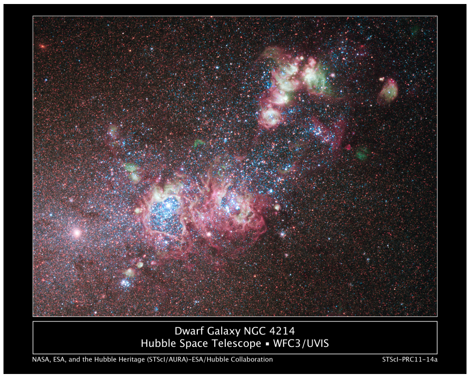
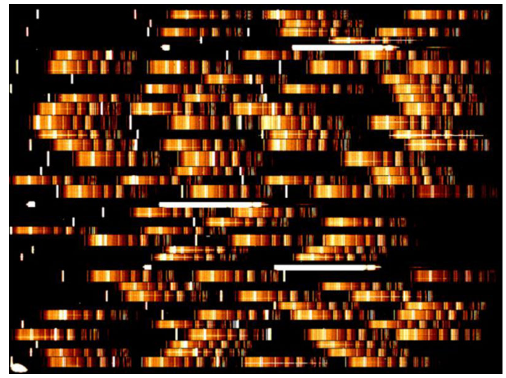
Observational Astronomy (ASTR 3130) Syllabus





Course Description and Objectives

How big is the universe? How do galaxies evolve? How do stars form? How do planets form? Is there life out here?

For thousands of years, humans have looked up at the heavens and wondered about these questions. Today's astronomers have access to an unprecedented array of telescopes, both on Earth and in space, to provide new insights into the answers to these questions. The pictures at the beginning of the syllabus show some excellent examples of the capabilities of modern telescopes.

In this course, you will join the long, proud tradition of observational astronomy. You will learn how to plan observational experiments, obtain images like those in the syllabus, and use them to understand the universe. By the end of this course, you will:

- design an observational experiment
- use a telescope to make the two fundamental types of astronomical observations: photometry (how bright is something) and spectroscopy (how does the brightness change as a function of wavelength)
- understand why and how to go from raw data, fresh from the telescope, to data with units like erg/s or magnitudes that you can do astronomy with
- understand the role of uncertainties in determining fundamental physical properties (mass, brightness, size, distance, etc.) and how to include uncertainties appropriately in your analysis
- integrate findings from the astronomical literature and other resources to support your research into astronomical phenomenon
- effectively communicate the results of your research to others
- strengthen your experience working in research groups

Although the content of this class is specific to astronomy, the general principles are also applicable to a wide range of other problems including remote sensing and medical imaging.

While this is an exciting course (both to take and to teach), it is also a very challenging one with a significant time commitment. The audience for this course is upper-level astronomy majors and other upper-level science and engineering majors. I will assume that you have a basic understanding of astronomy at the introductory level. Observational astronomy involves a significant amount of computing. It is not necessary to know how to program to be successful in this class, but experience using research grade computing environments (Mathematica, Matlab, R, IDL, etc) will be helpful. Most astronomy today is done as collaborative research. In the observing lab, you will work in groups to obtain and analyze your data. The groups will be selected to balance individual strengths and weaknesses to produce a well-rounded group. You are expected and encouraged to learn from each other. If you have any questions about the suitability of this course for your educational plans, please see me.

How To Succeed in This Course

Keep up with the material in the textbook and attend lecture. In lecture, we will build on the information presented in the textbook. This information is vital for you be able to perform and understand the laboratories. The reading for each day is listed in the syllabus. You will complete a short quiz based on the reading material by 9 a.m. the day of class. You have unlimited attempts at this quiz and I will record only your highest score.

Read and thoroughly understand labs ahead of time. Make sure to also read any associated telescope manuals. Telescopes are complicated and generally not very user friendly. Your time at the telescope will be limited and you need to make the most of it.

Assume that Murphy's Law holds. Make sure you have back up plans for if a source is down, filters are not available, or the weather suddenly takes a turn for the worse. Always back up your data, analysis, and lab report in multiple places (personal computer, astronomy computer, USB thumb drive, etc). Don't let data loss happen to you!

