Astronomy 602: Syllabus

Course Goals:

The goal of this course is to introduce you to the observational, statistical, and computational techniques used by observational astronomers. The course is designed to give you some of the basic skills you need if you decide to pursue a career in astronomy. In order to fully develop these skills you will be expected to do an observational research project and write it up as you would for publication. Many of these skills you will develop in this class are extremely useful in other careers as well as astronomy. In addition, the class is designed to improve your scientific writing and analytical thinking skills.

Introduction:

In order to learn about the techniques used by observational astronomers we must cover a lot of ground in this course. We will learn about telescopes and detectors, methods for taking, reducing, and analyzing data, and the statistics required for understanding the data and analysis. The course will rely heavily on the use of computers and you will be expected to become proficient in using the Linux environment and data analysis programs. **Because of the quantity and diversity of material that you will need, this class will require substantial time and effort. You must expect to invest a significant amount of time in this class to succeed. The time investment will include time spent at the campus telescope at night for observing.** In return for your effort, I will work hard to help you build these skills. I also hope that this class will be friendly, collaborative, and fun.

ASTRO 602 Lab:

Astronomy 402 consists of a lecture and laboratory portion of the class. You **must** sign up for both the lecture and the lab at the same time, the laboratory session is an integral part of the class. During the first few weeks of class we will meet for the telescope training and for some group observing sessions during the lab time. Later in the semester, after you have passed your telescope training and have been cleared to observe on your own (although you will always observe at least in pairs), you will be expected to sign up for observing time to collect data for class exercises and ultimately for your class project. The class observing time will always be available for this, but it might not be optimal for your project or weather might interfere. Because of these issues, you might need to have some flexibility in your evening schedule so that you can sign up for observing at other times if that becomes necessary. Using a telescope to make observations for your project is a significant time commitment, a minimum of 3 hours a week are expected to be devoted to the observing/data taking portion of this class.

Telescopes:

Using telescopes is always a bit tricky and never works as you plan it. There will undoubtedly be obstacles to deal with including instrumentation which does not always work as planned and weather that can sometimes be uncooperative. For the observations we also have access to remote telescopes in Chile that we can use if too many problems arise or if they would provide a useful supplement to the campus telescope for your designed investigation.

Computers:

The use of computers is fundamental to astronomical work so they are going to play a very important role in this class. We will use the computers located in the classroom. These computers are all running the Linux operating system with which you will become familiar if you are not already. For data reduction we will use astroImageJ but for some projects learning and using IRAF, software written for professional optical data reduction, may become necessary. You will also be expected to use a computer for some of the plotting and analysis of data. For this you may use any program with which you are already familiar.

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Office Hours: By appointment
Course web site: http://physics.gmu.edu/~jrosenb4/observational.html
Recommended Texts:
Observational Astronomy, by Birney, Gonzalez, and Oesper
An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurement, John R. Taylor
Handbook of CCD Astronomy, Steve B. Howell

Accomodations for Disabilities:

If you are a student with a disability and you need academic accommodations, please see me and contact the Office for Disability Services (ODS) at 993-2474, http://ods.gmu.edu. All academic accommodations must be arranged through the ODS.

Honor Code:

GMU is an Honor Code university; please see the Office for Academic Integrity for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely. There will be collaborative projects in this class, for those projects all contributors

should be credited. For individual projects on which only your name appears, you are welcome to discuss your ideas but the end result must be yours alone. If you are ever unclear as to the expectations for a part of this class please ask for guidance and clarification.

Grading:

	Graduate
Class Exercises	35%
Telescope Proposal	20%
Observing project (written)	35%
Observing Project (oral)	15%

Telescope Proposal

The graduate-level telescope proposal will be different from the undergraduate proposal for this course. For students pursuing a PhD with an emphasis in astrophysics, this project will be a proposal for a national facility rather than a proposal of the observing project for the campus telescope (your description of your plans for that project will be part of the homework assignments). If there is a proposal that you can write based on your research that would be ideal. If your research does not have a component that could lead to an observing proposal then we will discuss a project that you could propose. The proposal should make use of your understanding of astronomy and astronomical research. The format of the proposal should follow the format of proposals for the telescope you choose.

