ASTRONOMY 511: OBSERVATIONAL TECHNIQUES (Fall 2003)

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Course Web Site: `http://www.astro.virginia.edu/class/oconnell/astr511`. The web pages will contain announcements, lecture notes, and information on assignments and deadlines. If you have questions, this is the place to look first. The pages also contain links to supporting web sites on observing, computing, weather, databases, and so forth.

Course Description:

This an introduction to observational astronomy in the ultraviolet, optical, and near-IR bands (the "UVOIR," roughly 0.1–3μ), which is astrophysically the richest part of the electromagnetic spectrum. The course is intended to acquaint students with the basic concepts, tools, and available resources for planning, executing, analyzing, and interpreting UVOIR observations. It describes current facilities and instrumentation. Assignments consist of problem sets and laboratory exercises, making substantial use of computer and image-processing facilities.

Because some of our students have physics or engineering backgrounds, no prior exposure to observational astronomy is assumed. The course is intended as much for theoreticians as for observers. Of necessity, it is topic-oriented, with the order of presentation dictated by the sequence of lab work, rather than by logic. Problem sets roughly parallel the lectures but will not necessarily be closely tied to contemporaneous topics.

There is some discussion of observational capabilities in other electromagnetic bands, but this is limited because other courses in the department cover high energy, radio, and infrared astronomy.

Texts:

There is no really suitable text for this course. I've ordered two, with very different styles. If you buy only one of these, make it the Lèna text.

Observational Astrophysics by Lèna, Lebrun, & Mignard (2nd edition). Up-to-date, wide ranging coverage of all types of observational techniques, leaning toward the formal theory of observations rather than "real life" practical methods. Much improved over first edition. A useful basic reference, strongly recommended for purchase. There will be selected reading assignments in this text, but it covers some topics in more detail than useful for this course while omitting others.

Astrophysical Techniques by Kitchin (2nd edition). Aimed at advanced amateur astronomers. Has clear, straightforward descriptions of standard instrumentation and techniques. Much more concrete than Léna, though less comprehensive and sophisticated. Recommended as a secondary purchase.

Astronomy 313/511 Observatory Handbook: A compilation of instructions for operation of the local Observatory equipment. Can be found under ASTR 313 at Newcomb Hall Bookstore. Required for all students. (The Handbook is available on the department web pages, but please do not print copies wholesale from there).

SUPPLEMENTARY READING: Many other useful books and articles can be found in the Astronomy Library. Some will be put on reserve, and these can be checked out overnight. A excellent bibliography is given in Lèna (p. 485), and supplementary lists of references will be handed out.

Requirements: Your grade will be based on the following:

A. Problem sets (40%): There will be 5 problem sets assigned, concentrated to the first 9 weeks of the semester. These will include computer-based problems and "rough order of magnitude" problems (ROMPs). Grading will be on a 3-level system (pass, fail, partial credit). Solutions will be provided.

   The ROM problems are intended to simulate "real life"—i.e. they deliberately draw on a student's general knowledge beyond the confines of the course, with the intention of encouraging development of broader knowledge of astronomy. Such problems may be divorced from earlier lecture presentations. Details on expectations for ROMPs are given in Problem Set #1.

B. Laboratories (60%). There will be 4 of these, subject to modifications owing to weather or equipment availability problems. For Labs III and IV, work will be done and submitted by groups of 4-5 students working together.

   I. Visual Observations with the 6-in and 10-in McCormick Telescopes

   II. Introduction to Image Processing

   III. CCD Fiber-Fed Spectroscopy with the Fan Mountain 40-in Telescope

   IV. CCD Filter Imagery with the Fan Mountain 40-in Telescope

   For Lab IV, each lab group will choose its own scientific program and targets in consultation with me. A project proposal will be due in late September. The main writeup will be collective. However, each student will be asked to make a supplementary individual proposal for extension of the project on the 40-in or other telescopes to which UVa has access.

Computing Literacy:

Computer literacy is essential for working astronomers. Aside from making it possible to manipulate large amounts of data rapidly and efficiently, interactive computing permits understanding of numerical data in ways which were possible only for analytic functions 20 years ago. This is a fundamental, qualitative change in the conduct and scope of scientific research.

Work in this class therefore involves extensive use of the department's UNIX computing facilities. Problem sets and labs will require that you become familiar with IDL, which is the best and most versatile of the interactive computing systems used in astronomy. Learning to program in IDL is reasonably straightforward, especially if you already know C, FORTRAN, or other languages. Extensive notes and a 3-part on-line tutorial will be provided. The "pipeline" reduction of raw CCD data will be done using the NOAO-supported IRAF system.

You will need to work on the main department UNIX system (i.e. not from LINUX or, God forbid, Windows computers) for access to IDL and to share files easily. Create a subdirectory named "astr511" under your login directory and keep all files related to classwork there. If you are unfamiliar with UNIX, it is a very good idea to buy & digest one of the many introductory manuals on it. For problem sets or labs where you use IDL, you should keep automated "journal files" of your interactive work. Store these in a single "jnl" subdirectory.

Policy on Submitted Work: You will work in groups on two of the labs but individually otherwise. You are free to consult reference sources and one another during work on problem sets, except where noted (e.g. ROMP problems). However, excessive collaboration will obviously be a hindrance to developing your own skills. Any work you submit—i.e. the detailed treatment of a problem—should be *entirely your own* except in the case of labs where you are asked to submit a group report. There will be a one-class-meeting grace period after each PS or Lab deadline, during which work can be submitted for half credit. If there are serious difficulties with the schedule, the deadlines will be extended for everyone, but not on an individual basis.

Don't be misled by the increasing emphasis on group work in courses like this one. Successful scientific groups are based on complementary strengths, not mutual weaknesses. Each group member is expected to be fully conversant with basic concepts and techniques and to carry an equal share of the overall burden of the project. Group writeups should specify the contributions of each individual.

Personal Scheduling: I realize there are many demands on your time. On the other hand, UVa graduate courses are designed to involve 6–10 hours per week of work outside of class. ASTR 511 has the added complication of requiring night-time observations in an area with unreliable weather. *You must be prepared to take advantage of clear weather when it occurs for observing labs,* or you will not be able to complete the coursework. Expect to spend about 8 nights of observing throughout the semester.