Observational Astronomy

ASTR 341

Instructor Info

Prof. Karen Masters

Student Hours: find when I am free https://calbird.com/karen/1136

Observatory A or online

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Course Info

Prereq: ASTR204 or ASTR206

Mon, 7.30-10pm

Stokes 018/Observatory/Remote

Overview

Astro 341 consists primarily of several observing projects that involve using the CCD camera on the 16" Schmidt-Cassegrain telescope (located in the large dome of the Strawbridge Observatory), techniques of data mining from astronomical catalogues, as well as projects(s) using small radio telescope(s) at the Green Bank Observeratory. Data from these observations will be analyzed with either an image processing software package (AstroImageJ) or Python. The results of the projects will be written up as formal reports and one will be presented at the end of the semester.

The course will be very informal/student led. After the initial instructional observing sessions, each observing team (consisting of two students) will have the responsibility for scheduling observing with the 16" telescope. The regularly scheduled "class time" (Mondays, 7:30-10:00 p.m.) will serve three purposes. First, some of this time will be used for workshops on a variety of topics; e.g., an introduction to image processing, operating the 16" Schmidt-Cassegrain telescope, an introduction to CCD cameras and the data they create, introduction to radio astronomy. One session will be used to hold a radio astronomy "TAC" meeting to prepare for our GB observations. In addition, we will meet during this time to discuss the details of individual projects and reports. Finally, this time slot will give assurance that there is at least one night a week when members of all observing teams do not have scheduling conflicts. Because observing sessions often last for 5 or 6 hours, do not make any other commitments on Monday evenings that you cannot reschedule. Of course, because of the weather, there are other days of the week when you might have to observe. If we can be on campus plan to observe the first night it is clear that you can observe. Don't waste clear nights - they are a precious commodity for (optical) observational astronomers.

Material

Supplementary Texts:
An Introduction to Observational Astrophysics, by Mark Galloway
Handbook of CCD Astronomy, by Steve Howell

Other helpful/required journal articles and book chapters will be provided or linked to on Moodle.

List of Project Target Deadlines

Fri Sept 25th*	Extended Object Imaging lab: Generate a high quality color image of an extended object (or objects) from data taken with the CCD camera on the 16" Strawbridge telescope.
Sun Oct 11th*	An Introduction to CCD Observations: Characterizing the CCD camera and becoming fluent in basic computational techniques
~~Sun Nov 8th~~	~~A Proposal for Radio Observing: In teams of two, you will propose something we can observe on the 20m at GBO. As a class we will form a TAC to decide the most suitable project(s). We will likely be able to observe all feasible projects.~~
Sun Dec 6th*	Radio Astronomy Project Writeup: A write up of the project done at GBO
End of Finals	Final Project: e.g. Color-magnitude diagram of an open star cluster: Should include some data taken with the CCD on the Strawbridge 16" telescope and/or make use of archival data (e.g. Gaia).

* You must had something in, but work in progress can be improved up to Friday 11th December

FAQs

Will I learn how to use a telescope in this class?

Yes. That's the point - but we'll do more than just use the telescope - we'll use them to learn about astrophysics!

What is astrophysics?

The use of physics to understand and learn about objects in the night sky. All areas of physics, as well as a lot of chemistry (and some biology) are important to the full understanding of astrophysical objects.

What's the difference between astronomy and astrophysics?

It's really just semantics in the modern useage. The most useful distinction is that there are lots of Amateur Astronomers (someone who as a hobby uses a telescope to view the skies), while it's much more unusual to be an Amateur Astrophysicist (someone who uses physics to interpret objects in the Universe). At Haverford the Astrophysics Major is basically the same as the Physics Major with an Astro emphasis, while the Astronomy Major has more astronomy and less core physics.

What is your favourite astronomical object?

Galaxies. Which are pretty hard to observe with our telescopes, but not impossible..... try the Whirlpool galaxy (M51).

Honour Code

Collaboration is an important part of science. You are strongly encouraged to work together and/or consult one another for work in this class. You are encouraged to consult any books necessary as well as resources on the internet. You must, however, turn in your own individual homework, and this must be written on your own. Copying and pasting (even parts of sentences) is not permitted and is a violation of the Honour Code. Good collaboration involves everyone understanding what is going on in the assignments. Therefore even if the basic solution is shared you must explain it in your own words (including mathematical words). Please list any students that you collaborated with. Please pay attention to your classmates to make sure no one is being left out of collaborative work.

You may not obtain materials from students who have taken this course in previous years, nor may you distribute your current materials to students not currently enrolled in this class. Please consult me if you have any questions.

Diversity and Inclusivity Statement

Our classroom should be a place where all members will be treated with respect. I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability - and other visible and non-visible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class. If something was said in class (by anyone including myself) that made you feel uncomfortable, please talk to me about it (anonymous feedback is always an option). I appreciate any opportunity to continue my learning about diverse perspectives.

