Introduction to Astrophysics

ASTR204

Instructor Info

Prof. Karen Masters

Student Hrs: Wed 12.30-1.30pm (Coop); Thur 11.30am-12.30pm (ASTR204 priority) and 3-4pm (PHYS105 priority). Or by appointment.

Observatory A

www.haverford.edu/users/klmasters

klmasters@haverford.edu

Course Info

Prereq: PHYS 106 (or co-req in BMC equiv.)

Tues & Thurs

11.30am-1pm

Observatory Classroom

Lab Info

TBD

Five evening lab sessions

Observatory

TA Info

Emily Harrington

Homework Help: TBA

TBA

Overview

Astronomy 204 is the Introduction to Astrophysics class required for both astronomy and astrophysics majors and astronomy minors. This course provides a broad physical foundation to astronomy and astrophysics and serves as a prerequisite for the study of advanced topics. We will cover the physics of stars and stellar remnants, nebulae and star-formation, as well as an introduction to Galactic and extragalactic astronomy, and the basics of observational and theoretical cosmology.

Another goal of ASTR204 is to provide an introduction to tools of the research scientist. We will learn some tools of the observational astronomer through the completion of observational projects. These will require additional instruction in the use of telescopes during evening Observing labs (dates TBC). We will also begin to learn about how to read the astronomical literature,

Material

Textbook

Ryden, B. & Peterson, *Foundations of Astrophysics*.
I am aware that this is a relatively expensive book. It will be useful in future ASTR courses you may take, but if you do not wish to/cannot buy it, copies will be held in Reserve in the Observatory Library and Physics Lounge.

Grading Scheme

30%	Homeworks
30%	Observing Assignments (see last page)
10%	Review Paper (see below)
10%	Participation and Contributions
20%	Final Exam

Homework and Lab Reports

Either homework or a lab report will be due every week at 2pm on Thursday.

You will not be able to participate fully in class if you do not keep up with the Homework/lab schedule. However, if requested in advance, a 48 hour extension will be granted no questions asked. If you do not ask in advance, or go beyond that, 10% credit will be lost each day that any assignment is late, up to 50% off. After ten days late, an assignment will earn no credit.

The expectation for homework, lab reports and other written work, is that a physicist will be able to understand exactly what you're calculating and why without looking at the question you were asked. A lot of learning takes place in the process of doing science, not in simply getting a numerical answer as quickly as possible written work will be evaluated as such. Please show your work cleanly and neatly, and help us to give you partial or full credit! It will help your grade if you are neat and organized – we can't grade what we can't read.

You will have the opportunity to resubmit your Homework to recover 50% of lost points by explaining what you did wrong. This resubmission will be due a week after the first submission. No extensions are possible on resubmissions.

Review Paper

Students will choose a scientific article concerning a topic or astronomical object that is related to the topics being covered in class. For this assignment, you will write a 3 page summary of the paper, including any relevant necessary background. You will give short ($\sim$ 5 min) presentation of the paper to the class the week of Thanksgiving. We will determine the topics for presenting in the first week of class. There will be a workshop on paper reading, and use of LaTeX/Overleaf during a (cloudy) lab session. Please find your paper using: `https://ui.adsabs.harvard.edu/`). KLM must approve your paper choice.

FAQs

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

Yes. Part of the labs will involve training on the Strawbridge Observaory 12" telescope, the Solar telescopes in the Library and remote use of a radio telescope.

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 favorite astronomical object?

Galaxies - the building blocks of the Universe, and fascinating in their own right.

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 papers 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

Stars and Planets

Week	Topic	Readings	Deadlines[1]
Week 1	What is Astrophysics. Introductions and plan		
(Sep 3, 5th)	The Sun & The Solar System	Chapters 7, 8	
Week 2	Telescopes	Chapter 6	HW1 (Solar Physics)
(Sep 10, 12th)	Observations of Stars	Chapter 13	
	Evening Lab 1		
Week 3	Physics of Stars: Spectral Lines	5.3,5.6 (some) 14.2, 14.1, 14.3	HW2 (Observing)
(Sep 17, 19th)	Physics of Stars: Hydrostatic Equilibrium	9.2, 14.1 & 15.1	
Week 4	Nuclear Fusion in Stars	Chapter 15.2, 15.3	First Lab Report due 9am Mon 30th[2]
(Sep 24, 26th)	Physics of Stars: Modeling Stars and Solar Neutrinos		
	Evening Lab 2		
Week 5	Stellar Lifecycles	Chapter 17.2	HW3 (Stars)
(Oct 1, 3rd)	Pulsating Stars	Chapter 14.1 & 15.1	
Week 6	White dwarfs, Neutron Stars and Pulsars	Chapter 18.2	HW4 (Stars)
(Oct 8, 10th)	Supernovae and Stellar Mass Black Holes	Chapter 18.3	
	Evening Lab 3		

