Physics 629: NOAO/SALT Observing Proposal

Call for Proposals: Nov. 10, 2004
Submission Deadline: Dec. 15, 2004

An essential first step in carrying out a successful observational program is writing an observing proposal, in which an important astrophysical problem is identified and a strategy for resolving it is outlined. In this exercise, you will devise an observational program that will shed light on a key astrophysical question; this observing proposal will be prepared using the same tools and resources that you would use in "real life".

The only limitation on these proposals is that they make use of the facilities supplied to the US astronomical community by the National Optical Astronomy Observatories (NOAO) or that they make use of the Southern African Large Telescope (SALT). NOAO operates a number of observatories, offering access to both the northern (Kitt Peak National Observatory, KPNO; Gemini North) and southern (Cerro Tololo Inter-American Observatory, CTIO; Gemini South) skies. These are world-class facilities that offer a versatile range of instruments in the optical and infrared regions, and telescopes ranging in size from 0.9m to 8m. SALT is effectively a 10 m diameter telescope that at first light will have instrumentation for spectroscopy and imaging in the optical and near-UV regions. "First light" is scheduled for November 2005, but some "shared-risk" observing will begin next spring.

NOAO also maintains web-based tools and databases to aid in the preparation and submission of observing proposals: i.e., summaries of available telescopes and instruments, information on deadlines, exposure time calculators, proposal forms, current and past observing schedules, etc.. Unfortunately, the SALT website is less well-developed at present. Some useful websites are summarized in Table 1.

Table 1: Important Internet Addresses for NOAO Facilities

http://www.noao.edu/	NOAO site
http://www.ctio.noao.edu/	CTIO site
http://www.noao.edu/kpno/	KPNO site
http://www.gemini.edu/	Gemini site
http://www.salt.ac.za/	SALT site

A complete listing of telescopes and instruments offered by NOAO may be found on the websites in Table 1 and was also handed out in class earlier. Note that a fraction of time on the Keck, MMT, Hobby-Eberly, and Magellan telescopes is available to the NOAO community but, in the interests of simplicity, we shall limit ourselves to the facilities at KPNO, CTIO, Gemini North/South, and SALT. Some details about the SALT instrumentation are given in an Appendix. An article describing the SALT instrumentation is available on the class website.

With real observing proposals, the deadline is taken very seriously: no proposals are accepted after the deadline. I will be more relaxed about the deadline, but please try to get your proposal in on time. Writing a good observing proposal takes a significant amount of time, so please don't leave things to the last minute!

A recent STScI Newsletter (Vol 19, Issue 1, Page 4) offers some good advice for would-be proposal writers. Although their comments are tailored to Cycle 11 *HST* proposals, much of this advice applies to the preparation of any observing proposal. Their advice is the following:

> *Remember that the scientific case must be compelling. Do no write proposals that are of interest to only a few experts in a narrow sub-discipline. Instead, present the big picture. The most successful proposals include sufficient background information to provide a compelling context. They describe the importance of the investigation to all astronomy in a convincing manner. Because this point was an explicit criterion for evaluation, proposals were downgraded for failing to address it.*
>
> *Don't pad your request for time: fewer than 5% of the approved proposals were cut (and those only to avoid duplicate observations). Proposers either got the time they requested or were rejected.*
>
> *Start from the science. Write a compelling story for your fellow astronomers. Ask for the resources genuinely needed. Justify your need for the number of targets and orbits that you request.*
>
> *Justify the need for Hubble. For example, even if you request observations in the UV, it may not be obvious why you cannot achieve the science aims of your proposal in a different wavelength range. In the IR, justify your need for Hubble and NICMOS by comparison with AO systems on ground-based telescopes.*
>
> *Because of the limited number of orbits available in a cycle, many truly excellent proposals must be turned down. Nevertheless, remember that rejected PIs are in very good company and that many of these proposals may succeed in future cycles.*

As the above statements make clear, the single most important component of a successful observing proposal is a strong scientific case. Before starting to write the proposal, please stop by my office and explain to me what you are planning to propose. If the proposal sounds interesting and feasible, I'll give you the "go ahead" to start writing. You'll probably want to come up with your own idea for the observing proposal but if you are stumped, some possible topics are given below. In each case, I've included a reference which might serve as a point of departure in planning the proposal.

(1) The fraction of stars with planetary systems probably depends on the fraction of stars which form with circumstellar disks. What is this fraction, and how does it change with time?

Reference: Haisch et al. 2001, ApJ, 553, 153

(2) Like most stars, low-mass L and T dwarfs sometimes stars sometimes have companions. How do the properties of these companions compare to the planets found with solar-type stars by radial velocity searches?

Reference: Reid et al. 2001, AJ, 121, 489

(3) Most high- and intermediate-mass galaxies contain black holes in their nuclei. Existing mass estimates for these black holes are often based on long-slit spectroscopy. How could one refine such mass estimates using 2D spectroscopy?

Reference: Peletier et al. 2001, NewAR, 45, 83

(4) Are the star formation histories of early-type galaxies dependent on environment?

Reference: Kuntschner et al. 2001, MNRAS, 323, 615

(5) Does the faint-end slope of the galaxy luminosity function vary from cluster to cluster?

References: Trentham 1997, MNRAS, 2876, 133
Trentham and Hodgkin 2002, MNRAS, 333, 423

(6) The globular cluster omega Centauri in unique in containing stars with a large range of metallicity. One hypothesis is that it is the nucleus of a tidally stripped dwarf galaxy. How could this hypothesis be tested or the star-formation history of omega Cen be explored?

References: Bekki & Freeman, 2003, MNRAS, 346, L11
Norris 2004, ApJ, 612, L25

(7) Many Local Group galaxies exhibit population gradients. Are these gradients due to internal gradients in age, metallicity, or both?

