

# Rooftop Variables Observing Cookbook

## 1. Acquire all necessary equipment:

- (a) Clear sky,
- (b) Tripod,
- (c) Telescope,
- (d) Controller computer,
- (e) CCD camera,
- (f) USB extension cord,
- (g) Large focal length eyepiece (30 – 40 mm),
- (h) Brown (2-prong) and red (3-prong) extension cords,
- (i) Roof/transit room key,
- (j) Bench/stool/table on which to put controller computer (optional),
- (k) Flashlight, preferably red.

## 2. Align tripod:

- (a) Place tripod on ground.
- (b) Extend out each leg and lock into place.
- (c) Swivel declination axis open (loosen knob first) so that when you look up the right-ascension axis of the telescope you can see through the open hole in the tripod.
- (d) Align tripod so that right-ascension axis lines up with Polaris. To do this, physically move the legs of the tripod around until you can find Polaris through the open hole along the axis.
- (e) Once you have Polaris in your sights, swivel the declination axis back to its original position roughly 90 degrees (blocking the hole in the tripod) so that the two arrows on the side of the mount align with each other. Tighten the declination knob.

## 3. Mount the telescope and eyepiece:

- (a) Unscrew the two screws in the tripod mount so that they are flush with the inner track where the telescope will attach.
- (b) Using *two people*, one person hold the telescope, while the other is ready to tighten the screws on the mounting track.
- (c) The person with the telescope should slide it into the track so roughly half of the telescope is on the left and half of it is to the right of the track.
- (d) The person on the mount should tighten the screws and make sure the telescope is secure on the mount before the first person releases the telescope.
- (e) Attach the eyepiece to the telescope by tightening the screws once it is in place.

## 4. Align on Polaris:

- (a) Confirm that the two arrows on the declination axis of the mount are still aligned with each other.
- (b) Look in the guide scope on the top of the telescope and identify Polaris (probably the only bright star in the field).
- (c) Twisting the two small cogs at the base of the mount allows you to make minor changes left-right changes in the right-ascension axis. You can use the metal key-looking thing to adjust the altitude of the right-ascension axis. Use these to manually align Polaris with the cross hairs in your finder scope.
- (d) Polaris should now be visible in the eyepiece if you did the last step properly. If it is not, go back and center it in the eyepiece again.
- (e) Once you see a bright star in the eyepiece of the telescope, adjust the focus knob (the only knob on the back of the telescope) to bring the star to as small a point as possible.
- (f) Using the same means of manipulating the rotation axis of the telescope as you did when centering the star in the finder scope, center Polaris in the middle of your field of view in the eyepiece of the telescope.

5. Plug things in, turn things on:

- (a) Place the stool next to the telescope and put the computer on it (optional).
- (b) Plug in the two extension cords and unfurl them to the telescope.
- (c) Plug in the telescope on the brown extension cord.
- (d) Plug in the computer to the red extension cord.
- (e) Turn on computer, turn down the LCD screen brightness using F1(?).
- (f) Bring up web browser, and go to <http://www.time.gov/>. Make sure the computer clock is set to this time within 1 minute of error. Leave this window open.
- (g) Start up Parallels software.
- (h) Select the Windows XP installation, and press the play button on the right to start up Windows.
- (i) Within Windows, start up the Meade camera controller software.
- (j) Make a new folder in Windows with the label as the date of observation. Make a folder inside of it for darks and one for flats.
- (k) Turn on the telescope (switch located on the mount).

6. Calibrate the telescope:

- (a) Using the telescope controller paddle, answer the setup questions (N.B. The defaults will be the date/time/etc when last the telescope was used; you *must* change these.)
- (b) To use the paddle, enter the numbers as appropriate followed by *center* (as enter). If you make a mistake, use the *undo* button. To toggle through a menu, use the 6 and 9 keys as up and down, *NOT* the arrow keys—the arrow keys control the pointing of the telescope.
- (c) Telescope prompts you for the current time—set it to the time according to the standard time you found on your web browser.
- (d) Telescope prompts you for the date, location, daylight savings time, etc. Set it appropriately. Remember: Daylight Savings time begins the second Sunday in March and ends the first Sunday in November.
- (e) Telescope will prompt you for calibration method. Navigate to the menu item of “Two Star Alignment” and press enter.
- (f) There will be a host of different stars that you can choose from for this step; choose stars that are above the horizon. If you don’t know a star’s location in the sky, look it up in Starry Night on the computer in the “find” tab. If you are still struggling, you can change the list of stars to pick from by hitting the “Menu” button. Keep in mind that you want to use stars on either side of the sky to align.
- (g) Suggested stars are:
  - Navi – the central star of the 5 Cassiopeia stars
  - Almach – one of the stars in Andromeda
  - Capella –
  - Pollux –
  - ... (this list should be fleshed out a bit)
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- (h) After selecting a star, the telescope will slew to where it thinks the star is in the sky. Use the arrow keys on the paddle to control the position of the telescope and find it in the finder scope. Once you have centered it there, center it in the eyepiece of the telescope. Press the *center* button and then the *align* button on the paddle.
- (i) The paddle will prompt you to find a second calibration star, follow the same algorithm as above to find and center the star.
- (j) The paddle will ask you if you want to add any additional calibration stars. Add stars to the calibration until the telescope goes directly to a star (and pretty close to center in the eyepiece); usually this takes 4 stars total to get this kind of accuracy.
- (k) Now you have the telescope calibrated! Congratulations!

