



UNIVERSITY OF CONNECTICUT

Department of Physics  
College of Liberal Arts & Sciences

## ***PHYS 2701 – Foundations of Modern Astrophysics*** **Course Syllabus, Fall 2021**

*Syllabus information is subject to change. The most up-to-date syllabus is located within the course in HuskyCT.*

### Course and Instructor Information

**Instructor:** Professor Cara Battersby

**Office:** Gant South S113F

**Virtual Office:** <https://uconn-cmr.webex.com/meet/cab16109>

**Email:** [cara.battersby@uconn.edu](mailto:cara.battersby@uconn.edu)

**Office Hours:**

- (Previously was Tuesday and Fridays for the first half of the semester, made by appointment only starting October 25, 2021)
- **by appointment only** starting October 25, 2021: just ask me or try: <https://calendly.com/battersby>

**Class Meeting:** Tu/Th 3:30-4:45pm

**Class Location:** GP110

### (Highly) Recommended Course Materials

***An Introduction to Modern Astrophysics*** by Carroll & Ostlie, 2<sup>nd</sup> edition, published by Pearson. Also known as the BOB (Big Orange Book) for reasons that will soon be obvious. The same textbook is used in both PHYS 2701 and 2702. A used copy is perfectly fine.

### Course Objectives

Astrophysics is the study of the Universe, with a particular focus on stuff outside the Earth. In this course, you will learn how we know what we know about the universe, learn about what we don't know, and develop the skills and knowledge to begin to unravel the mysteries of the universe for yourself (cool, right?).

This course is the first in a 2-part sequence. PHYS 2701 will focus on the foundational physics concepts of light (production, transfer, properties), gravity, and orbits and the phenomenology of stars and planets. PHYS 2702 will focus on the techniques of astrophysics, with a subset of topics including telescopes, optics, statistics, and data analysis and the phenomenology of galaxies and cosmology.

Main objectives:

- 1) Develop and advance **critical thinking and problem solving skills** and apply them to astrophysical phenomena
- 2) Build a **foundational understanding** of astrophysical concepts (light, gravity, orbits, stars, and planets)
- 3) Get experience with **communicating scientific ideas**

### Pre-requisites

The course assumes a strong background in physics and calculus. The PHYS 2701-2702 sequence is designed for students intending to pursue an astrophysics minor and its associated advanced astrophysics coursework. General science and engineering students who want a more challenging and quantitative introduction to the universe than presented in the general education introductory astronomy course (PHYS 1025) may also take the course, however, be aware that it will require a lot of hard work. Both PHYS 2701 and 2702 count as upper-level physics electives and count toward an Astrophysics Minor.