In an ideal world, science would be objective. However, science is done by people, and is historically built on a small subset of privileged voices. In this class, we will make an effort to read work from a diverse group of scientists, but limits still exist on this diversity. I believe that integrating a diverse set of experiences is important for a more comprehensive understanding of science. We may discuss issues of diversity in astrophysics as part of the course from time to time. Please contact me (in person or electronically) or submit anonymous feedback if you have any suggestions to improve the quality of the course materials.

Accommodation Statement

Haverford College is committed to providing equal access to students with a disability. If you have (or think you have) a learning difference or disability – including mental health, medical, or physical impairment, please contact the Office of Access and Disability Services (ADS) at hc-ads@haverford.edu. The Coordinator will confidentially discuss the process to establish reasonable accommodations.

Students who have already been approved to receive academic accommodations and want to use their accommodations in this course should share their verification letter with me and also make arrangements to meet with me as soon as possible to discuss their the specific accommodations. Please note that accommodations are not retroactive and require advance notice to implement.

It is a state law in Pennsylvania that individuals must be given advance notice if they are to be recorded. Therefore, any student who has a disability-related need to audio record this class must first be approved for this accommodation from the Coordinator of Access and Disability Services and then must speak with me. Other class members will need to be aware that this class may be recorded.

Draft Class Schedule

Date	Topic/Plan	Activities/deadlines
Optical Astronomy		
Week 1 - Wed 9th Sept	Introductory Material (telescopes, co-ordinates etc)	Planning for Imaging Lab
Week 2 - Mon 14th Sept	Data into Pretty Pictures	Practice with AstroImageJ
Week 3 - Mon 21st Sept	CCDs and Image Processing	Extending Object Imaging Lab due Sun Sept 27th
Week 4 - Wed 30th Sept	CCDs and Image Processing	Planning for CCD lab
Week 5		
Mon 5th Oct 7-8.30pm	CCD Project Work time	
Wed 7th Oct 10-11am	Jocelyn Bell Visit	CCD Characterisation due Sun Oct 11th
Week 6 - Mon 12th Oct	Planning Session for Final Optical Project	Observing plan for final project
Radio Astronomy		
Week 7 - Mon 19th Oct	Introduction to Radio Astronomy	Problem set on sources of radio emission
Week 8 - Mon 26th Oct	Proposal Writing process	Status checkin assignment
Week 9 - Thur 5th Nov	Virtual visit to Green Bank Observatory (TBD)	~~Radio Proposal due Sun Nov 8th~~
Astronomy and Society		
Week 10 - Mon 9th Nov	Cultural Significance of Astronomy	~~Read Radio Proposal~~
Week 11 - Mon 16th Nov	~~Radio Astronomy TAC Meeting~~ TBD	Status report for both projects.
Project Work and Data Mining		
Week 12 - Mon 30th Nov	Remote: Data Mining Techniques (using Gaia)	Radio project write-up due Sun Dec 6th.
Week 13 - Mon 7th Dec	Wrap Up Class - Student Presentations	Presentations on a Project/Part of a Project
Finals (14-18th Dec)		
Date set by College	Final (Optical) Project Write-up	

ASTR341, Fall 2020 - Prof. Karen Masters
Specification Grading

Your final grade will be determined by your successful completion of different aspects of Observational Astrophysics. Detailed specifications and instructions for each of the five projects will be distributed as we go through the semester.

1. To earn a 1.0 by the end of the course, you must satisfactorily:
   - ☐ be checked out on the 16" telescope (remote is fine).
   - ☐ within the confines of what is safe and possible[1] engage in a reasonable number of observing sessions with the CCD not he 16" (in person or remote).
   - ☐ make a colour image of an extended astronomical object using images through 3 filters
   - ☐ complete one of the preparatory projects (CCD characterisation ~~or the radio proposal~~) to an adequate level

2. To earn a 2.0 by the end of the course, you must satisfactorily:
   - ☐ do everything in level 1
   - ☐ make a good contribution to the course
   - ☐ complete ~~both of~~ the preparatory projects (CCD characterisation ~~and the radio proposal~~) to good standard
   - ☐ make a really good image of an extended astronomical object
   - ☐ complete one of the science observation projects (optical or radio) to a good standard

3. To earn a 3.0 by the end of the course, you must satisfactorily:
   - ☐ do everything in level 2
   - ☐ make a really good contribution to the course
   - ☐ ~~read radio proposals and make a good contribution to the radio "TAC" (time allocation committee)~~
   - ☐ complete both of the science observation projects (optical and radio) to a good standard
   - ☐ give a good presentation on one of the science observation projects

4. To earn a 4.0 by the end of the course, you must satisfactorily:
   - ☐ do everything in level 3
   - ☐ make an excellent contribution to the course
   - ☐ complete both science observation projects to a high standard
   - ☐ give a high quality presentation on one of the science observation projects

To gain
- +0.33: complete one level, and one other item.
- -0.33: complete all but one task in a level (except at Level 1, which would result in a 0.0).

