut Alt+F then Alt+A.
      ii. In the **Save in:** menu, go to **My Network Places.**
      iii. Click on the **star** folder, then the **24InchData** folder, then the **iraf** folder, then tonight's folder (**nYYMMDD**)

   (b) **Save the image with the name of flatFilter-number (see below example).** For the file name, keep the .fit extension OR just make sure that the "File Filter:" is set to FITS Images. NOTE: You must ensure your file is saved as a FITS file; otherwise, you will lose valuable information and you might just as well have taken the image with your cell phone rather than a CCD camera.

      example: **flatU-1.fit**

      Number the flats in the order that you take them. Start back at 1 when you change filters.

   (c) **MOVE THE TELESCOPE BY A COUPLE OF HUNDRED COUNTS OR SO IN RANDOM DIRECTIONS BETWEEN EACH EXPOSURE.** The point of "**dithering**" the telescope like this is to avoid structure in the flats which might creep in if there were a bright star in the field. Remember, it is

getting darker out there, which is why each successive flat has a lower mean. If your flats are rather low in counts, saturated, or look in any way peculiar, note this on the log sheet. This is very important! Re-do flats which require it if there is time.

(d) It is very important to save each flat before you take a new one. If you don't, the file will be written over and you will lose it forever!

(e) You should take five flats through each filter you'll be using that night.

(f) **Enter the flats in your log sheet.** See Log Keeping (Chapter 7).

5. **When switching filters (§2.2)**, you need to repeat step 3 to determine your ideal exposure length, then repeat step 4. Keep repeating steps 3 and 4 until all the filters that are needed for the night have 5 flats each.

2.2 Changing Filters

The filter wheel is controlled through MaxIm DL, the same program that controls the camera. You should change filters in the following way:

1. **In the Camera Control Window, under the Expose tab, there is a pull-down menu from which you select the filter.**

IMPORTANT: The software thinks we are using a ten-filter wheel, but we are only using an eight-filter wheel. **DO NOT SELECT THE LAST TWO FILTERS, as they do not exist!** The eighth position is empty, so you will only need to go here if you are doing unfiltered observations.

2.3 Taking Darks and Biases

(*NOTE:* If time is tight, then Darks and Biases can also be done at the end of a night of observations).

Right after the flats are done, **go back out to the dome and put the cap back on the telescope**. The shutter on the CCD has a very slight light leak which shows up when darks and biases are taken. Also pull down

the shades (for the warm room window, the window by the stairs, the door closest to the warm room, and for the door at the top of the spiral staircase) to avoid any escaping light from affecting your later images.

1. In the **Camera Control Window**, click on the **Expose** tab, then click the **Autosave** box.

2. In the **Autosave Filename** box, type the name of your evening's folder.

   example: **n090215**

3. Make sure the **Start at** box is set to **1**; make sure only the rows you'll be using are enabled, scroll down the list to check.

4. **Set the type for each row.** For the first row, make the type **Bias**; for the second row, make the type **Dark.** We don't have to choose the filters here, because the shutter does not open for biases nor darks.

5. **Set the Suffix for each row.** For the first row, make the suffix **Bias**; for the second row, make the suffix **Dark.**

6. **Set the Exposure time.** Biases have a zero-length exposure, so this window is not active. If there is a time listed in this box, you won't be able to change it, nor do you need to. For darks, set the exposure time to 120 (seconds), or, if you will be taking science exposures longer than 60 seconds, twice the length of your longest exposure.

7. **Set the Repeat times.** For biases, set Repeat to 15. For darks, set Repeat to 5. You can leave the "Delay first" box at 0, and the "Delay between" box at 0.

8. **Set your destination path.** In the **Autosave Setup** window, left-click on **Options**, and select **Set Image Save Path...**. It may take a little while to load. Under **Desktop**, choose **My Network Places**, then **star**, then **24InchData**, then **iraf**, then your evening's folder (**nYYMMDD**). Or just check to make sure you are in the proper folder. When you're done, hit OK.

9. **In the Expose tab, click Start.** Look at the darks and biases as the images are loaded. Both darks and biases should have average counts of 1,000-2,000 (counts might get lower in colder weather). Note any unusual counts in the log book.

10. **Enter the darks and biases in your log sheet.**

IMPORTANT NOTE: Avoid moving the telescope, dome, filter wheel, etc., while taking darks and biases.

2.4 Focusing - the One Touch Method

(NOTE: Focusing may also be done after your target object is found). Focusing is arguably the toughest part of observing. It can be a source of great pride and self-satisfaction to obtain an excellent focus. It can also be a source of great frustration if difficulties arise. Here at VVO we have evolved the "One Touch" method to help you. This should work in all cases, maximizing the satisfaction and minimizing the frustration – just follow the simple rules. This method assumes that you are pretty close to a good focus to start with, and that will normally be the case. If not, one may need to do a more elaborate procedure or call for assistance.

The focus should be checked after each sequence of images and adjusted as needed. You may use any star in the frame of your field, except that it cannot be saturated and it should have a reasonable number of counts at its central peak ($>$ 10,000). You may use a shorter exposure time than one minute for focusing – in fact, that is recommended to save time. Basically, use the shortest exposure time that you can such that you have sufficient counts in the brightest star on your frame. Even exposure times of a fraction of a second are fine, if you have a really bright star available.

1. **Take an image where the brightest star is not saturated and has $>$ 10,000 counts.** Try an exposure length of 10-30 seconds at first. ***To make sure the star is NOT SATURATED*:** open the Information window, set it to Aperture, and place the aperture over the brightest star in the field. **Make sure the maximum value is below 65,000, and the average value is above 10,000**. NOTE: As you approach a better focus, you will be more likely to saturate, so be sure to check this every time.

2. When you have a good image, **save it into the evening's folder, and name the image according to the counter on the focus box, using p for positive numbers and m for negative**. This way you will be able to keep track of where the focus was good or bad.

   example: focusp0952.fit

3. **In the IRAF xgterm, type**

   !ds9 &

   to open ds9.

4. After ds9 opens, **in the IRAF xgterm, type**

   display [name of file] 1

   to open your image in ds9.

   example: display focusp0952.fit 1

5. **To view a specific portion of the image, drag the aqua-colored box in the miniature version of the image in the upper right-hand corner over the portion of the image you wish to see, or press the Zoom button, then the "out" button, to view more of the image.** You may have to reposition the aqua-colored box at the top of the screen after you zoom. NOTE: ds9 might not display the image in the same orientation as it appears in MaxIm DL. At the time of writing this ds9 flips images 180° vertically but leaves horizontal orientation the same as MaxIm DL.

6. **In the xgterm, type**

   imexamin

7. **In ds9, your cursor will turn into a blinking circle.** You may have to hit enter twice to get the blinking circle.

