

Operation of the 1-m Telescope and Echelle Spectrograph

Ritter Observatory

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This manual is not a substitute for thorough training in the use of the telescope, the computers, and the spectrographs, but rather is intended as a reminder of what was learned in such training. Do not attempt unsupervised use of the equipment unless you have been authorized to do so by the Observatory Director.

Opening up

In the control room

- Log in to the Windows 2000 computer Juno. In SI Image, check the CCD Status window. The temperature should be close to -103.5°C and the pressure to 0.002 Torr. Also check that there is at least 700 MB of free space on Juno's C: drive. If not, contact the author or the Observatory Research Assistant to confirm that it is safe to delete an old night of data.
- Click 'Setup' under 'Multiple Images' and fill in the Data Series with tonight's UT date in the format 'YYYYMMDD'. Click 'Choose Folder' and create a new folder with tonight's UT date, in the same format as above, for its name.
- Begin your initial sequence of 5 bias frames (exposure time 0 seconds), noting the universal time.
- Log in to the 'observer' account on the Linux computer Ceres4. Start the web browser, and open a log sheet for the night. Log your set of bias frames, and 'Save As ...' the log sheet with a file name 'logYYYYMMDD.html' where 'YYYYMMDD' represents this evening's UT date, as before. Fill in the header of the log sheet when it is convenient.
- Log in to the Windows computer Gonzalo.
- Open CCDOPS to operate the ST-9 auxiliary CCD camera. In CCDOPS, select the Setup menu in the floating toolbar. Turn on the temperature control for the camera by selecting a temperature set point (i.e., operating temperature) such as -10°C and pressing ENTER. Select a temperature that is below the lowest air temperature you expect during the night. Doing this now will allow the camera temperature to stabilize while you finish opening up. Then, select "Fan Enable," select "Active," and click "OK."¹

¹If the outdoor temperature is expected to drop below freezing, it may not be necessary to cool the ST-9 at all.

- Return to the Windows desktop and double click the icon entitled, “New ROBOTICS.” This program selects calibration lamps for use, turns the flat lamp and the comparison lamp on and off, flips the mirror to direct the lamp light into the spectrograph, and opens and closes the cover on the top end of the telescope. Make sure the flat lamp is selected and that the mirror is in ‘Lamp’ position, and turn on the flat lamp.
- In SI Image, change the exposure time to 0.5 second, or whatever is currently in use for the flat lamp. In ‘Multiple Images Setup,’ change the number of the first file to 6 and click ‘OK.’ Start a sequence of 5 flat lamp exposures.

When it is finished, open the ‘View’ menu of SI Image, select ‘Row-column Plot,’ and make sure the ‘Averaged Rows’ plot is displayed. Read the value at the blue cursor, which should be at the top of the third peak from the left, and enter this value in the log under “ADU.”

In the dome

- Open the dome: plug in the extension cord at the dome motor control box and press “Open.” The motor will stop automatically when the dome is open.

Once dome is open, be sure to disconnect power cord before moving dome!

Open and close the dome only when the telescope is covered!

- Remove the large hose from the panel on telescope; hang it neatly and gently over the railing with the open end below the platform and facing downward.
- Turn on the main telescope console using the key that hangs on the bulletin board in the control room.
- Unplug the dome slot motor and make the cord retract.
- While the slot is opening, you can slew the telescope to your first star, if the sequence of flat lamp exposures has finished.

After the dome slot is open, open the telescope cover by clicking the “Open Telescope” switch in the ROBOTICS screen. Or see the posted instructions for operating the telescope cover in manual mode.

Échelle calibration frames

To summarize, the sequence of calibration frames is as follows.

- 5 bias frames (exposure 0 sec, no light on chip) at both beginning and end of night

- 5 flat frames at both beginning and end of night. The exposure time for the flat lamp varies. Take a test exposure, then adjust to give a total exposure in the range 3000—5000 ADU as read from the maximum value displayed on the plot. If your test exposure is no good, just repeat it; SI Image writes over identically named files without warning.
- One comparison lamp frame just before the first stellar exposure and after every stellar exposure; check the observing log for the exposure time currently in use. After the first exposure, check the image display on Juno to make sure the correct lamp was exposed. After some practice, you'll recognize it.

Controlling the calibration lamps with the “ROBOTICS” program on Gonzalo

- When the system starts, the lamp selector should indicate the flat lamp.
- To select a new lamp, click the desired lamp. Do not power on the lamp until the turret has stopped moving.
- For normal échelle operations, the thorium-argon lamp (Th-Ar) is used.

