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 Linux computer Ceres according to the instructions in the separate manual for the Ritter Camera Control System. There are a paper copy and a short "cheat sheet" in the control room, and a link to the on-line copy will be displayed if you start the browser (Mozilla) on Ceres.
- Begin your initial sequence of bias frames according to that manual, and carry out the following steps while they are in progress.

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.
- Record the temperature and the relative humidity readings from the dial on the railing for later entry into the observing log.
- Unplug the dome slot motor and make the cord retract.

In the control room, at the Windows computer "Gonzalo"

- Maximize CCDOPS to operate the ST-7 CCD camera. In CCDOPS, select the Setup menu. 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 about 10°C lower than 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" and select "Active."

- 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.

Open the telescope cover by clicking the "Open Telescope" switch in the ROBOTICS screen.

Taking initial échelle calibration frames

On Ceres, follow the instructions for the Camera Control System. 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 3500—5000 ADU as read from the maximum value displayed on the plot. Exposure times, in seconds, must be integers. If your test exposure is no good, delete it with the Unix command `rm`.

- A 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. Always check the section plot on Ceres 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` or use normal Windows techniques.

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.

If you should press two Set or Guide buttons at once, the telescope will probably stop tracking. It may also do so after a long or a very short slew. 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:

- If you make a long slew to another star, move the dome (not simultaneously) in order to keep the opening more or less in front of the telescope. We do not guarantee that the "flower petals" of the cover, when open, will not strike some part of the dome.
- 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 square with the fiber in the center. If CCDOPS was running when you began, 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.

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. The best way to check it is to take short spectrograph exposures of a bright star and adjust the focus until the count level is maximized. If the sky is cloudy or the seeing is bad, however, this procedure will not work well, and you will have to rely on experience.

- 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.

- As of fall 2005, the appearance of the fiber at best focus is a black hourglass. The star should appear as a bright, sharp dot at or just below the center of the upper lobe of the hourglass. This is a change from previous configurations, and it may also change in the future. Further details will be added to this manual as experience is gathered or if the configuration changes again.

  If the star is low in the sky, 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.

Follow the CCS manual for instructions on taking your exposure.

Inspect the plot that you obtain for obvious problems; for stellar exposures, make sure it appears as expected for the star you are attempting to observe. In the cross-sectional plots, the best clue is the height of the rightmost peak, which is the section of spectrum containing Hα, compared to the others. For a star with strong Hα emission, this peak will be higher than the others, while, for a hot main-sequence star with strong Hα absorption, it will be lower. Most of our scientific programs require that the signal-to-noise ratio in the reduced spectrum be at least 100 per pixel. Experience shows that this is achieved if the number at the top left corner of the plot is 160 or more.

To inspect the full image, open a new terminal window on Ceres and type `ds9&` to open the display server. In its *Open* menu, type the desired path and file name as follows: `/mnt/halebopp/yyyymmdd/yyyymmdd.0nn` where `yyyymmdd` is the 8-digit representation of tonight's date and `nn` is the serial number of the file you wish to open. Select a false color representation for your image in the *Color* menu item at the top of the ds9 screen.

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

Adverse environmental conditions

Under some conditions, observing should not be attempted.

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 There is no hard limit. The most 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 at least 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.

Open the Setup menu of CCDOPS and set the temperature control to "Inactive" and the fan to "Disable." Leave CCDOPS running, but minimized.

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 telesocpe, take flats.

Any time after the comp exposure has finished, point the telescope precisely to the zenith (HA = 00:00:00, Dec. = +41°40′). Turn off the synchronous motor at the console, then the console. **It is imperative 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."

Copy your spectroscopic data files from Halebopp to Ceres as described in the CCS manual if you have not already done so. Close all windows on Ceres and log out.

Make sure all doors are locked!

Report any problems and abnormalities to R. J. Burmeister (copy to the author): either

- Fill out the trouble report form **or**
- Send e-mail to `RJB@astro.utoledo.edu` (copy to `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.

Error in image header: Please correct any typing errors that you may discover in the headers of images already taken. To do so, copy the offending image(s) to Ceres and run the program `ccdedit`. A common error is to forget to change the name and data type to "flat" after the bias exposures. Of course, you have to change these entries in all five of your flat exposures. There is no need to copy the data back to Halebopp after you correct them, since the version on Ceres is the one that will be used for subsequent data reduction. **For safety reasons, do not edit the original on Halebopp!**

High bias readings or odd-appearing bias frames: Check that there are no lights on in the spectrograph room. If the room is dark, the CCD has become warm. Usually, manually commanding a fill of the dewar is in order. If you are not experienced in handling liquid nitrogen, telephone for help.