### Course Schedule

*Tentative Course Schedule\* -- subject to change – shared here:*

<https://tinyurl.com/PHYS2701-Fall2021-Schedule>

Date	Unit	Topic	Reference Reading	Assignment/Exam Notes	Notes
Tuesday, August 31	1 - Intro and Scales of the Universe	Intro, scales of the universe		HW #1 assigned	
Thursday, September 2	2 - Celestial Coordinates	The Sky at Night, Sidereal vs. solar time	Chapter 1		
Tuesday, September 7		LST, RA, Dec, solstices and equinoxes			
Thursday, September 9	3 - Gravity.	Gravity, Newton's laws, Kepler's laws	Chapter 2	HW #1 due, HW#2 assigned	
Tuesday, September 14		Gravity, escape speeds, Kepler's laws			
Thursday, September 16		Lagrange points, virial theorem, parallax		HW #2 due, HW #3 assigned	
Tuesday, September 21	4 - The Nature of Light	Finish Unit 3, start Unit 4	Chapters 3, 5		
Thursday, September 23		Electromagnetic Radiation,			
Tuesday, September 28		Magnitudes, Thermal radiation		HW #3 due, HW #4 assigned	Brainstorm Astrobite Paper ideas
Thursday, September 30		Blackbody Radiation, Light and Matter, Kirchoff's laws			
Tuesday, October 5		Doppler, Spectral lines, deBroglie $\lambda$	Chapter 8		Finalize astrobite topic choice
Thursday, October 7		Bohr Model, Uncertainty, Zeeman		HW #4 due	
Tuesday, October 12	Exam Take #1	Exam week			
Thursday, October 14	Exam Take #2	Exam week			
Tuesday, October 19	5 - Stellar Spectra and Atmospheres	Stellar spectra: Formation	Chapter 8		
Thursday, October 21		Stellar spectra: Abundances		HW #5 assigned	Give out feedback form!!!
Tuesday, October 26		Stellar atmospheres	Chapters 8.2, 9.5		First draft astrobite due!
Thursday, October 28		H-R diagram	Chapter 9.2, 9.3		Extra credit for wearing an astro-themed costume!
Tuesday, November 2		Radiative transfer, Opacity, mean-free path	Chapter 9.2, 9.4	HW #5 due	
Thursday, November 4	6 - Stellar Interiors and Evolution	Limb Darkening, start Hydrostatic equilibrium	Chapter 9.3, 10.1, 10.3	HW #6 assigned	
Tuesday, November 9		Hydrostatic Equilibrium, chemical, gravitational, and nuclear timescales.	Chapter 10.1, 10.3		
Thursday, November 11		Coloumb barrier and quantum tunneling, Nuclear fusion in stellar interiors	Chapter 10.3	HW #6 due, HW #7 assigned	
Tuesday, November 16		Nuclear fusion, Eddington limit	Chapter 10.3, 10.6, 13.1 (briefly)		Final astrobite due - Workshop presentations
Thursday, November 18		Stellar evolution, Post - Main Sequence evolution	Chapter 13.2, 16.2, 13.3, 15.1-15.3		
Tuesday, November 23		Thanksgiving Recess - No class			No class
Thursday, November 25		Thanksgiving Recess - No class			No class
Tuesday, November 30	7 - Planets and Life in the Universe	Dust, gas, ISM, formation of planets	Chapter 12	HW #7 due, HW #8	Astrobite presentations, part 1
Thursday, December 2		Formation of stars and planets	Chapter 12 and 23		Astrobite presentations, part 2
Tuesday, December 7		Exoplanets!	Chapter 23	HW #8 due	
<b>TBD</b>		<b>REVIEW SESSION!</b>			
Thursday, December 9		Mock Final Exam		Final Exam, try 1	Mock exam
12/13/21 - 12/19/21		Final Exam Week		Final Exam, try 2	Final exam

## Grading and Course Work

This course is designed to reward hard work and in-class participation. Intelligence is fluid and learning to learn is an important component of this class.

Grade Component	Weight
Homework and Quizzes	30%
Midterm Exam	25%
Final Exam	25%

Grading	Scale	(%)	
93-100	A	73-76	C
90-92	A-	70-72	C-
87-89	B+	67-69	D+
83-86	B	63-66	D
80-82	B-	60-62	D-
77-79	C+	0-59	F

In-class participation	5%
Astrobite and pop talk	15%

### **Exams**

In an effort to minimize stress, maximize learning, and offer you the opportunity to demonstrate your learning, rather than exam-taking skills, each exam will be offered *twice (different versions)*, first as a mock-exam, then as a regular exam. You can take the best grade of the two. Students should contact the instructor at the beginning of the semester for any planned absence.

The midterm exams (mock and regular) will be *Tuesday \*\*\*Oct. 12<sup>th</sup> and Thursday Oct. 14<sup>th</sup>.\*\*\** The mock final exam will be *Thursday, Dec. 9.* The regular final exam will be *during final exam week.* Final exam week for Fall 2021 takes place from 12/13/21 – 12/19/21. Students are required to be available for their exam during the stated time. If you have a conflict with this time, you must visit the Dean of Students Office to discuss the possibility of rescheduling this exam.

