

## ASTR 511: HINTS ON OBSERVING

- 1) You can depend on something going wrong during an observing run. Modern telescopes and instruments are complicated systems, with dozens of failure modes, and they are typically undersupported. To minimize the impact of unforeseen problems and to ensure a successful outcome overall, the single most important element is **planning**. You must thoroughly understand your project and the equipment involved and come well prepared in all ways. In the following, we assume you are trying to make observations of relatively faint objects with ground-based telescopes at optical wavelengths.
- 2) Depending on your project and other factors, you will need most or all of the following:

**Target list**, with (at minimum) J2000 coordinates accurate to a few arcsec. If appropriate software is not available at the telescope, you will need coordinates precessed to the current epoch. For very faint objects, you will need to measure  $(x, y)$  “blind” offsets from detectable sources.

There is a plethora of catalogs for objects of all types available on the Internet at present. However, don't rely on being able to figure these out or verify their quality “on the fly” during your observing run. Take all necessary information with you.

The list should include a range of primary and secondary targets in different parts of the sky together with calibration sources. If your main program is strongly dependent on, say, good seeing or photometric conditions, you should have a backup program which is not so sensitive.

**Finding charts** for all objects fainter than about 7th mag, including calibrators. Preferably, images copied from the POSS or other sky survey. Wavelength used should match the detector of the finder system (e.g. POSS E for naked eye or CCDs; POSS O for blue-sensitive TV-type detectors). The scale should be large enough that the charts include several diameters of the primary field of the telescope. Most important for fainter objects.

POSS-based (and other) finding charts: the *Skyview* web site at  
<http://skyview.gsfc.nasa.gov/cgi-bin/titlepage.pl>;  
 The Digitized Sky Survey at <http://stdatu.stsci.edu/dss/>;  
 The NASA/IPAC Extragalactic Database (NED) (for galaxies) at  
<http://nedwww.ipac.caltech.edu/>.  
 Starcharts: The USNO-A2.0 Catalogue web site at  
<http://www.nofs.navy.mil/data/FchPix/>.

**Flashlight**. Equip with removable red filter (glass or gel, not paper), to preserve night vision if you will not be using a remote control console.

**Auxiliary information**: E.g. manuals for telescope, equipment, and software systems; literature on targets and calibrators; estimates of exposure times; finding charts for spectroscopic comparison spectra; sample output from earlier observing runs; maps or diagrams of extended objects (galaxies and star clusters); Web addresses of critical data sites; etc.

**Personal logbook** for recording project log. Many observatories provide inadequate means for documenting observations. Software headers for recorded files, for example, often omit crucial information. Plan to record yourself everything you need to know about your data, in writing or using a portable computer. You may want to make up your own special data forms to fill out as you go. Some observatories supply useful blank data forms.

**Supplies** such as special filters, magnetic tapes, digital camera for quick snaps, diskettes, cryogenics, and so forth. Don't necessarily expect these to be provided, even at “national” observatories—you should check in advance. (E.g. always take your own digital-certified cassette tapes). Also take convenience items such as masking tape, fiber tape, marking pens, transparent plastic for overlays, etc.

**Small calculator:** very useful because not supplied even at national observatories; must be capable of trig, log functions, etc; useful to have a brief guide to various important calculations also available, e.g. precession; atmospheric refraction; x, y to RA, DEC conversion; zenith distance; etc. Alternative: have such programs ready to run on a laptop (e.g. with IDL).

**Appropriate clothing:** even with remote consoles, you will be working in the dome (probably cold) some of the time. If you are uncomfortable, your efficiency and judgment will certainly suffer. For the same reason, hot coffee, chocolate, midnight lunch, or snacks are also important. Be prepared for low humidity and low oxygen conditions at high altitude sites, and don't skimp on altitude acclimatization if that's recommended.

**Portable computer:** A laptop could obviously serve as the best repository for the information you need to take with you on an observing run. However, if you don't take paper backups of critical items you flirt with a "single-point-failure," as many eminent astronomers relying on PowerPoint displays for talks have discovered.

3) The more familiar you are with your equipment and telescope, the better. For the more straightforward equipment at Fan Mountain, plan to arrive 3 hours before astronomical twilight on your first few runs. A rushed set-up will inevitably lead to problems. Go over every important function of the telescope and equipment. Run extensive checkout and calibration tests; do as many of these in the daytime as possible. Take nothing for granted. Try to visualize what you will need to know later as you go through the data reduction and analysis.

At national observatories you are usually expected to be available at the telescope by noon on the first day of your run. At observatories with less elaborate support (essentially all non-federal ones), it's a good idea to spend at least 1-2 prior nights at the telescope, even if the equipment you are planning to use isn't on the telescope.

You will almost always find, for some reason, that other peoples' instrumentation software is obtuse. Plan for a significant learning curve. Try to get and stay on the best possible terms with support personnel.

4) Sample **pre-observing checks** you should run at McCormick and Fan include the following:

PHOTOGRAPHIC PLATES: Say what?