Reference: Harbeck et al. 2001, AJ, 122, 3092

(8) The Local Group contains a population of high velocity HI clouds which may, or may not, be extragalactic in nature. How might distances (or *limits* on distances) be measured for these objects?

References: Trentham et al. 2001, MNRAS, 322 658
Blitz et al. 2001, astro-ph/0105134

(9) Numerical simulations of the Local Group predict many more low-luminosity galaxies than observed. Could the difference be due to "dark galaxies" containing only dark matter and hot gas?

Reference: Reynolds et al. 2004, astroph/0411120

(10) There is a longstanding debate on whether or not the Cepheid Period-Luminosity relation shows a metallicity dependence. How might this issue be resolved using nearby spiral galaxies?

References: Udalski et al. 2001, AcA, 51, 221
Bresolin et al. 2002, ApJ, 567, 277

(11) HST imaging of the outer disk of M31 reveals metallicity for disk stars which is higher than that expected from simple galaxy formation models. Could this conclusion simply be the result of a poorly known disk scale-length for M31?

Reference: Ferguson and Johnson 2001, ApJ, 559, L13

(12) It has been suggested that surface density profile of low-luminosity galaxies in clusters is flatter than that of the bright galaxies. If so, how might the properties of the diffuse light in these clusters be used to test this suggestion?

Reference: Adami et al. 2001, A&A, 371, 11

In the past few years, NOAO has adopted a a web-based scheme for preparing and submitting observing proposals. For this assignment, you will use a more traditional approach and prepare your proposals using a LaTeX proposal form and style files, which I've downloaded from the NOAO website. Retrieve these files from the course website. The relevant file is called observingprop.tar, which may be unpacked using the command "tar xvf observingprop.tar". It contains four files:

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template.tex..........LaTeX template for NOAO observing proposals
pnoao.sty.............Accompanying LaTeX style file
sample.tex............Sample NOAO proposal in LaTeX format
sample.ps.............Sample NOAO proposal in postscript format
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The sample proposal is a successful KPNO 4.0m proposal written by L. Ferrarese for the 2001A semester.

APPENDIX: SALT Telescope and Instrumentation

The Southern African Large Telescope (SALT) is an 11-m aperture telescope that will begin scientific operations in March 2005. SALT has a spherical primary mirror array consisting of 91 identical hexagonal segments. The telescope is inclined at a fixed 37 degrees to the vertical, but can rotate in azimuth to any angle. Thus, it can observe an annular band on the sky that extends in declination from +5 to –72 degrees. During an observation the telescope is static, and the object is followed by a tracker moving across the telescope's focal plane. The tracker contains an imaging CCD camera (SALTICAM), a versatile prime focus imaging spectrograph (PFIS), and a fiber feed system to send the light of selected objects to instruments located off the telescope (none will be available for the next two years). Individual objects can be observed as they transit through the telescope's field of view, with maximum tracking times ranging from 45 minutes near the celestial equator to 2.5 hours near the telescope's southern limit. Observations will be queue scheduled to maximize the telescope's efficiency. Rutgers is a 10% partner in the international consortium that is building and will operate the telescope. SALT is located at the South African Astronomical Observatory.

SALTICAM:
The detector consists of two 2k×4k CCDs with a gap between them. The image scale is about 0.15 arcsec pixel^{-1}, so the whole 8 arcmin diameter field is imaged. Filters will be available for the standard Johnson-Cousins UBVRI passbands. An AB=20.0 mag object will produce about 1.0 detected photon s^{-1}Å^{-1} at $\lambda = 3500$ Å, 2.0 detected photons s^{-1}Å^{-1} for $\lambda = 4000$ Å – 6000 Å, and a rate that decreases linearly with wavelength from 2.0 to

1.0 detected photons $s^{-1}Å^{-1}$ between $\lambda = 6000$ Å and 9000 Å. An AB magnitude calculator is available at http://www.stsci.edu/jwst/science/jms/abmag.html. It calculates an AB magnitude at a specified wavelength for an input standard magnitude and a spectral type for the object.

PFIS:

PFIS is described in the articles by Kobulnicky et al. and by Burgh, which are available on the class webpage. The detector is three 2k×4k CCDs and the image scale is 0.13 arcsec $pixel^{-1}$. PFIS is a complex spectrograph with many modes. The two principal modes for our purposes are 1) a grating spectrograph that can be fed with either a long slit or up to about 100 slitlets and 2) an imaging Fabry-Perot. Spectropolarimetry is also possible, but I suggest that you not write a proposal using that mode.

Grating spectrograph: The possible combinations of wavelength, resolution (resolving power, i.e. $R = \lambda/\Delta\lambda$), and wavelength coverage for the five volume phase holographic (VPH) gratings are shown in Figure 2 of the Burgh article. One observes with a fixed grating tilt, which are the sloping lines labeled with numbers like 30 and 40. There is also a low-resolution regular grating that gives a resolution of R=500. The S/N per wavelength resolution element in a 3000 s exposure is given in Figure 9 of the Kobulnicky et al. article. I believe that this plot assumes a grating efficiency of 90% and no slit losses (i.e., all of the light gets through the slit). A reasonable estimate for the slit losses at the median site seeing is 40%, so Figure 9 is really giving the S/N for a 3000/0.6 = 5000 s exposure — and even somewhat longer if the grating efficiency is less than 90%.

Fabry Perot: There are four possible wavelength resolutions: R = 300, 700, 1700, and 9000. The available wavelength range is 4300 – 8600 Å. Use the photon rates for the SALTICAM, except multiply by an efficiency of 0.50 for the two lower resolutions and by an efficiency of 0.35 for the two higher resolutions.