

## ASTR 586 Instruments and Techniques of Astronomy – Workshop for Teachers

### Course Description

Observatory and laboratory experience in investigating the modern techniques of imaging in observational astronomy. Characteristics of telescopes, CCD cameras, film and emulsions, electronic data acquisition and processing systems. Methods of reducing raw data. (3 credit hours)

### Course Objectives

The participant will 1) become familiar with the functions of the MS Windows operating system, 2) learn to use a comprehensive scientific image processing software package to reduce and process images, 3) become familiar with the quantitative properties of digital images, 4) be able to acquire and use standard calibration frames 5) evaluate the potential of a telescope/CCD camera system for astronomical imaging applications, 6) extract data from images necessary to complete basic scientific tasks appropriate for student or teacher research projects.

### Course Rational

Image information is very common and provides excellent visual stimulation when used to teach astronomy. Modern astronomy relies heavily on the use of digital images to collect data which can be used to determine physical properties of celestial objects. The modest cost of computer controlled telescopes and CCD cameras present an opportunity for middle and high school science teachers to expose their students to celestial images using computer controlled telescopes and cameras. This workshop will encourage teachers to become more proficient in the use of the MS Windows operating system. Many teachers are strongly attached to Apple systems and need practice in the use of the MS Windows environment. They will become proficient in the science of scientific image processing and learn basic skills in general image processing. This will provide confidence in the manipulation of image data for projects or for presentations. They will also become more knowledgeable about properties and formats used for digital images.

### Course Content, Format, and Bibliography

#### *Content*

Participants should be able to demonstrate the following skills at the conclusion of the workshop:

(In the following objectives the name SkyPro should be replaced by the appropriate name of the software package to be used in the workshop.)

1. Define the following terms related to IBM personal computers: bit, byte, Mb, Kb, memory, floppy disk, hard drive.
2. Define the following terms related to CCD cameras: pixel, ADU, dark frame, bias frame, image or light frame, flat field, readout time, blooming.

3. Define the following terms related to astronomical imaging: sensitivity, spectral response, reciprocity failure, linear detector.
4. Perform the following tasks as recommended by the SkyPro Software Manual: load files into windows (from any drive and/or subdirectory) use the linear and normal zoom windows and describe their differences identify the basic areas of the SkyPro screen
5. Briefly describe the three possible components of an image file and discuss how the size is related to the A to D converter and the array size.
6. List the number of bytes required to store 1) an ASCn character code, an integer and a decimal or floating point number in a computer or on a disk.
7. Explain what bias is and how one can obtain a measure of bias. Describe how and when bias frames are obtained, how they are processed and explain why.
8. Explain what dark counts are and how one can obtain a measure of dark count rates. Describe how and when dark frames are obtained, how they are processed and explain why.
9. Explain what a flat is and how one can obtain a measure of a flat field. Describe how and when flat frames are obtained, how they are processed and explain why.
10. List the sources of noise present in a typical CCD image.
11. Given a copy of the profile, histogram and examine screens, label the axes with numerical values and titles.
12. Use information in the profile and examine menu, find the most appropriate values to use to higWight a specified feature.
13. Describe quantitatively the effect of focal length and aperture on the image size, light gathering power, resolving power, magnification plate scale and field of view of a telescope
14. List the data needed to estimate the exposure times for celestial objects.
15. List the four types of astrophotography and identify appropriate applications of each.
16. Discuss the criteria for matching telescope focal length to the CCD pixel size and list the optical devices which can be employed to alter the focal length.
17. Explain how the following filters are designed in terms of pixel modifications: low-pass filters, high-pass filters, averaging filters, median filters unsharp masks and select appropriate filters to process CCD images.
18. Apply SkyPro software to create attractive CCD images which permit more useful applications.
19. Use magnitudes to determine brightness ratios and distinguish between the different magnitude systems in terms of color.

20. Point out the following on the sky: astronomical horizon, zenith, nadir, altitude, azimuth, local celestial meridian.
21. Define the following terms: celestial equator, celestial pole, ecliptic, solstice, right ascension, declination and precession.
22. Define without assistance the following terms: local time, zone time, apparent solar time, mean solar time, sidereal time, transit, local celestial meridian, circumpolar
23. List the steps required to align a portable telescope.
24. Use a computer program to update coordinates by correcting for precession.
25. Print images from SkyPro.
26. Copy images from SkyPro to other windows software.
27. Create multimedia files linked to images created in SkyPro.
28. Search for CCD Images and other astronomical information on the Internet using the World Wide Web

#### *Format*

#### Class Meetings

Workshop sessions are organized in a lecture/computer laboratory format. Lecture/demonstrations will be followed by extensive laboratory time to practice the required image processing tasks.

#### Examination and Extra Credit Project

Examination questions will be based on questions concerning reading assignments and on activities which were done during class sessions. Use the course goals and objectives, information on the assignment sheets and the summary questions in the exercises to guide you in preparing for the final exam. Practice quizzes will be given during the week to permit you to evaluate your progress. The final exam will be distributed on Friday afternoon. Part of this exam must be completed before you leave. The part of the exam which can be taken home must be returned to the Department of Physics and Astronomy Office by 4:00 PM on the Monday immediately following the conclusion of the workshop or postmarked on that date. The two portions of the exam will be averaged to determine your course grade. If you want to complete an extra credit project the subject must be approved by the workshop staff.

This course is taught as a dual undergraduate/graduate course. Students will be required to complete activities appropriate for the level of the course in which they are enrolled. Student performance on homework, exams and/or labs will be evaluated using different standards for undergraduate and graduate students.

*Bibliography*

Berry, Richard and Burnell, James, The Handbook of Astronomical Image Processing, (Willmann-Bell, Richmond, V A, 2000).

MaxIm DL Image Processing Software User Manual (Diffraction Limited Software, 1998) MIRA Pro Image Processing Software User's Guide (AXIOM Research, 1996).