You are now running two programs: CCDOPS and the ROBOTICS program. To switch from one to the other, press ALT-TAB .

Acquiring a star

The telescope coordinates are shown on the computer display on the platform near the console. Turn on the Synch Motor (the telescope's sidereal tracking drive) and move the telescope to the coordinates of your star. Position the dome opening in front of the telescope. Be careful to move the telescope in only one direction at a time. The floor may be moved while the telescope is moving.

After acquiring your first star, note the relative humidity reading from the dial on the railing for later entry into the observing log.

If you should press two Set or Guide buttons at once, the telescope may stop tracking. If it does,

1. **Turn off the Synch (tracking) motor**
2. Turn off the console
3. Wait 10 seconds and turn it on again
4. Turn the Synch motor back on

More pointers on moving the telescope:

- Always keep the platform well clear of the telescope. If slewing to the west, start moving the platform **down** early in the process.

- If the telescope is pointed at an object low in the sky, move first in the direction (RA or Dec.) that will bring the telescope upward toward the zenith.

When you have a star in the eyepiece:

- Flip the mirror.
- On the platform is a second monitor/keyboard combination for Gonzalo. To take your acquisition exposure, press `alt-tab` until the CCDOPS window is active. Select the Focus command (hot key: `ctrl-f`). Or use the trackpad.
- Choose an exposure time. For a 1st-magnitude star, 0.1 s is appropriate; extend exposure times for fainter stars accordingly.
- Press `Enter`. The camera will acquire a full-frame exposure.
- When the download of the image is complete, the monitor of Gonzalo will display the field of view of the CCD.
- If Planet mode was selected, the center of the image display shows a white box, which outlines the part of the frame that will be included in a partial image.
- Back in the control room, adjust the box until it is a small rectangle with the fiber in the center. Usually, the square should be properly adjusted already.
 - If not, and if you are not sure where the fiber is, move the star out of the field of view of the CCD and take a 1-second exposure of blank sky. If the star is not too bright, you may be able to see the fibers even with the star in the image.
 - The two fibers will appear as dark spots on a left-right line in the middle of the frame.
 - The fiber that leads to the échelle is the one on the right. The one on the left carries light to the Low-Dispersion Spectrograph, which is the subject of another manual.
- Your goal is to put the star in the box. How you should proceed depends on how far the star is from the box initially.
 1. If it is close to the box and you can get to the box by moving in one direction: click `Resume`, make sure the telescope speed is set to Guide, and hold the proper button until the star enters the box.
 2. If it is a long way from the box, change the camera mode to Full. CCDOPS will take repeated exposures, but the box will not be visible. Using Set speed, move the star close to the fiber and then carry out step 1. **As a precaution, always change the speed back to Guide when you are finished with Set.**
- The integration cycle of the CCD may take some getting used to. The main thing to remember is that, each time you correct the telescope pointing, you must wait through an entire expose-digitize-download-display cycle of the camera before you can see the effect of your correction. If you make another correction too soon, you will be in an unstable feedback loop.

Taking a stellar spectrum

Move the viewing mirror lever up to look through eyepiece or take lamps, down to direct starlight toward the fiber. Or use ‘Robotics’ to move the mirror.

The photon throughput to the spectrograph, and hence the data quality, are quite sensitive to the focus of the telescope; be aware of the focus and make adjustments as needed. At this writing, good focus at the eyepiece will result in good focus of the star image on the fiber, depending on the individual observer’s vision.

- If there is a lot of image motion, the problem is seeing, not focus. Effort spent on focusing will not be much help; you’ll just have to lengthen your spectroscopic exposure times. If the star is low in the sky, differential refraction may give the image the appearance of having “ears” even if the focus is good. Focus on a star near the zenith.
- As the temperature drops during the night, the telescope tube will shorten, requiring some “Out” motion. Don’t be too trigger-happy, though; adjust the focus only when the need is clear. Sometimes it’s really the seeing that has changed.

Before taking your first stellar exposure, the last thing you do should be to take your first comp lamp exposure. For best accuracy of the wavelength calibration, we want as little time as possible to elapse between the preceding and following comps.

The first Th-Ar exposure is your first single exposure with SI Image. To start taking single exposures, turn ‘Auto Save’ (in the File menu) off and then on again.² In the dialog box that open, specify the same data series as for the calibration exposures and **specify the correct file number**. Care here is crucial, since SI Image writes over files without warning.

Use the “Comments” column of the log to provide an explanation for any anomalies or significant delays in the observation sequence.