8. **Click anywhere on the ds9 screen to activate ds9.**

9. **Place the cursor over the star on which you want to focus, and then press "r" on the keyboard.**

10. **You should get an irafterm graphics window that displays the radial profile of the star.** There are two things you are looking for in a good focus: a small value (at least less than 10.0, but shoot for closer to 6 or 7) for the stellar profile full width at half maximum (FWHM), and a small scatter of the points in the profile plot at a given radius. The FWHM value is given in the bottom right-hand corner of the graphics window. For an out-of-focus image, the FWHM and the scatter in the profile plot will be large. As sharp focus is approached, the FWHM should decrease somewhat, **and the scatter in the profile should go down significantly**. Since the value of FWHM depends primarily on seeing, which can be highly variable, it is unwise to rely on it. **The sharpest focus should occur when the scatter of the points that make up the profile are minimized.** See examples at the end of the observing manual. FOR EXOPLANET TRANSIT OBSERVATIONS slight defocusing is fine, even preferred (e.g. FWHM about 10-12pxls, say), as long as PSF looks fine and no stars appear like donuts or O's.

11. **To quit out of ds9 window and to be able to type in the IRAF xgterm, hit the "q" key** (you have to make sure you're active in ds9, so if it doesn't work the first time, click on your radial profile box and then hit "q" again).

12. **To change the focus:**

    (a) **Hold in the red button on the side of the focus paddle while at the same time giving one of the buttons on the top ONE short tap (remember which button you pushed: red or black!)**

    (b) **Take another test exposure and save to folder as focus#.fit where # is p or m and the number read off the focus box.** (Example: focusm1284.fit)

    (c) **Use IRAF to view the radial profile of the new focus image.** If it is good or excellent (see examples at end of manual) you are finished. If you think you can do better, then follow these instructions (carefully!)

    (d) **If the focus is not yet good or excellent, but did improve** *or stayed the same* **then give the focus button another tap in**

the same direction and repeat the process. If the focus got worse, then tap the focus button in the opposite direction. Again, follow the directions carefully – when things get better *or stay the same* keep going in the same direction you were going. When things get worse, reverse direction. If you cannot get a good to excellent focus after six or seven tries keep reading.

(e) **Several things can frustrate the focus process.** It may be partly cloudy, so that when you take some images clouds may be disturbing the seeing disk. In this case, you will never get a good focus so take the best you can get. If it ever looked good at one particular point, just go to something close to that and be happy.

(f) **Another possibility is that your field is too low on the horizon (airmass exceeding about 1.5).** If this is the first field of the night, try to focus on something closer to the zenith. If you are following an object to higher air mass, then you will probably just have to live with a poorer focus. It is sometimes just not possible to do better.

(g) **A third possibility is that the focus star you chose is too faint.** Faint stars will never give tight fits to the profile because of signal-to-noise problems. Choose a brighter star! If brighter stars are saturated, then shorten your exposure time.

(h) **Obtaining a good focus is something of an art and it comes with experience.** It is a mark of a good observer that they can get a good focus when possible and recognize the conditions under which it will not be possible. They also recognize the proper balance between spending too much time focusing and spending enough time. **Usually you can achieve a good to excellent focus by the One Touch method in under six or seven tries – often much less. Knowing when to stop is a real virtue in this process!**

13. **Check the focus after each sequence of 5-10 images or so and adjust if necessary.** Focus will change with temperature and with location in the sky. Usually you will find the focus drifting in a single direction during the night since it usually gets colder. Usually pushing the Black button to correct for this will be the right direction to go and

usually just one tap will be needed to tweak the focus when it becomes noticeably worse.

2.5 Quick Checklist

1. **Flats** (order: U, HaN, HaB, B, V, R, I, Unf)
   (a) Wait until it's dark enough that a 4s exposure in U has an average value just under 30,000 counts
   (b) For each flat:
      i. Expose
      ii. Make sure average counts are between 10,000-30,000. If counts are too high, wait until it's darker. If too low, increase exposure time.
      iii. Save image (example: **flatU-1.fit**)
      iv. Dither
      v. Repeat until you have 5 flats for each filter
   (c) Enter the Flats on the logsheet
2. **Darks and Biases**
   (a) Put cap back on telescope
   (b) In the Autosave Setup Window:
      i. Enter the Autosave Filename: nYYMMDD (the name of tonight's folder)
      ii. In Autosave Setup, check the Slot boxes for the Bias and Dark rows (row 1 and 2)
      iii. For the **Bias** row, make sure the entered/selected items are: Bias, Bias, [nothing to select], 15.
      iv. For the **Dark** row, make sure the entered/ selected items are: Dark, Dark, [120 or twice the length of your longest science exposure], 5
      v. Set Image Save Path: My Network Places/star/24InchData/iraf/nYYMMDD
      vi. Click OK, and then Start
   (c) Enter the Darks and Biases on your logsheet

3. **Focus**

   (a) Take an exposure. Make sure the brightest star isn't saturated and has >10,000 counts.

   (b) Save the image (example: focusp0952.fit)

   (c) Open ds9

   (d) In IRAF: display focusp0952.fit 1

   (e) In IRAF: imexamin

   (f) In ds9: center the blinking donut on your focus star and type "r" (type "q" to quit)

   (g) Now change the focus:

      i. Pick a direction to move the focus, and tap the corresponding button on the paddle

      ii. Save the image

      iii. Inspect the image in IRAF with imexamin

   (h) If the focus is worse, tap the opposite button and repeat (g)

   (i) If the focus is better, keep tapping the same button and repeating (g) until it gets worse, then return to where it was good.

Chapter 3

Finding Your Target

Finding your target in the sky can be a great joy as well as a suitable challenge depending on what it is you wish to observe and how experienced you are. Here is a way in which you can go about finding your desired celestial target.

1. Begin by finding your **object's RA and Dec coordinates** using SIMBAD [http://simbad.u-strasbg.fr/simbad/] or any other source.

2. Then in the 24" dome **use the slew/set paddle to move the telescope to the appropriate RA and Dec**, as measured by the appropriately labeled dials on the face of the telescope pier. Adjust the dome so that it is NOT blocking any part of the 24" telescope or autoguider. Be careful when moving the telescope that it does not hit anything, go too low (getting horizon limit alarm), or strain the wires hanging from the telescope.

3. Back in the warm room **take a quick exposure**, by clicking on the **Expose** tab then, check that the correct filter is chosen in the **Filter Wheel** drop down menu, click on the word **Single**[1], then chose a relatively quick exposure (e.g. 10 seconds or however long is needed to see a useful starfield, one which has enough stars for you to match it up with a star chart/starfield), then click **Start**.