[1] This is by necessity vague - without knowing how the weather and pandemic progress I cannot put a number on this. If you are worried you won't make it ask me.

Definitions of Quality Assessments:

You will meet the criteria to have done an assignment/activity (e.g. all activities in 1.0 level) if you make a attempt to, on the whole do what is asked for, and at a level that at least adequate (fair).

Other quality assessments will use the below rubric (some language inspired by the "Kosman" Grading Rubric").

The posted deadlines provide the recommended schedule to keep up with the class. You must submit something for each deadline, but you may improve and resubmit any work (except the radio proposal and TAC which are time sensitive) until the end of the semester to meet a given quality criteria.

Extended Imaging Lab
An acceptable submission will be of an extended astronomical object (i.e. not a single star), and will be a colour image constructed using your own data analysis on 3 single filter images. You will include a caption explaining something about both the imaging, and the physics of the object.

A"*Really Good*" submission demonstrates some imagination or flair in your choice of object, your skill in observing and/or data reduction, aesthetically pleasing composition and choice of colours, and your understanding of the physics of the object (as assessed by the caption).

CCD Characterisation
"*Good*": Work that is GOOD, does most of what could be asked for in a more than just satisfactory way. For the CCD project, this means that most questions are answered demonstrating an understanding of the reasons for asking them, and that you participated in taking most of the data used, and did a good job with the analysis.

"*Adequate*" means that you have at least attempted to answer most questions, using some data you participated in obtaining.

Radio Proposal
"*Good*" In the context of a radio proposal, this means that a good attempt was made to comment on the technical feasibility of the observations you wish to make, and there was also a good attempt at a scientific justification demonstrating good understanding of what would motivate the observation.

Radio TAC
"*Good*": For the Radio TAC "good" means that you demonstrably read all proposals, made a constructively critical (or positive) comment (either in writing, or in person) on each submission, and attempted to provide an opinion about the ranking of submitted proposals.

Radio observing science project
"*High Standard*" means work of EXCEPTIONAL or EXCELLENT quality, involving a deep and comprehensive understanding, or original research of the highest quality, or some out of the ordinary restructuring of an issue, etc. In the context of the radio project I would expect to see excellent engagement in the observing trip, data taking, an excellent attempt at some kind of data analysis and a write up in the style of a formal scientific report or paper.

"*Good*: For example this would mean something was slightly less than excellent - for example that you did not participate in the observing trip and data taking, or that the analysis was only attempted in a cursory way.

Optical observing (e.g. cluster) science project

"*High Standard*" means work of EXCEPTIONAL or EXCELLENT quality, involving a deep and comprehensive understanding, or original research of the highest quality, or some out of the ordinary restructuring of an issue, etc. I would expect to see excellent engagement with all aspects (i.e. the observing, data analysis and data mining parts) of this project, and an excellent write up in the style of a formal scientific report (or paper) which clearly demonstrates your understanding of the project.

"*Good*": I would still expect that a lot of the project is done extremely well, but some aspect of it might be short of excellent in some way.

Presentations

High standard - you present your work in a way that is professional, memorable, motivating, contains accurate scientific information (appropriately credited), and only the necessary information. You presentation is well organised (with an introduction, methods and conclusion) and you use the time to demonstrate your deep understanding of the topic of your science project.

Good - a presentation which meets most of the above criteria, but may be lacking in one or two ways.

Course Contributions

Attendance to all scheduled classes (unless you have a medical or other reasonable excuse), and working on the assigned projects is obviously necessary for contribution, but in itself is not enough. My evaluation of your contributions will reflect

- consistent and rigorous preparation for class
- consistent, enthusiastic attempts to engage with your peers and the professors in class
- efforts to engage with the material and share questions, techniques, or other realisations
- professional and respectful interactions with everyone in class, and a willingness to share expertise in parts of the class where you have more background experience (e.g. understanding the motions the stars; the astrophysics; practicalities of observing - including organisation of a project; coding skills).

Excellent - a contribution of EXCELLENT quality would reflect a high level of engagement in all aspects of the class, from observing, to data analysis and scientific interpretation and that you are fully prepared for all class time. You will be also a professional and respectful member of the class, and an exemplary member of all project groups you work in.

Really Good a contribution of REALLY GOOD quality reflect much of the above, but perhaps engagement varied amongst different aspects of the class. You are a really good member of all project groups you work in, contributing your skills to the team success.

Good contributions may be infrequent (or patchy), but reflect satisfactory preparation. You are a useful member of the project groups you work with in at least some ways.