SPECTROGRAPHS: Check comparison lamp function; check order eliminating filters; check grating; take a series of focus exposures; adjust focus and tilt of grating appropriately; check entrance slit and adjust for observing; check detector (CCD) functions, settings, cooling; at twilight, get a bright star on the slit and focus the telescope.

PHOTOMETERS: Check filters; check apertures; have list of both as function of slide positions handy; check field viewer for absence of obstructions (look at dome with mirrors open); run through recommended procedure on tube power-up and cool-down; check field lens heater current; check aperture illumination; check dark current during cool down; check all functions on amplifier/counter, printer, computer; take enough sample integrations to know that system is functioning normally.

CCD'S: Check filters to be sure they are the ones you want and are clean and undamaged; [if you need to clean optics, use recommended procedures and solvents]; make list of filter slide positions; check that correct filter is positioned when commanded; check cryogen; start cooling cycle; start dry-N<sub>2</sub> flow; check software functions; prepare disk area to receive data frames; check tape for image storage; when cold, check dark signal and bias; run sample exposures to test software; take bias frames; if using dome flats, take these during day; monitor CCD temperature; be ready to take sky flats immediately after sunset; check flats for signal level and iterate as necessary.

TELESCOPES: You should be completely comfortable with using your telescope: know the controls; check the balance; know the field size and orientation (NSEW) of each field you will use (finder, guide box, slit viewer, etc.); check cables to equipment and clearances to be sure you can reach your targets (critical if you are using a remote console!); if you need them, be sure ladders and observing chairs are available. As soon as possible, get telescope on a fairly bright field star; test various track/slew motions; adjust finder scope

to match main telescope centering; calibrate coordinate readouts; allow to track for 5 minutes and adjust tracking rate; focus telescope and evaluate seeing. If using a guider system, practice guide star acquisition and check quality of the tracking.

ELECTRONICS: With any electronic detector system, you should test for RF interference from dome motors, guiding motors, instrument motors, dimmer switches, etc. and take appropriate action; if possible, run long or multiple integrations, measuring dark current and background as check on radar and other external interference; using flashlight, make thorough tests for light leaks and tape them up.

#### 5) During observing

- (a) If working in the dark, use a red flashlight to preserve night vision. ALWAYS carry a flashlight when observing.
- (b) Each night, start with an easy, brighter target (preferably a calibrator) to provide complete check on system. Examine results (e.g. inspect CCD image) to be sure they are as expected. (This means *you should know what to expect!*) Move to more important or difficult targets only when satisfied things are OK.
- (c) Finding faint objects is often the most difficult part of observing. You will need good finding charts. Even on an instrument with excellent pointing, you must always double check your target identification. Be patient. Learn to use obvious patterns in field to compare sky with finding chart. Knowing the scale and orientation of the finding field is very important here. If necessary, you can reverse cardinal directions on a finding chart by shining flashlight through it. If problems persist, go through whole procedure again from initial setting of telescope; coordinates may be wrong. Go on to an easier object if can't make progress.
- (d) Check sky conditions often. Learn to estimate seeing diameter in the telescope and transparency by looking directly at sky (go outside dome). Watch humidity levels. Keep eye on any clouds and check for changes. At Fan, contrails from jets are a problem.
- (e) Keep good notes. All relevant settings of equipment should be recorded. Note sky conditions or potential problems with equipment.
- (f) Treat all equipment with respect. Some of it is fragile and expensive, even irreplaceable. NEVER touch optical surfaces. If they need cleaning, ask for expert assistance.
- (g) NEVER FORCE ANYTHING. If you are having problems, it is likely you are doing something wrong. Stop and rethink. If serious equipment problems persist, be sure they are reported.
- (h) Take extra safety precautions. Some equipment (e.g. employing high voltages or cryogenics) is obviously dangerous. But an observatory is generally hazardous by its nature, especially if you are working in the dark. Stay alert, move slowly and deliberately, use a flashlight. Report injuries if they seem remotely serious.
- (i) Attitude control: you want to make the best possible use of the instrument and good observing conditions without wasting time. Being prepared and pro-active is the best way to accomplish this. But things *will* go wrong, and you need to learn to roll with the punches. Stay calm and cool. Never take out frustrations on support personnel or dumb instrumentation. Think your way out of problems. If a retreat is necessary, make it orderly. E.g. if your prime target becomes inaccessible for some reason, do support/calibration observations so you won't have to repeat them next time.
- (j) Shutdown: you will be tired, but be systematic about shutting the equipment and telescope down to prevent potential damage or problems and to be sure things are ready for next user. Follow check lists carefully. If there aren't any checklists, complain. Stow and store all items properly. Turn off power as specified; some power, nitrogen flows, etc. may be supposed to stay on. Leave work areas cleaner and more organized than you found them. Be sure to fill out observing logs and trouble report logs. For serious problems, use the phone or email reporting procedures.