[1]NOTE: There should be little dots that show which exposure type and camera number, etc. you have chosen, however, at the time of writing this they are often not seen for unknown reasons, so its best to click on the word to make sure you have the correct item chosen.

4. Look at the image and **compare it to a known starfield** for your target. These starfields can be found with the finder cards for different objects in the warm room, or online via the Digitized Sky Survey (DSS) [http://archive.stsci.edu/cgi-bin/dss_form][2] or the Exoplanet Transit Database (ETD) [http://var2.astro.cz/ETD/][3].

   If you've found your target you can put it in the pixel region denoted by its finder card or a region chosen by you, zero the RA & Dec counters on the warm room control box and then go on to the next chapter. The same applies for any of the other steps which follow: if you find and appropriately place your target you are free to move on to the next chapter.

   If you've not yet found your target the following options should help you find it:

5. Move the starfield, as viewed in the 24" CCD, in little increments (start with say 100 counts in a given direction to get a feel for how much the starfield moves, then you can increase if needed), but don't do this for too long. Only use this if you see regions that look like they could be adjacent or close to your target's starfield.

6. **Take an exposure with autoguider**. Press the **Guide** tab then **Expose**. Take an exposure starting at about 2 seconds, and increase as needed to see a useful starfield. Compare this to DSS starfields. Try to find unique star patterns or objects in your image and try to find them somewhere in the DSS image. If you do find your target, place it in center of the field-of-view of the autoguider which will place it roughly in the center of the 24" CCD (as the two are well aligned), then go about placing your target in the appropriate region of the 24" CCD. *NOTE:* The autoguider is centered/aligned with the 24" CCD and both are oriented the same, as viewed in MaxIm DL.

[2]At the DSS website type in the object name or catalog number into the object name search, press 'Get Coordinates'. Choose a height and width in arcmin (the 24" CCD is approx. 12×12 arcmin, and the autoguider CCD is about 38×29 arcmin). Set 'File Format' to 'GIF' then hit 'Retrieve Image'. These images are typically deeper than what the 24" CCD sees, though their orientation is the same (i.e. MaxIm DL image is oriented the same as the DSS image).

[3]Here, find your transiting system, click on the name then click on 'Show transit predictions for next 365 days'. An image, from DSS, will come up and the target star will be marked.

7. Make sure the target is bright enough to detect with our equipment and also check that the weather or fullness of Moon is not affecting its visibility.

8. Go out to the dome and **double check that the telescope RA and Dec dials** match the RA and Dec of your target.

9. Check to make sure that the dials on the telescope are properly calibrated by checking them on a bright star, see §8.12. After it is properly calibrated, move the telescope to the RA and Dec of your target.

3.1 Quick Checklist

1. Find target RA and Dec
2. Move telescope to target RA and Dec using dials
3. Check for target in 24" CCD field-of-view
4. If no target try:
   (a) Dither the 24" CCD
   (b) Take exposure with autoguider
   (c) Check target's visibility (telescope, weather, Moon)
   (d) Double check RA and Dec dials
   (e) Recalibrate RA and Dec dials

Chapter 4

Autoguider

The autoguider is a useful instrument for keeping the 24" telescope pointed more precisely in the sky. It is very useful when taking long exposures or long series of exposures. At the time of writing (2012), there is a long term drift with the autoguider where the stars drift north and east about 10 pixels per hour (1 pixel per 6 minutes), for reasons unknown. This means that images can be taken up to a single 6 minute exposure without it drifting roughly more than a pixel in the 24" CCD. Also, depending on the precision of pointing needed, manual adjustments to the telescope's pointing may only need to be made every several hours to keep your target in the desired pixel region.

4.1 Setting Up the Autoguider

1. Once at your target starfield, go to the dome and **remove the 'slew/set' paddle from the telescope**, so that it is no longer hanging on the telescope, and place it gently on the ground or ladder, somewhere where it will not disturb the telescope when you use it during observations. On the side of the 24" telescope mount, check that the switch for the **slew/set** speed is set to **paddle** control and the **set/guide** speed to **computer** control.

2. Back in the warm room, flip the switch on the side of the warm room control box from **control box** to **autoguider**.

3. Set RA and Dec speeds on the control box to **guide**.

4. Select the **Guide** tab in the **Camera Control** window. Set the exposure time to 2 seconds in the box labeled **Seconds**, this time can be increased say to 10 or 30 seconds if a sufficient star field is not found; however the exposure should ideally not exceed 1 minute. Then set **Aggressiveness** for X and Y to 7.

5. Take an exposure by clicking on **Expose** then **Start**.

6. Once the exposure is done you should see a starfield, and a guide star should be chosen automatically. If a guide star is not chosen automatically you can chose it yourself by clicking on one. You can tell if a guide star is automatically chosen by looking at the **Guide Star** box and seeing if the X and Y values match the brightest (or one of the brightest) stars in the field.

7. Once a guide star has been selected, click **Calibrate**, then press **Start**. The guide star should be seen to make an L-shape as the software calibrates movements in all four cardinal directions. If there are issues here see §4.2 for troubleshooting tips.

8. After the calibration is complete, click **Track** mode then press **Start**. This will make the autoguider guide on the star it calibrated off of, however you can tell it to guide off another star in the field by clicking on it then start tracking, as per the beginning of this step.

9. At this point the autoguider is guiding, and the star should appear in a small window.

10. **Zero the counters on the warm room control box**. By keeping an eye on these counters as well as the image of the star, you should be able to see if your guide star is drifting in any way. A print out in the bottom window for **Camera 2** (in either the **Expose** or **Guide** tabs) shows **XErr** and **YErr** which tell how far away from its initial position the guide star currently is (ideally equal to zero); you can also use these to gauge how well the guiding is working. *If the guide star is moving too much or too little* in a given direction you can adjust the **Aggressiveness** while it is guiding to try and remedy the problem; higher numbers to make the autoguider move more, lower numbers for it to move less. This aggressiveness adjustment can be done at any

time during observations as needed, without stopping autoguiding or science imaging.

11. Before beginning exposures for the night, **check to make sure that your target is still visible in the 24" CCD** as after calibration the autoguider, at time of writing, usually leaves the stars at slightly higher X and Y pixel numbers than where they were initially were placed. *A NOTE FOR LATER*: Before beginning a set of observations, check the dome position such that the 24" points out the left most side, making sure not to obscure any of the 24" telescope aperture or the guidescope view. Doing this usually affords about a half-hour before the dome needs to be readjusted; shorter when looking near zenith, longer when about the celestial pole.