After each exposure, inspect the image display for obvious problems; for stellar exposures, make sure it appears as expected for the star you are attempting to observe. In the ‘View’ menu of SI Image, select ‘Row-column Plot’ and make sure the ‘Averaged Rows’ plot is displayed. Read the value at the blue cursor, which should be at the top of the third peak from the left, and enter this value in the log under “ADU.”

This reading is our index of counts obtained in the image. Most of our scientific programs require that the signal-to-noise ratio in the reduced spectrum be at least 100 per pixel, which is achieved if this reading is about 640 ADU or more.

After you have completed a stellar exposure, and then as you go along during the night, back up your data to the small orange external USB drive (‘Carte Orange’) that is connected to Juno.

Please observe at least one radial-velocity standard and, usually, one telluric water-vapor standard, per night.

²In multiple image mode, Auto Save must be on in order for the files to be saved properly.

Adverse environmental conditions

Under some conditions, observing should not be attempted. This information can also be found in a web page on Ceres4.

Clouds Use judgement here. If you can collect enough photons to get a usable spectrum in a reasonable length of time, keep working. If you pause to let a patch of clouds go by, close the telescope cover as cheap insurance against that unexpected rain shower. If you want to augment the cloud forecasting capability of your eyes, check out the satellite imagery at one of the weather bookmarks in Mozilla on Ceres.

Humidity Unless you are taking time-critical observations, close up if the humidity exceeds 95% as read from the gauge on the platform railing. In critical situations, you may continue to observe if the humidity exceeds this value, but under no conditions should you observe in the presence of fog.

Cold The limitation here is slippage in the telescope's declination encoders. Experience shows that this problem becomes unmanageable at ambient temperatures below -11°C as read from the uncooled ST-9.

The other cold-sensitive component in the system is the dome shutter. If it labors and groans when opened, it will be even more difficult to close later. Use caution.

Wind Normally avoid pointing the telescope into any wind stronger than about 15 mph; stay about 90° away. If you see particulate matter (snow, dust, pollen) in the air, close. Close if the wind gusts above 40 mph at any of the airports in the area, as reported on a reliable source of weather information, such as the Hourly Weather Roundup on Buckeye Weather (see the web bookmarks on Ceres).

Fireworks and searchlights Here the concern is particulate matter, not light. Close if the fireworks are upwind.

Lightning visible Use caution; check Internet radar maps for location of thunderstorm.

Closing down

While taking your last comp, close the telescope cover with the button in the ROBOTICS screen or with the manual override red button on the telescope.

In the Camera menu of CCDOPS, select "SHUTDOWN." This command shuts off the cooling system in a CCD-friendly manner and quits the application.

Cover the finder telescope. Check this even if you didn't open the finder; maybe a previous observer did.

Close the dome. **Open and close the dome only when the main telescope and the finder are covered!**

Begin taking bias frames. After you have finished moving the telescope, take flats.

Any time after the comp exposure has finished, point the telescope precisely to the zenith (HA = 00:00:00, Dec. = +41°39'36"; arcseconds should be precise to about 10"). Turn off the synchronous motor at the console, then the console itself. **It is essential that the synch motor be turned off before the console.**

In summer, turn off the console lights (switch in lower left-hand corner of console). Leave them on in winter and at any time of year when the humidity is high.

Set up humidity control equipment for telescope storage

- Re-attach large hose to panel on telescope
- If heavy rain is anticipated, turn on all 3 fans on the telescope tube for better moisture control.

Cover and push back the keyboard of Gonzalo's slave monitor.

In the ROBOTICS screen, click "Shutdown."

Make sure all your spectrum files have been copied to the orange USB drive that is connected to Juno. Do not log out of Juno. Close all windows on Ceres and log out, and log out of Gonzalo.

Make sure all doors are locked!

If you encounter problems that make it difficult or impossible to make observations, please consult the phone list on the bulletin board in the control room. Report any less serious problems and abnormalities by email to the author: NDM@astro.utoledo.edu

Solutions to frequently encountered problems

Star not in main eyepiece: First, double check your coordinates. Then, try the finder. If that fails, find a naked-eye star, preferably 2nd magnitude or brighter in the *Astronomical Almanac* and put it in the finder by bore sighting if necessary. At the telescope readout computer on the platform ("Noah"), press any key, then press **a** and follow the program's instructions to adjust the telescope coordinate offsets. If you have to bore sight, there has been a major failure of the encoder readout system, or a serious error by a previous observer, either of which you should report.