Fall Break

Week 7	Interstellar Medium (ISM)	Chapter 16	HW5 (Compact Objects)
(Oct 22, 24th)	Star Formation	Chapter 17.1	
	Evening Lab 4		
Week 8	Exoplanets (KLM away 29th)	Chapter 12.3	Second Lab Report
(Oct 29, 31st)	Planet Formation	Chapters 8 & 12.1–12.2	

[1] 2pm Thur unless noted
[2] There will be four deadlines for Lab reports, and you may hand any one in at any deadline (but must hand one in for each deadline)

Galaxies and Cosmology

Week 9	The Milky Way	Chapter 19	HW7 (ISM and Milky Way)
(Nov 5, 7th)	The Milky Way		
	Evening Lab 5		
Week 10	Galaxies (normal)	Chapter 20	Third Lab Report
(Nov 12, 14th)	Galaxies		
Week 11	Galaxies (active)	Chapter 21	HW8 (Galaxies)
(Nov 19, 21st)	Large scale structure	Chapter 22	
	Evening Makeup lab (if needed)		
Week 12	Student talks		Review papers due Tue before class
(Nov 26th)	Thanksgiving Nov 28th	Holiday	
Week 13	Observational Cosmology	Chapter 23	Final Lab Report
(Dec 3, 5th)			
Week 14	Physical Cosmology	Chapter 23	HW9 (Cosmology)
(Dec 10, 12th)			
Exam Week	Final Exam - Open Book, Take Home (4 hours allowed)		

Observing Projects

There will be 1-2 hours per week of workshops held outside of class five evenings throughout the semester. You must attend at least three of these (you may attend all). These workshops will cover the basics of observational astronomy, including navigating the skies, the use of the 12" telescope and the Solar telescopes and remote use of a radio telescope. We will schedule these during the first week of class based on your availability. Some labs will also depend on the weather, so exactly what happens each workshop will be determined as we go.

On one cloudy evening we'll use the time to discuss tactics for reading papers, as well as practice use of LaTex (using Overleaf.com) to write papers the way professional astronomers (and other types of physicists) do it.

Four observing projects will be assigned during the term. There will be four deadlines for these projects, and you may hand any one in at any deadline (but must hand one in for each deadline).

You may use the Solar telescopes on any sunny day, but please use them only in the vicinity of the Observatory (unless you have special permission) and always return them to the library.

Students must work in teams of two or three at the 12" telescope. After being checked out on the telescope, students are allowed to sign up for independent use as long as they are accompanied by another qualified observer. WARNING: The weather is a formidable foe. Even though the actual number of hours you spend observing will be few, if you don't get your optical Observing done early in the semester you may have to be "on call" for much of the time. You should plan to give optical observing top priority on clear evenings to ensure successful completion of the projects.

1	Naked Eye Observing	You will learn how to use Stellarium or other software to work out what is visible on a given night, and explain the annual and daily motions of the Sun, Moon, stars and planets as observed from Earth. During one of the evening sessions you will point out three constellations to the professor or TA, and comment on the phase of the Moon and any visible planets. The report will comprise a narrative description of this process (how you selected your targets, comments and challenges in pointing them out).
2	Observing with the 12"	You will learn to observe with the 12" and select (using Stellarium or in consultation with the Professor or TA) and point the telescope at two interesting objects (on a clear evening session). The report will be a narrative description of this process, including your explanation of how to observe with the 12".
3	Solar Observing	You will make use of one of the small solar telescopes (in the library) to observe the Sun, measure it's angular diameter to estimate its physical size, record the Sunspot number to compare to archival data, and use the motions of sun spots to estimate its rotation rate. Observations for this project must be completed over a period of several continuous sunny days when a sunspot is visible on the Sun.... archival data is available as a backup if the weather (Solar or Earth based) does not co-operate. The Sun has been in an extended minima recently, so sunspots have been rare.
4	Galaxies and Cosmology	You will learn how to use a radio telescope remotely to observe the HI 21cm spectral line coming from an external galaxy. You will use this observation to estimate the dark matter fraction of the galaxy, and contribute your measurement of the redshift of the galaxy, along with an estimate of its distance to a class database to create a Hubble diagram which should demonstrate the expansion of the Universe. At least half of the class must complete the observing/analysis before this report can be handed in. This project is not weather dependent - radio observing can happen through clouds.