12. Now with the autoguider and dome ready, you can begin taking exposures as normal.

    NOTE: Adjust the dome every half-hour using the **slew/set** paddle inside the 24" dome. Don't lift up the paddle just leave it on the ladder/floor and press the appropriate dome button. BE CAREFUL NOT TO HAVE EXTRANEOUS LIGHT SOURCES or PULL ON THE WIRES or BUMP THE TELESCOPE as these may all adversely affect your observations.

4.2 Troubleshooting with the Autoguider

There is a very thorough treatment of autoguider troubleshooting found in the MaxIm DL manual, pages 9-6 to 9-9, as well as many other helpful tidbits about the autoguider parameters etc.. What follows is my own addition to their troubleshooting.

4.2.1 What settings should be used for the autoguider

I've not found any issues with MaxIm DL's **Default** setting for the autoguider parameters, though you can adjust different ones as desired. It has been found that the minimum pulse length detectable by the telescope is about 0.1 seconds so you can appropriately change the **Minimum Move** in X and Y (found in the guider **Settings** under the **Advanced** tab) to that. Also there

is a known backlash of about 1 second in Dec (Y), with no major backlash in RA (X), at least as of the time of writing. Backlash can be adjusted by clicking on the **Settings** button and then appropriately adjusting the times labeled **Backlash**.

4.2.2 The guide star is not moving at all

First make sure that the switch on the warm room control box is set to **autoguider** not **control box**. If it still does not move check to make sure the **set/guide** switch in the 24" dome is set to **computer** control. If this is still an issue check that the autoguider guide signal output cable (looks like a telephone wire) is properly plugged into the autoguider.

4.2.3 The guide star does not move enough, and autoguider can't calibrate.

First try increasing the calibration time for the direction in which it is not moving enough. To do this select the **Guide** tab in the **Camera Control** window, click on **Settings** then increase **Cal. Time** in which ever axis needs it. If that doesn't work, especially if you are observing near the celestial pole, you can put the RA speed to 'set' which should hopefully fix the problem. Putting Dec to 'set' speed usually results in lots of overshooting. If this problem occurs when you are not observing near the pole or even with a maxed out calibration time check that that the guide motors are working properly in the telescope (by using the warm room control box in guide speed to move the telescope), as this may be symptomatic of a more serious recurrent issue with the telescope motors.

4.2.4 The guide star moves too much in calibration and it moves outside the field-of-view

First check to make sure that the control box in the warm room is set to **guide** speed and not **set**. If the star still moves too much after this fix, try decreasing the calibration time for the given axis. To do this select the **Guide** tab in the **Camera Control** window, click on **Settings** then decrease **Cal. Time** in which ever axis needs it.

4.2.5 The autoguider is not calibrating properly, the red line is not properly tracing the star's movement

Try adjusting the exposure time so that the guide star has as high an SNR as possible. Make sure that the guide star is not saturated (count of about 255), as it's harder for the software to track the star then. Also you can try taking darks for the autoguider by selecting **Options** in the **Guide** tab then selecting **Simple Auto-dark**, then begin by taking exposures and calibrations again. In addition, in the **Imaginova StarShoot Autoguider** window which pops up when you first connect to the cameras via MaxIm DL, you can choose **Smoothen (for guiding)** and/or **Enhanced Noise Reduction** to see if these fix the problem and increase the SNR for the guide star.

4.2.6 The autoguider is jumping around, where the star seems to overshoot the mark or is randomly moving about

First try decreasing the **Aggressiveness**, if that doesn't work and it is affecting the science images, stop the autoguider by pressing **Stop** in the **Guide** tab or by flipping the warm room's control box switch from **autoguider** to **control box**. You can the try switching control back to the autoguider to see if that fixed it.

4.2.7 Wires coming from the telescope are taut/strained.

It is good practice during the course of a night to check, by eye, that none of the wires coming from the telescope are taut. If any are, gently loosen them and note it in the observing log. This may cause a slight bump, drift or displacement in the starfield so if your observation is very close to being done you can leave the wires and loosen them when you finish. If left alone for a long time however, the tension on the wires, along with being bad for the telescope, may cause it to drift.

4.2.8 I'm looking at a different region of sky than when I originally calibrated.

It is good, if time permits, to recalibrate using this new starfield in case any physical adjustments of the scope affect the pointing abilities. If time is very pressured, it may be fine to eschew another calibration in favor of catching a specific observation.

4.3 Quick Checklist

1. Remove slew/set paddle from 24" telescope
2. Control box switch to **autoguider**
3. RA and Dec speeds to **guide**
4. Take an exposure
5. Choose guide star (if not automatically done so)
6. Calibrate autoguider
7. Check 24" CCD image
8. Begin guiding ('tracking')

Chapter 5

Taking Data

IMPORTANT! EVERY 30 MINUTES (at least): Check the weather forecast, the actual weather conditions outside, and adjust the dome[1] so it is not blocking the 24" telescope or autoguider(being careful about not lifting up the hand paddle or pulling on the telescope wires).

5.1 Recording Actual Images

If you followed the directions at the end of the last section, and locally set the telescope to your first object, then you are ready to take some images.

1. **Look on the object's index card for information regarding filter requirements, number of exposures, and integration times.** (If you are not using the autoguider then don't use MaxIm's Autosave feature for more than 5-10 minutes of data at a time.)

2. In the **Camera Control** window's Expose tab, click on **Autosave.**

3. **Make the Autosave Filename the name of the object exactly as it is written on the index card, but with the letters "obj" in front.**

example: **objngc1333b**

[1]CAUTION! You will not be able to see if the dome slit is blocking the 24" telescope by just looking at the CCD image, you must go out to the dome and check. The dome obscuration can only be seen in the photometry and can ruin a night's observations.

4. **Enable the third row, and make sure all the other rows are not enabled.**

5. Under type, choose **Light.**

6. **Choose the filter.**

7. **Make the suffix the same as the filter label.** Abbreviate H-alpha narrow to HaN, H-alpha broad to HaB, and unfilterered to Unf.

8. **Choose your exposure time.** MAKE SURE YOUR TARGET IS ***NOT SATURATED***! (over a count of 57,000-60,000 or so), see the section on focusing (§2.4) for specifics on how to check this.

9. **Set Repeat to the number of images desired.** When using the autoguider you can ideally set this number to go for the entire length of your observation, so that there is no break in the images taken. You can calculate the amount of images needed for a certain length observation by adding the length of a single exposure to the image download time (about 11-12 seconds per image), then multiplying until you've reached your desired time length.

10. **Check that your destination path is to the evening's folder you created.**

    (a) Left-click on **Options** and choose **Set Image Save Path.** This may take a little while to load.

    (b) **Your destination path should be:**

        //vvofiles/star/24InchData/iraf/nYYMMDD [tonight's folder]

        If this is not your destination path, then click on Desktop, then My Network Places, then orion, then iraf, then nYYMMDD.