Start work on the lab reports early! These reports are very extensive and require time and attention on your part. Research has shown that academic writers who write for 30-45 min every day write significantly more and have more original ideas than those who write in large chunks (>1h) only when they are inspired (Boice 1990). Even if you aren't done with the analysis for a report, you can still write up what you have or work on the introduction or data collection section. If you don't like something you write, don't worry! The magic of computers allows you to easily revise (or delete or add) material.

Learn from others. Your classmates, TAs, and instructor are incredible resources. Often when you're doing research on a topic, the best resources are other people. On the other hand, this resource is precious and limited. Don't waste it by asking questions that can be answered with a quick look at a textbook or lab manual or a simple Google query.

Evaluation

Your learning will be assessed in five ways.

1.) *Pre-labs (15%):* These exercises are designed to help you build your observational astronomy skill set so that you can successfully complete the laboratories. Pre-labs may take the form of problem sets, writing assignments, and/or quizzes. They will reinforce material from the readings and lectures and complement the work done in the laboratory. You will be evaluated on your mastery of the material. Because this course builds on skills learned earlier in course, there will be more pre-labs earlier in the semester than near the end of the semester.

[*]2.) *Lab reports (40%):* A critical skill for scientists and engineers is the ability to clearly, concisely, and accurately write up the results of their research. For each lab, you will be responsible for creating a document that describes what you did in the lab and what you found. We will go over detailed guidelines for creating and evaluating lab reports later in the class. These reports are the meat of the middle portion of the course.

[*] 3.) *Final Project (25%):* Telescope time is a limited and valuable resource. Observational astronomers have to apply for time to do their research. For the final project for this class, you will write an observing proposal to do a research project using Fan Mountain Observatory. The observing proposals will be evaluated by the class and the accepted proposals will be carried out. You will present a poster describing your group's project to researchers from the Department of Astronomy at University of Virginia and from the National Radio Astronomy Observatory. You will be evaluated on your individual observing proposal, your evaluation of your peers' research proposals, and your group's presentation of the research.

4.) *Lab Exam (10%):* To evaluate and reinforce your mastery of the concepts, procedures, and skills developed in this class, you will take a lab exam during the scheduled final exam slot. More information about the format of the exam and study strategies will be given later in the class. This exam will be cumulative.

5.) *Group work and class participation (10%):* Modern astronomy is done by collaborative groups of astronomers. You will be evaluated throughout the course on the effectiveness of your lab group, completion of reading pre-quizzes and in-class learning activities, and your contribution to the class learning.

You can assess your own learning in the following ways:

1.) Are you to complete the reading quizzes satisfactorily?

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[*] Completion of these components are very closely linked to your attendance at the observing labs. Missing observing opportunities will impact your ability to successfully complete these assessments. If there is a personal emergency that prevents you from participating in an observing opportunity, please contact me as soon as possible ahead of time.

2.) What feedback are you getting from your instructor, peers, and TAs on your lab reports?
3.) Are you able to contribute effectively to the classroom discussion?
4.) Are you able to discuss course content with your classmates, TAs, or instructor in a meaningful way?

If you have a question about how you are doing in the course, please come see me during my office hours.

Important Details

Lecture Times: Tues. and Thurs., 11:00 a.m. to 12:15 p.m., Astronomy Rm. 265
Lab Times: Tues., 9 p.m. to 11 p.m. or Wed., 9 p.m. to 11 p.m., Astronomy Rm. 265
Course Website: on UVAcollab under name "11F ASTR 3130-100 (CGAS)"

Instructor: Amanda Kepley, Ph.D.
Office: Astronomy Room 237
Office Hours: TBD
Phone: 434-924-4897
Email: kepley@virginia.edu
Instructor Contact Policy: My office hours are there for you to use. I welcome discussions of material that go beyond what we are doing in lecture and lab. I will reply to emails within two business days. If you don't hear from me after two business days, please re-send the email. Email works best for simple problems and requests. If you have a more complicated issue, it is best to come see me in person. If you are not available during my office hours, let me know and we can find a time that works for both of us.

Teaching Assistant: Jake Borish
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Office Hours: TBD

Teaching Assistant: John Allan
Office: TBD
Phone: TBD
Email: jsa4vv@virginia.edu
Office Hours: TBD

TA Contact Policy: The TAs are an important resource. However, they have many other demands on their time. *Use your TAs time and expertise wisely!* They are there to *help* you do the laboratories, not to do the laboratories for you. See the instructor contact policy for email and office hour guidelines.