For graduate students not pursuing a PhD, a telescope proposal might be beyond the scope of your previous knowledge of astronomy and astronomical research. In this case I will be open to discussing a project that is more in line with your interests and career goals. In the past graduate student projects have included additional observing projects or a paper on the specifications needed to build an exoplanet finding telescope on the moon.

Project Paper

The goal of the project paper is to describe the observations, data reduction, and results of your research project. Again because this is the writing intensive class there is a word limit **minimum** to the paper that is 2500 words. The format for this paper will follow the format of astronomical publications so it may be helpful for you to have a look at the Astronomical Journal to see an example of what this format looks like. The audience for the paper will be a scientific audience – it should be written at the level of an Astronomical Journal article but with a bit more detail as to your method than might typically be included in such a paper. The primary components of your paper will be:

1) Abstract: an overview of what has been done and the results of your project.
2) Introduction: explains why this project is of interest and what the goals of the project are. This section will look a lot like your scientific justification section from the telescope proposal (I highly recommend that you look at any comments on your proposal justification and edit this section accordingly).
3) Data Reduction: describes the details of the data reduction you have done. This section needs to be very thorough! Discuss all of the observations you have and details including but not limited to: telescope used, types of observations take, duration of observations, step-by-step description of the data reduction procedure including all calibration, photometry, etc. Include figures where they are relevant.
4) Results: describes the results of your project. This section should be about the science that was done with the data. Use figures to illustrate your results.
5) Conclusions: this section describes how your results fit with the hypothesis that you made in your telescope proposal. More importantly, it places the results in the context of the scientific literature.
6) References: bibliography in the style of the Astronomical Journal

These projects will be done in groups of 2-4, but the write-up must be your own. You will fail the paper if what you turn in is not original. This doesn't mean that you can't talk about the work that you are doing, it means that what you submit MUST BE IN YOUR OWN WORDS! Also make sure that you are the first author on the paper and anyone else that contributed is co-author (if they did a significant amount of work like you partner is expected to have done) or is cited in the acknowledgements if they were part of a useful discussion of the work or contributed a useful idea (but not a significant part of the results).

Project Presentation

Presenting your research is an important skill as an astronomer. It is also a skill that crosses many disciplines and professions. At the end of the semester we will have a presentation session (or two depending on the number of students) in which each group will present the research they have done over the course of the semester. The talk should be directed at your fellow students (i.e., upper level astronomy students – we may have additional people viewing the talks, but this is still your target audience). Everyone in your group is expected to give part of the presentation so you will need to coordinate what each member of your group is talking about. This means that you will need to work together and ultimately to practice the talk together before this final presentation. Important things to include in the talk:

- Background material explaining what has been done before in this field. This is where you set the stage for the project you have just executed.

- An explanation of why you pursued this particular project, why it is interesting, and what questions you hoped to answer. This is where you lay out the hypothesis that you made.

- A thorough discussion of your observational method, data reduction, and analysis.

- Summary of your results, discussion of whether your results support or negate your hypothesis, discussion of where these results fit within the larger context of the field and the literature. This section could also include a revision of the hypothesis and discussion of possible future work.

Date	Reading/Assignment due	Topic
Aug 30		Introduction, Coordinates and time, Telecopes
Sept 6	Exercise #1 due	Statistics **Exercise 2:** Statistics
Sept 13	Exercise #2 due	CCD Detectors, dark, bias, and flat field images **Introduction to telescope/taking darks, biases, flats**
Sept 20	Proposal outline due	**Exercise 3:** Image calibration
Sept 27	Exercise #3 due	**Exercise 4:** CCD Processing
Oct 4	Exercise #4 due	Photometry and image calibration (relative vs absolute photometry) **Exercise 5:** Photometry
Oct 18	Telescope Proposals due	Spectroscopy **Exercise 5:** Photometry continued
Oct 25	Exercise #5 due	Time allocation committee meeting **Exercise 6:** Spectroscopy
Nov 1		Radio Astronomy **Exercise 6:** Spectroscopy continued
Nov 8	Exercise #6 due	**Exercise 7:** Radio astronomy
Nov 15		Infrared astronomy **Exercise 7:** Radio Astronomy cont.
Nov 22	Observing Project "draft" due	Interferometry Work on observing project data

Nov 29	Exercise #7 due	Interferometry cont. Work on observing project data
Dec 6	Observing Project Presentations	Observing Project Presentations
Dec 13	Observing Project due	