11. **Click on OK**.

12. In the **Expose** tab, click on **Start.**

13. **Check the focus of the first image in the sequence.** If it is significantly worse than last time you checked the focus, repeat the focusing procedure (see §2.4). You should also check focus throughout your observation (say every 30min when you check the weather and

dome position). If focusing needs to be redone, stop the exposures and redo the focusing procedure of §2.4.

14. **Add the object to the log sheet along with the FWHM as measured by IRAF, and any other important information about the specific object.** Notice that the MaxIm DL saves each exposure with a number in the name, starting with 001. When filling out the log sheet, include the entire name under "Object."

    example: **orisouth**

5.2 Your Subsequent Objects

1. **Choose an object to observe.** Objects to observe are located on large index cards in the black binders in the observing room. Normally the cards should be in order of Right Ascension and you should observe them in the order they appear in the binder unless there are special instructions (see §5.3). Exoplanet cards are generally in alphabetical order.

2. **Take a short exposure in the I filter. In the Expose tab under the CCD Control Window, change the filter to I and set the exposure length to 10-30 seconds, then click "Expose".** You should now recognize stars from the finder chart for this field. If you don't, double check the RA and Dec dials on the telescope, or try a longer exposure. If you still don't recognize any stars, see §8.9.

3. **Use the Telescope Control Box**, in the warm room, **to make small movements of the telescope to center the field as pictured in the finder chart.** The orientation of the image is the same as the orientation of the compass buttons on the Telescope Control Box. If, for example, you want to move a star down (South) in the image, then you need to move the telescope up (North).

4. Once the field is centered, **zero the counters on the Telescope Control Box**.

5. Now you can start taking a sequence. **Follow the instructions in §5.1. Don't forget to focus and fill in the log sheet!**

5.3 When to Observe Objects

1. **Ideally, you would like to observe an object at its highest point above the horizon.** Observe the object at a sidereal time as close as possible to its RA.

2. **Unless there is contrary information on the observing cards, do not observe an object that has an airmass greater than 2 (i.e. less than 30 degrees above the horizon).**

5.4 Quick Checklist

1. EVERY 30min (at least), check weather and adjust dome!

2. Look at object's finder chart for filters and exposures

3. In the Camera Control window under the Expose tab, click on the Autosave button and:

   (a) Make the Autosave Filename obj[name from finder chart] (example: objngc1333b)

   (b) Select a row and fill in the needed info

   (c) Click OK and then Start

4. Check the focus in IRAF, and if much worse than before, refocus

5. Enter the object on the logsheet

Chapter 6

Closing up

6.1 In the Warm Room

1. **Turn off the power supply for telescope controls, focus box, and intercom.**
2. **On the iMac:**
   (a) **In the CCD Control window, under the Setup tab, click on Warm Up in the Coolers section.**
   (b) **When the cooler power gets below 85%, click on Off.**
   (c) **Click on Disconnect.** NOTE: Wait a couple seconds between shutting the cooler off and disconnecting from the camera; otherwise you will get a warning message that tells you the cooler is still on. If this happens, reconnect to the camera, make sure the Off button in the Coolers section is depressed, and disconnect again.
   (d) **Exit out of MaxIm DL.**
   (e) **Log off astroperkin.**
   (f) **Close all programs on the iMac and log out of the observer account.** You may have to force quit the remote access program (hit the "command", "option", and "esc" keys at the same time).

6.2 In the Dome

1. **Run the dome back to its usual position (slit over door).**
2. **PUT CAPS BACK ON ALL TELESCOPES.** Make sure they are all on securly, especially that the 24" telescope's cover sits flush with the edge of the telescope.
3. **Plug in the dome slit and start closing it.** Wait until the dome slit is closed before putting the telescope back to vertical.
4. **Crank up the bottom part of the slit, taking up the slack in the cable.** The lower slit door is heavy and will close in on you before the cable is done winding up. When this happens, wind the cable all the way back up but keep tension on it with your other hand to keep it taut. If you can try to ease the lower slit door in with your hand so that it doesn't bang against the dome.
5. **Turn off the dome slit motor just before it fully closes, allowing it to coast into the stop, making a snug, secure fit.** If you drive it all the way into the stop, it will shut off but it will leave the slit slightly bowed out and snow and rain can get through that opening.
6. **Unplug the dome slit motor and hang the cord up by the clamp above the door.**
7. **Leave both the warm cabinet and the computer inside it on.**
8. **Run the telescope to its vertical position.** First Dec to +40deg 0m 0s, then HA (hour angle) to 0h 0m.
9. **Turn off the telescope, remove the key, and return the key to the desk drawer.** NOTE: Turning off the telescope also turns off the camera and the filter wheel.
10. Hang the slew/set paddle back on the 24" telescope, making sure that it is hanging on a separate ring from the set/guide paddle.
11. **Put the cover back over the camera/filter wheel assembly.**
12. Unplug the autoguider USB from the autoguider.

13. **Turn ON the dehumidifier if it is not frozen over.**

14. **Before leaving the dome, MAKE SURE:**

    (a) Dome slit is closed.

    (b) Telescope is off.

    Everything should look dark (except for a couple indicator lights) and it should be quiet (indicating that drive motor is off).

15. **Repeat step the previous step.** The worst things you could do, in order of severity:

    (a) DO NOT forget to turn off the telescope (and camera, and filter wheel).

    (b) DO NOT forget to close the dome.

Penalties for a and b: **Decapitation**.

6.3 In the Warm Room

1. **Put tonight's logsheet at the back of the stack of logsheets on the clipboard.**

2. **Clean up any trash, and put away this manual.**

3. Raise all the shades which you lowered (door by warm room & window in staircase, at the least)

4. **Make sure the lights are off and all the doors to the building are locked.**

6.4 Quick Checklist

1. **In the Warm Room**:

    (a) Turn off Telescope Control Box, Focus box, and intercom

(b) In MaxIm DL, in the CCD Control Window, under Setup, click **Warm Up**, then **Off**, then **Disconnect**, then close MaxIm DL

(c) Log off astroperkin

(d) Close all programs and log out of the iMac

2. **In the Dome**:

(a) Move dome so slit is over door

(b) **Put the caps back on all the telescopes**

(c) Close the dome slit (top and bottom)

(d) **Unplug the slit motor**

(e) Run telescope to vertical, only after dome slit is fully closed [Dec +40deg 0m 0s, HA 0h 0m]

(f) Turn off telescope, put key in desk drawer

(g) Put cover back on camera/filter wheel

(h) Unplug autoguider USB cable

(i) Turn on dehumidifier

(j) **MAKE SURE telescope is OFF and dome slit is CLOSED**

3. **In the Warm Room**:

(a) Turn off the lights and lock the doors as you leave

Chapter 7

Log Keeping

7.1 Filling Out Log Sheets

See the example log to the left of the iMac.