Textbooks and other materials:

The following textbooks are required:

- Birney, D. Scott; Gonzalez, Guillermo; and Oesper, David. 2006, *Observational Astronomy.* New York: Cambridge University Press, 2nd edition. This book will be used throughout the semester to provide background material for labs.
- Lyons, Louis. 1991, *A Practical Guide to Data Analysis for Physical Science Students.* New York: Cambridge University Press. This book will be used later in the semester,

so if you want to hold off buying it for a week or two go ahead. I'll give you a heads-up before this book is used. If you have another data analysis textbook, talk to me. You may not need to purchase another one.
- The *Astronomy 313/511 Observatory Handbook*, which is available for free online. A link to this resource will be posted on the course website. Please do not print large sections (>10 pages) from this manual on the Astronomy Department printers. If you would like to print a large section of the manual, please use the University's public laser printers (http://www.virginia.edu/uvaprint/public.html) or a commerical copy shop like Fedex Kinkos (located in Barracks Road Shopping Center near Harris Teeter), ALC copies (located on the corner of Barracks and 29/Emmet), or The Copy Shop (the Corner).

I have placed the textbooks for this course on reserve in the Brown Science and Engineering Library. You may also find the following book useful for writing your lab reports:
- *The Craft of Scientific Communication* by Joseph E. Harmon and Alan G. Gross. This book is available as an electronic resource in Virgo.

You will also need to obtain:
- a lab notebook to record your observations and analysis. Lab notebooks with sewn bindings (i.e., composition notebooks) are more robust than spiral notebooks or glued notebooks. Avoid notebooks with perforated pages; it's too easy to loose vital information from them.
- a good flashlight, preferably one with a red filter. You can make your own red filter with a paper grocery bag or red cellophane.

You may also find it useful to refer back to the textbook used for your introductory astrophysics class.

We will also use a wide array of web resources for astronomy research. Your TA will introduce these resources during the lab and links to the resources will be placed on the course website.

Writing Requirement

This class can fulfill the second writing requirement. Please contact me if you are planning to use this class to fulfill this requirement.

Grading Scale

95% =< A < 100%	73% =< C < 77%
90% =< A- < 95%	70% =< C- < 73%
87% =< B+ < 90%	67% =< D+ < 70%
83% =< B < 87%	63% =< D < 67%
80% =< B- < 83%	60% =< D- < 63%
77% =< C+ < 80%	F 59% or lower

Resources

In this course, you will have the opportunity to use several telescopes owned by the university: some on campus at McCormick Observatory on O-Hill and others at Fan Mountain Observatory south of Charlottesville. Before each lab using these telescopes, you are required to submit an "Observing Run Preparation" (ORP) form to demonstrate your readiness to observe. You will also receive a key to the astronomy building so that you have 24-hour access to the astronomy computer lab. In the first lab, your TA will go over how to obtain a key to the building, the policies for acceptable use of these facilities, and some extremely important safety information. Access to these facilities is a privilege and a responsibility, not a right.

Honor Code and Group Work

You will work in small groups to collect the data. However, each member of your group is responsible for writing up his own lab report in his own words. You must explicitly identify any cooperation or assistance from anyone, including other students in the class, in your lab report. It is acceptable to do the data analysis as a group as long as all members fully participate in the analysis. Everyone in your group does not need to have the same interpretation of the data.

Course Timeline

This timeline is subject to change depending on the weather and your progress as learners. An updated copy of the syllabus will always be available on the course website. I will notify you when the syllabus is updated and what changes I made.

On days when reading assignments are due you need to complete the online reading quiz on the course website by 9:00 a.m. on that day. Observing Run Preparation (ORP) forms (available on the course website) are due by 9 a.m. the day of the lab. Lab reports are due three weeks after the data for the lab is taken. If the weather is good, you may take data for the next lab before you have turned in the previous lab.