### **Homeworks and Quizzes**

Homeworks will be due roughly every 1-2 weeks. *Homework must be highly legible. They can be turned in electronically on HuskyCT or they can be handed in at the start of class on white paper with no binder edges.*

***On the front page of each homework write your name, who you worked with, any resources you used, and how long the homework took you.***

Collaboration on homework problems is allowed (even encouraged!), but the final written work must be your own. *Homeworks are due at the beginning of class. Since we will discuss homework solutions in class, no late homeworks can be accepted. Each student's lowest two homework scores will be dropped.* Students should contact the instructor at least one week in advance to make up work associated with planned absences (like religious observances or extracurricular activities).

***The expectation for homework, and other written work, is that you clearly state the problem, demonstrate what you are calculating and why, clearly outline the steps and process for solving the problem, box your final answer, include appropriate units and significant figures for your answer, and assess the reasonableness of your answer.*** The focus is on problem-solving skills, not getting the right numerical answer, and the clearer your work is, the easier it is to assign partial credit. However, a “reality check” on your numerical answer is expected (does this answer make sense? Why or why not?).

Prof. Battersby has a **ZERO-TOLERANCE CHEATING POLICY**. You are absolutely forbidden from seeking homework answers online, posting homework questions online, copying from anyone, or any other form of cheating. If you do so, the incident will be

reported to academic misconduct, and Prof. Battersby will recommend failure of the course.

For each problem set, there will be an in-class quiz on the day the homework is due, on one of the homework problems. This is to give you practice with working on your own in an 'exam-like' environment that is low pressure, since you know the questions ahead of time, as well as to ensure that you understand the problem set you completed. Therefore, please ask any questions that you have about the homeworks ahead of time!

The written homework will be "spot-graded" meaning that I will only grade a 1-2 questions. We will have time to discuss the solutions and any questions in class and of course in office hours. Quizzes will comprise 40%, the graded homework questions will comprise 40%, and "completeness" of your homework will comprise 20% of the "Homeworks and Quizzes" portion of your grade.

### ***In-class activities***

This class will be an active learning experience with a lot of in-class work and participation expected. Since we are still living in a global pandemic (!) in-class work can be done remotely as needed to adhere to University guidelines regarding quarantine and stay home if sick procedures. For this semester, I will grade each of your worksheets as 0, 1, or 2, for not complete, partially complete, or complete to determine your participation grade. These can be done in person (preferred when possible) or remotely as needed.

### ***Astrobite and Pop Talk***

There is no way we can cover all of the amazing things in the universe in one semester, but I want you to have the opportunity to dive into an astrophysics topic that interests you and to share it with the rest of us. Moreover, no matter what profession you go into (astrophysics, teaching, lab manager, science policy, data science, etc) being able to research and clearly communicate what you find, both in written and spoken words, is an invaluable skill. Astrophysics is not stale and unchanging, scientists are discovering new things about the Universe every day. While much of this course will focus on fundamental properties of our Universe discovered decades or centuries ago, I want you each to have some first-hand experience reading and learning about cutting-edge astrophysics research.

To this end, you will have a semester-long project to research an astrophysics topic that interests you (topics will need to be approved by instructor), write a short "astrobite" on it, workshop the piece with classmates, revise, and submit. You will then practice presentation skills by workshopping a "pop talk" with a group in class on this topic and then, near the end of the semester, you will give a very short "pop talk" to the class on this topic.

You can find examples in the original astrobites (<https://astrobites.org>) or AAS Nova (<http://aasnova.org>). Your astrobite should be less than about 1000 words (1005 is okay, but don't push it) with references clearly documented. We will go over some example pop talks later in the semester, but it should be clear, exciting, short (< 3 minutes) with no slides or just a few good graphics (very little text).

More details on these assignments will follow in the first 3 weeks of class.

### **Extra Credit**

I encourage you to attend astronomy seminars (most Wednesdays 2pm) and Physics Colloquia (Fridays 3:30pm). If you attend at least **three** of these and hand in a short, 1 paragraph summary of each, you will be awarded extra credit, up to an additional 5% of your final exam. If you wear an astro-themed costume on Halloween, er, Oct. 28th (and show off your costume in front of the class!) you will be awarded an additional 10% extra credit on your most recent homework assignment.