Keeping accurate and thorough observing is a critical step in making sure we can properly use the data that you're collecting.

For the sake of consistency and ease in interpreting entries, please use the following rules as a guideline for filling out the log sheets. Although using a pencil allows you to erase mistakes, pen ink will last longer than pencil. **Please use a black pen.**

WRITE NEATLY, LEGIBLY AND CLEARLY, even if this means writing slower! If you make a mistake *do not scribble* it out, simple put a single or double line through it, and if necessary note the reason for the mistake or a correction to it. Your clear, full and proper record keeping will help those people in the future who wish to use this data.

Date Record the date with the following format: 12/13 Nov 2008 for the night that started on the 12th of November and ended on the 13th in 2008.

Observers Please write your full name(s). This will guarantee we never forget who you are and always give you credit!

Cooler Temp Write the cooler temp as given in the Setup tab in the CCD Control window.

Image Type Flat, Dark, Bias, or Light.

Object Write the object name as it is saved when you take the image (assuming you labeled it correctly).

Image #'s The number assigned to these images

Time (EST) EST as read from the digital clock in the warm room but converted to 24 hour format (ie. 5:00 p.m. should be entered as 1700).

Exp. (sec) Exposure length in seconds.

Filter Enter the filter designation: U, B, V, R, I, HaB, HaN, or Unf.

FWHM Write down the FWHM of the final focus image to one decimal place.

Obs. Cond. Observing Conditions (e.g. clear, hazy, thin cirrus, some clouds, etc.). Check on this often!

Dome T. The dome temperature as read from the thermometer on the desk in the dome in C. Do this at the beginning of the night, somewhere in the middle, and at the end.

Comments Please write anything weird or unusual here. If you need to pontificate profusely, please just make a short note and write on the back of your observing log sheet for that night (or if you need even more space use the 24" Observing Problems Notebook). If you close early due to clouds or such, please write that here. If you have instrument problems; make sure you tell somebody about them, don't just leave a note in the log book (see below).

Please refer to the example log sheet posted to the left of the iMac.

If there are problems during the night please email or call the Head Observer (emails and phone numbers are on the bulletin board in the warm room)

Chapter 8

Trouble Shooting Guide

This troubleshooting guide is not intended to be an exhaustive list of all the problems you may run into while observing. It may, however, serve to help you solve, on your own, some of the more frequently occurring problems that do crop up. The best guide is your own experience. If you find a solution to a problem, try to remember what that solution is (you can even add it to this list). If at any time you think there may be something peculiar about an image, please be sure to make a detailed note in the log book. Other items listed here are miscellaneous because they don't fit anywhere else.

8.1 The Camera Fails to Initialize

In the dome, check the following:

1. The telescope is on.
2. The power source for the camera is plugged into the telescope.
3. The power cord and USB cable are firmly plugged into the camera. It wouldn't hurt to unplug them, then plug them back in, just to make sure.
4. The USB cable for the camera is plugged into the computer in the warm cabinet.

8.2 The Filter Wheel Fails to Initialize

This error might occur upon trying to connect to the camera. If the filter wheel won't initialize, then you can't connect to the camera. First, conduct the same steps as described for the case in which the camera fails to initialize, except now you're checking the power and cable for the filter wheel. If everything looks good, then do the following:

1. On the desktop of astroperkin, there is a folder called "Emergency Filter Wheel Control." Open it.

2. Click on the icon called "Shortcut to CFW10."

3. Change the filters a couple times using this control, then exit the CFW10 program.

4. Try again to connect to the camera, and now you should have no problem. Operate the filter wheel from inside MaxIm DL, as usual.

8.3 The Image is Too Dark/Light

Click on the Screen Stretch Window button, fifth from the left on the top row. It is also located under the View menu, or can be accessed using the shortcut Ctrl+H. The button looks like a histogram with two red and green lights along the bottom (or, for those with more imagination, a roller skate). Check that the red and green triangles underneath the histogram in the Screen Stretch window are both under white portions of the plot. You can move them by dragging them, or by selecting anything other than manual in the pull-down menu. Usually Medium is a good way to go.

8.4 The Filter Wheel Won't Move

Check to make sure that the filter wheel power cord is seated correctly in its socket. The socket is very loose and the cable can easily become unseated or even fall out.

8.5 Telescope is Too Low and Will Not Move

If you run the telescope into the limit while taking off the dust caps (or by accident during the night), the telescope controls will go dead. At the telescope pier, turn the controls from computer to paddle if necessary, hold down the limit override button located near the position dials, and at the same time use the hand paddle to move the telescope out of the limit in SET SPEED. Return the controls to computer.

8.6 Telescope won't move using warm room control box buttons

Check to make sure that **set/guide** speed in the dome are set to **computer** control. Then check that the switch on the side of the control box is set to **control box** not **autoguider**.

8.7 Part of the Field of View is Blocked Off

If there is a rectangular obscuration, then the 24" eyepiece was probably left pushed into the telescope. If this is the case, you will have to unscrew the locking screw, pull the eyepiece out of the telescope, and re-screw the locking screw to hold the eyepiece in place in its withdrawn position.

On infrequent accounts, you may be too close to the moon. Although it won't be directly in the FOV or finder scope, it may still cast too much light to observe other objects near by, and your image will look completely smooth and/or have crescent shaped "shadows" on it. In this event, if you are sure you are at the correct coordinates, and you can see by direct observation that you are very close to the moon, simply abort this object for the night, record it on the log sheets, and go on.

8.8 Telescope is Not Tracking

Ensure the tracking motor power is connected. There should be a 'regular' 2-pronged power cable labeled "Tracking Motor Power Cable" coming out of the base of the telescope and going towards the south/south-east wall of the telescope. Make sure that this cable is plugged in.

8.9 I Can't Find the Field to Which I Moved the Telescope

The first thing to do if you cannot see an object in a particular field is check that the filter is on I. Try taking a longer test exposure.

If you still don't see anything, you must now brave the elements and go out to the dome. Before going into the dome, look at where the dome slit is pointed. Look for clouds in the direction of your object. If the dome seems ok, and no clouds are present, go into the dome. Make sure that the coordinates are correct by checking the dials on the telescope. If none of these work, we recommend you use the bright star method (see §8.12).

In the event that you spent what you feel to be an inordinate amount of time searching for something (over an hour), then you may have to move on to the next object.