7. Set up the CCD camera and focus:

- (a) Remove the eyepiece from the telescope and attach the camera where the eyepiece was attached. The edges of the camera should run roughly parallel to the declination axis. This will make centering objects on the CCD much easier.
- (b) Plug the camera’s USB cord into the USB extension cord and plug that into the Computer.

- (c) Switch the computer to the Meade camera control software.
- (d) ...Go to “Images/DSI Imaging”
- (e) Click the “Live” checkbox and set the exposure length to 1 second in the software to get a live view of what the camera sees.
- (f) ...
- (g) How to focus camera inside of software
- (h) ...(leave on bright star, focus)
- (i) ...(find fainter star, focus)
- (j) Add filter bar to camera. If it doesn't fit, then flip it over. Filters are in the order: Blank, Red (R), Green (V), Blue (B). If you get confused then shine your light or cell phone through it to discover its true nature.
- (k) Switch to appropriate filter for observation. You should feel a little click when you shift the filter to the right place.
- (l) Refocus on the faint star with the filter in (the focus will change with different filters).

8. Take data and keep a log:

- (a) At this point, you can move the computer and into the stairwell. BE VERY CAREFUL not to yank on anything with the various cables you are unfurling (USB Cable and power cable).
- (b) On the telescope paddle, go through the menu until you find “User-Defined Objects.”
- (c) Set an object with RA and Dec or chose one of the objects already in your list.
- (d) Go to object; wait until it stops slewing (the little asterisk in the top of the paddle will disappear when it is done slewing).
- (e) Take a 15 second exposure to get a deeper image.
- (f) Bring up a finder chart from SDSS? POSS? Starry Night?
- (g) ID target star; if not there, slew around a little bit (see next step).
- (h) Move target star to center of field of view using the paddle slew arrows. N.B. You may want to lower the slew rate to 5 or lower for this. To change the slew rate, press the rate button (lower right), then press a number; the higher the number, the faster the slew speed.
- (i) Change the Meade camera control software settings to save images to the folder for tonight's observations for images and darks.
- (j) Check the long exposure checkbox, and make sure the exposure length is set to 15 seconds.
- (k) Drag a box around another bright star in the frame for reference.
- (l) Check box/make setting for taking raw exposures only (no processing).
- (m) Start taking exposures. Let it sit for as long as you want (5 min, 30 min, 60 min, etc.) Make sure the star remains tracked on the screen?
- (n) Note the time you began exposing, the target, the exposure length, the filter, the filename, and any comments (e.g., CCD temperature, sky conditions, etc.) in the observing log. The log will be your best friend when it comes time to reduce data, so treat it well.
- (o) Finish data? How?

9. Take cals:

- (a) There are two sets of calibration data that you will want to take: darks and flats.
- (b) For darks, put the lens cap back on the telescope and...
- (c) Take darks of the exposure length of your target exposures (e.g., 15 seconds).
- (d) For flats, have someone hold a piece of white paper (printer paper) over the aperture of the telescope.
- (e) Now illuminate that white paper with some sort of light source with roughly uniform illumination (LED headlamp works well, flashlight without a cover, etc.)
- (f) Take a few different exposures with different exposure lengths: 3x2 seconds, 3x4, 3x6, 3x8, 3x10. You want a few exposures that have  $\sim 30,000 - 50,000$  counts per pixel in terms of illumination.

10. Finish and clean up:

- (a) Make sure all of your images and calibration images are in the appropriate folder. Backup to external hard drive?

- (b) Shut down Windows (the way you would normally). After it is shut down, close Parallels. Shut down computer normally.
- (c) Remove USB cable from computer and camera.
- (d) Remove camera and filter set, and put them back in Ziploc bag in storage box.
- (e) Park telescope back at Polaris.
- (f) Turn off telescope.
- (g) Put lens caps back on telescope, finder scope, and eyepiece hole in telescope.
- (h) Put eyepiece back in appropriate container and back in transit room.
- (i) Using *two people* unscrew and remove telescope from tripod mount.
- (j) Unplug extension cables and roll them up. Put them back where you found them.
- (k) Put camera, roof key, computer, and USB cable back where you found them (Pupin 1333).
- (l) Put telescope and tripod back where you found them in stable positions.
- (m) Double check work are to make sure you didn't leave anything.
- (n) Lock roof door, warm up, and have a celebratory beverage.