Date	Class	Assignment due	Lab	Assignment due
Aug. 23 (T)	#1: Introduction and welcome	Pre-class questionnaire & knowledge survey		
Aug. 23/24 (T/W)			#1: Introduction to the lab, group work, and safety procedures	

Date	Class	Assignment due	Lab	Assignment due
Aug. 25 (TH)	#2: Navigating the night sky	Read Birney, Ch. 1		
Aug. 30 (T)	#3: Navigating the Night Sky	Read Birney, Ch. 2 & 3 (3 is short. Don't worry about memorizing it).		
Aug. 30/31 (T/W)			#2: Best observing practices and using online catalogs	
Sep. 1 (TH)	#4: Optics	Read Birney, Ch. 6		
Sep. 6 (T) ADD DEADLINE	#5: Telescopes			
Sep. 6/7 (T/W) Sep. 7 DROP DEADLINE			#3: McCormick orientation -- Make sure to bring flashlight	Read Manual for McCormick and Doghouse telescopes
Sep. 8 (TH)	#6: Measuring Light	Read Birney, Ch. 5		
Sep. 13 (T)	#7: Atmospheric effects	Read Birney, Ch. 7		
Sep. 13/14 (T/W)			#4: Intro to telescopes lab or Intro to ADS (cloudy)	Read introduction to telescopes lab. Submit ORP*.
Sep. 15 (TH)	#8: Errors and Error Propagation	Read Lyons or equivalent		
Sep. 20 (T)	#9: Model Fitting			
Sep. 20/21 (T/W)			#5: Intro to Telescopes Lab or Intro to ADS (cloudy)	
Sep. 22 (TH)	#10: How to Write a Lab Report	Journal Article Reading Assignment		

Date	Class	Assignment due	Lab	Assignment due
Sep. 27 (T)	#11: Detectors in Astronomy	Read Birney Ch. 8 (sections on the eye and CCDs only)		
Sep. 27/28 (T/W)			#6: Intro to Telescopes Lab or Intro to Astronomy software (cloudy)	
Sep. 29 (TH)	#12: Calibrating CCDs	Read Birney, Ch. 9		
Oct. 4 (T)	#13: Photometry	Read Birney, Ch. 10		
Oct. 4/5 (T/W)			#7: Photometry lab or Intro to Astronomy software (cloudy)	Read photometry lab, read Fan Mountain Manual, & submit ORP*
Oct. 6 (TH)	#14: Photometry			
Oct. 11 (T)	READING DAY			
Oct. 12 (W)			#8: Photometry lab	
Oct. 13 (TH)	#15: Spectrographs	Read Birney, Ch. 13		
Oct. 17/18 (T) Oct. 18 DROP WITH W DEADLINE	#16: Spectroscopy	Read Birney, Ch. 14		
Oct. 18/19 (T/W)			#9: Photometry lab or Spectroscopy lab	Read spectroscopy lab, re-read Fan Mountain Manual, & submit ORP*
Oct. 20 (TH)	#17: Spectroscopy			
Oct. 25 (T)	#18: Asking Good Questions	Reading assignment TBD		

Date	Class	Assignment due	Lab	Assignment due
Oct. 25/26 (T/W)			#10: Spectroscopy lab	
Oct. 27 (TH)	#19: Research time for projects			
Nov. 1 (T)	#20: How to Write a Good Observing Proposal			
Nov. 1/2 (T/W)			#11: Spectroscopy lab	Submit ORP* for final project
Nov. 3 (TH)	#21: Observing Proposal Work Time	Proposal due Sunday at 10 p.m. EST		
Nov. 8 (T)	#22: Final Project Time Allocation Committee (TAC) meeting	Read proposals		
Nov. 8/9 (T/W)			#12: Final Project or spectroscopy lab	Final Project ORP
Nov. 10 (TH)	#23: Final project background	Reading assignments TBD		
Nov. 15 (T)	#24: Final project background			
Nov. 15/16 (T/W)			#13: Final Project	
Nov. 17 (TH)	#25: How to Create a Good Poster	Elements of good poster design assignment		
Nov. 22 (T)	#26: Work on final project			
Nov. 29 (T)	#27: Work on final project			
Nov. 29/30 (T/W)			#14: Final Project	
Dec. 1 (TH)	#28: Work on Final Project			
Dec. 6 (T)	#29: Poster Session			Submit final project

Date	Class	Assignment due	Lab	Assignment due
Lab Exam & Post-Class Knowledge Survey: Monday, December 12, 9:00 a.m. to noon				

* Observing Run Preparation form