8.10 I Can't Seem to Get a Decent Value for the FWHM

Adjust the focus first in the I filter, and make sure the exposure times are long enough to be meaningful. To focus in the shortest amount of time, you should attempt to focus on a region that contains a relatively bright star. If there is no bright star in the centered field of the object that you are observing, look for a bright star within the finder field on the observing card. Zero the counters on the position control panel and then move to the region that contains the bright star. If you have been changing the focus in one direction (i.e. pressing black only or red only) and find that you have to move back in the other direction, be aware that there is some backlash in the focus control and that you may, when switching directions, have to hold the new button down for a tad longer than you might have guessed.

When you are done focusing, move back to the object by moving the telescope until the coordinates are back to their zero levels. It should not take more than about 10 minutes to obtain a reasonable value for the FWHM. If the value persists in jumping around, it may mean that the atmosphere is especially turbulent, for which there is nothing you can do. Check the sky and make sure that it is not cloudy. Another possibility is that you are trying to focus on something that is too low in the sky. If the altitude is less

than 30 degrees, the object is too low and you will have to move to another object. (Do this unless specified otherwise on the observing card.)

8.11 Dome Won't Move

Go inside the dome and turn on the lights. Turn to left. On the south wall of the dome you will see a metal box with a button. Push it with a pencil or pen to reset circuit breaker (call the Head Observer if uncertain what to push).

8.12 Using Bright Stars to Confirm and Recalibrate the Telescope's Position

If at anytime during the night you feel that the telescope may not be pointed to the area of the sky that you have selected, you can use a bright star to check the position of the telescope. Stars brighter than 3rd or 4th magnitude have large diffraction spikes that appear on relatively short exposure frames. Therefore, they are good to use as a quick check of the position.

1. **Choose a bright star from the Bright Star Catalog (on the shelf in the observing room), or in the Starry Night program, that is relatively close to the RA that you are now at, or better yet, close to the RA of your next object.** This will make the move quicker, and disrupt the observing program as little as possible.

2. **Go to the Dome.**

   (a) **Use the slew/set paddle on paddle control.**

   (b) **Using the dials on the pier, move the telescope to your chosen bright star.**

   (c) **Look through the finder scope to make sure the telescope is pointing at your bright star.** Center the bright star in the finder scope, using the hand paddles on SET. NOTE: If you don't see the bright star, then make sure you are looking at the correct declination (positive not negative, or vise-versa).

   (d) **Return the telescope controls to computer control.**

3. **Return to the Warm Room.**

   (a) **Take a 1 sec exposure.** You should see the star now. If you don't, check to make sure it's not cloudy (ok, you really should have already done this by now...). If it's clear, check to make sure that the eyepiece is not in the way.

   (b) **If the star is there, center it in the frame and zero the counters.**

4. **Go to the Dome**

   (a) Adjust the RA and Dec dials using an appropriately sized allen wrench (found in the drawers of the desk in the 24" dome or the tool set in the dome) to set the dials to match the object's RA and Dec.

Chapter 9

Miscellaneous

9.1 Checking Weather and Time on the Internet

The clear sky clock for VVO is linked to the department web page under the "links" section. Located in the same place are links for sidereal time, sunset, Moon phase, and other useful information.

9.2 Continuously Check Sky Conditions

It is the responsibility of the observer to remain vigilant for changing sky conditions. **Make a quick check of the sky (i.e. actually go outside and look) at least once per half hour**, and include frequent notes about the sky conditions on the log sheets.

9.3 Adverse Weather Conditions

There are certain conditions under which it is not safe to be observing, even though it may be clear. The two most common of these are high winds and high humidity. If the wind speed is above 40 - 50 mph (e.g. it hurts when you look into the wind) it is too windy and you should shut the telescope down. Likewise, if the humidity rises significantly above 90% as read from the digital thermometer in the warm room, and thick dew or frost starts to form on car windows and the railings outside, you should close. **Observing under**

extreme conditions could cause severe damage to the telescope or its instrumentation.

9.4 Keep Warm Room Clean

Remember that the telescope dome and the warm room are used by many different people. Please keep the work area cleaned up at all times. Do not leave personal belongings, work, etc., strewn about the warm room. There is a can of furniture polish and paper towels on the shelf to the left of the window. Try them out– cleaning at midnight is fun!

9.5 Declination Dial 0-9 Numbers

The declination dial on the 24" telescope has two sets of numbers 0-9 running opposite each other. The inner set is for positive (+) Dec, while the outer set is for negative (-) Dec.

9.6 The Local Horizon

The figure below (Figure 9.1) shows the local horizon as viewed by the 24" telescope (as of 2011, from the Honors Thesis of Marshall Johnson), i.e. to what altitude you can slew in a given direction before some obstacle (trees, the Observatory building, etc.) blocks the view of the sky. The figure does not include declinations north of 55° as at these high declinations there are no obstacles at less than 7 hours in hour angle from the meridian. The altitude axes are in degrees and a circle is overplotted at an altitude of 45°.

9.7 Who is that Man in the Picture Frame from the 24" Dome?

Why it's Richard Perkin, the original owner of our 24" telescope!

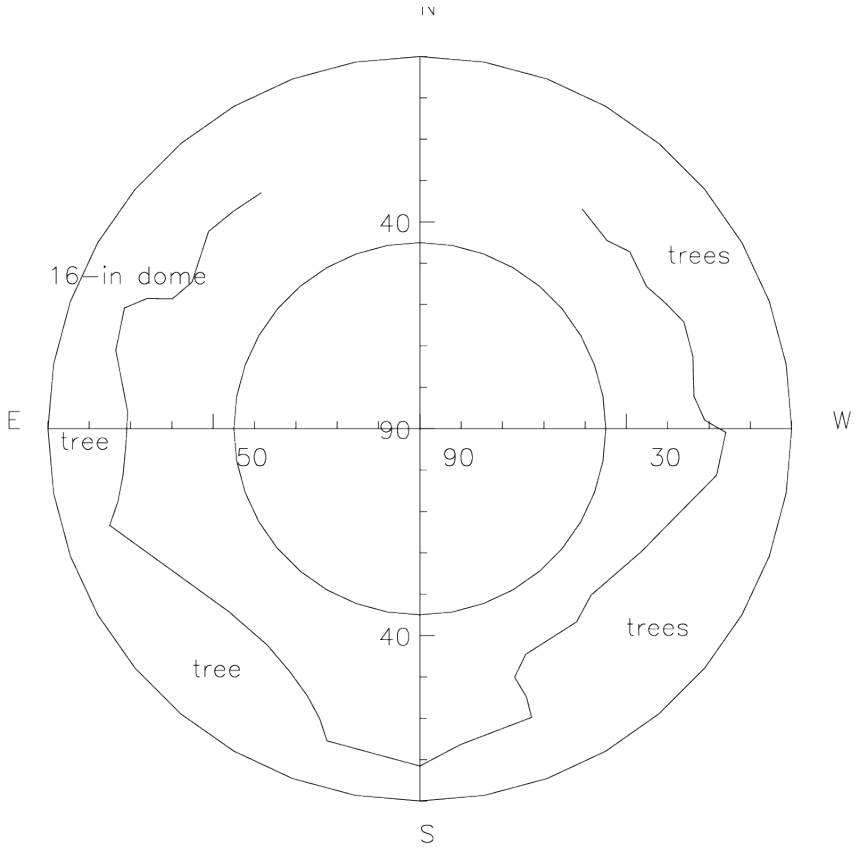

Figure 9.1: Local Horizon for the 24" telescope, as of 2011.

9.7.1 A Brief History of Richard S. Perkin and his Telescope[1]

Richard S. Perkin (Figure 9.2) was born in Brooklyn, New York on October 17, 1906. At the age of nine Dick received his first telescope, from his father, which he would look through often. Not two years after that, he began building his first telescopes out of cardboard tubes and old glasses lenses. By about age 13 he had ground and polished his own 6" refractor. By this point he had been bitten and smitten with astronomy. Throughout his schooling Dick would hold a fascination with the subject.

In 1936 he went to the Tercentenary Celebration at Harvard where there would be meetings involving amateur and professional astronomers. There he bumped into Charles Elmer, the two had a mutual love of astronomy and agreed on the dearth of optics production in the United States. This spark culminated, after several more meetings with Elmer, in the formation of the Perkin-Elmer Corporation in 1937, which would produce precision optics. In 1941 the company opened a Connecticut plant in Stamford, later it would relocate to one in Norwalk. In 1949 Dick Perkin moved into a house on over seven acres of land in New Canaan, Connecticut, about an hours drive from Middletown. He would live in this house for the rest of his life.

In 1965 Perkin-Elmer acquired Boller & Chivens, another precision optics company, which he would soon task in building a 24" Cassegrain telescope to his specifications for an observatory he had built on his property[2]. It is this very telescope which we now house at Van Vleck Observatory. Fahy (1987) mentions that the "optics were of such perfection that Dick became the envy of every astronomy enthusiast who had the occasion to use the instrument." In the years leading up to his death in 1969, Dick would use "the telescope to ponder developments in the Milky Way, flights of astronauts into space, probes of Mars and Venus, and the new mysterious quasars and pulsars." (Fahy 1987). The telescope itself was maintained, among others, by a master optician for Perkin-Elmer. A picture of the telescope can be seen in Figure 9.3, sending a laser beam to the Moon in 1968 (a year before anyone landed there!). Interesting things to note in this picture are the step

[1]Based on Richard Scott Perkin and the Perkin-Elmer Corporation by Thomas P. Fahy (Perkin-Elmer Print Shop, 1987). Wesleyan's library now has a copy of this text, for those interested in the man whose telescope we now use. The text itself focuses mostly on Dick Perkin in relation to his company.

[2]http://bollerandchivens.com/?page_id=558

Figure 9.2: A photo of Richard S. Perkin later in life. This same picture is framed in the 24" dome, and may even be the original as written on the back in pencil are the words 'front piece', the very location of this image in the source text. Image from Fahy (1987).

ladder, hand paddle and 6" finder scope which remain in roughly the same condition as they appear there.

After Dick Perkin's death in 1969 he was honored by many. In 1970 the International Astronomical Union (IAU) honored him, Richard Scott Perkin, with an eponymous crater on the far side of the Moon. His company, in 1977 would be selected as the primary contractor for the Optical Telescope Assembly of the *Hubble Space Telescope*, which included the 2.4m (∼8ft) primary mirror[3]. However, most important to us is that in 1971[4], after "Dick's death, the telescope that he had made for the observatory at his New Canaan home was sought by several deserving universities. Wanting to keep it as close as possible to New Canaan and Dick's astronomer friends, Gladys [his wife] arranged for the telescope to go to Wesleyan University in Middletown, Connecticut." (Fahy 1987).

[3]http://hubblesite.org/the_telescope/nuts_.and._bolts/optics/optics2.php
[4]http://www.wesleyan.edu/astro/research/facilities.html#24inch

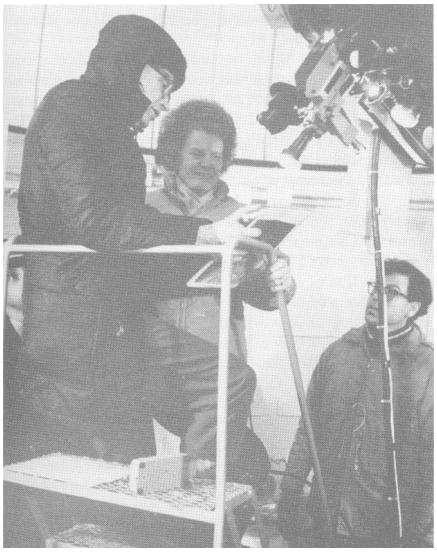

Figure 9.3: "Richard F. Kinnaird and Gladys T. Perkin at the Perkin Observatory, Sending a Laser Beam to the Moon 1968". Image and quoted caption from Fahy (1987).

9.8 Squirrels

Occasionally, squirrels like to use the telescope. For living in, not for observing. When this happens, they make a big mess. So humane traps are sometimes set for them. Wesleyan is prohibited by law from poisoning or inhumanely trapping these rodents, so it tries to deal with the problem by using humane traps and then taking the captured squirrels to remote locations where they are set free. This is actually good for the squirrel, because living in the dome can be a dangerous thing, as Sam will attest. **PLEASE DO NOT RELEASE SQUIRRELS FROM TRAPS. If you find a squirrel in the trap in the dome, notify either Linda or Bill immediately (by e-mail, if at night)**. We will contact the proper people to take care of the squirrel. Under no circumstances should you touch the squirrel or the cage. Once notified, the animal control people will respond promptly. A squirrel can stay in a cage safely overnight. The trapping agency checks these traps regularly and will take care (humanely and safely!) of the squirrels. They will not die. They will live better. If you release them they will

probably be caught again and may get trapped in the dome opening mechanism or worse. Domes are not a good place to live and these little critters do not listen to reason on the subject. Transporting them far away is the only reasonable and humane solution.

If you find an injured squirrel (such as one that has been caught in the dome slit motor, yes this has happened before), don't bring it into the warm room (yes, this has happened too...) Call a wildlife rehabilitator:

Rosanne Falconieri 203-265-1646 or 203-988-8733

As a preventative measure please DO NOT LEAVE ANY PAPER PRODUCTS or any other type of material in the 24" dome as they may (and have) used this for nesting material.