### **General Rules of Conduct**

It's still a global pandemic, y'all! I have a small child at home who cannot get vaccinated, so I will exercise extra caution in trying to keep myself protected, and ask that you please be respectful of all University guidelines regarding vaccination, mask-wearing (over your nose and mouth), and quarantining / staying home if you are potentially sick or exposed.

Silence all cell phones when entering class. People sometimes forget that their instructors are people, not TV screens. If you're texting, yes we can see it, and yes, it is rude. You may be asked to leave class for repeated distractions caused by electronic devices. You are welcome to use a laptop to take notes during lecture and for group work.

### **Academic Integrity**

**Don't cheat. Not even once, not even a little bit.** Academic honesty is a fundamental tenet of education. Copying someone else's work, letting someone copy yours, seeking or using homework solutions or old exams (found online, from a friend, *anywhere*) is cheating. If any of you are caught cheating in any way, Prof. Battersby will report the incident to Academic Misconduct and recommend failure of the course.

Take responsibility for your learning process and be a part of the community of scholars at UConn. Similarly, plagiarism in any form, meaning the failure to adequately document the source(s) of one's work, is wrong. Both copying and plagiarism violate the UConn Student Code. See Appendix A: Academic Integrity in Undergraduate Education and Research: <http://community.uconn.edu/the-student-code-appendix-a/>

Instances of copying or plagiarism will be handled under the guidelines specified in the Student Code (<http://community.uconn.edu/the-student-code-preamble/>). You are responsible for acting in accordance with this code. Review and become familiar with

these expectations. “I didn’t know” is not an excuse. Please note that copying another student’s assignment is not the same as sitting down in a study group and discussing the assignment. As long as you maintain the boundary of *doing your own work* following discussion, there should not be a problem.

*All lectures, notes, handouts, homeworks, exams, quizzes, and displays are copyrighted by state and federal law. You are welcome to take notes and share them with other students in the class. You are not authorized to share course materials outside our class, and are expressly forbidden from commercial use of course materials.*

### UConn policies

Full UConn policies can be found on the web, here is a good place to start:

<http://provost.uconn.edu/faculty-and-staff-resources/syllabi-references/>

### **Policy Against Discrimination, Harassment and Related Interpersonal Violence**

The University is committed to maintaining an environment free of discrimination or discriminatory harassment directed toward any person or group within its community – students, employees, or visitors. Academic and professional excellence can flourish only when each member of our community is assured an atmosphere of mutual respect. All members of the University community are responsible for the maintenance of an academic and work environment in which people are free to learn and work without fear of discrimination or discriminatory harassment. In addition, inappropriate amorous relationships can undermine the University’s mission when those in positions of authority abuse or appear to abuse their authority. To that end, and in accordance with federal and state law, the University prohibits discrimination and discriminatory harassment, as well as inappropriate amorous relationships, and such behavior will be met with appropriate disciplinary action, up to and including dismissal from the University. Additionally, to protect the campus community, all non-confidential University employees (including faculty) are required to report sexual assaults, intimate partner violence, and/or stalking involving a student that they witness or are told about to the Office of Institutional Equity. The University takes all reports with the utmost seriousness. Please be aware that while the information you provide will remain private, it will not be confidential and will be shared with University officials who can help. More information is available at [equity.uconn.edu](http://equity.uconn.edu) and [titleix.uconn.edu](http://titleix.uconn.edu).

### **Students with Disabilities**

The University of Connecticut is committed to protecting the rights of individuals with disabilities and assuring that the learning environment is accessible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, please let me know *immediately* so that we can discuss options. Students who require accommodations should contact the Center for Students with Disabilities, Wilbur Cross Building Room 204, (860) 486-2020 or <http://csd.uconn.edu/>

Accommodation will help ensure that all students have the opportunity to do their best work and optimize their academic experience.

**Inclement weather and emergency preparedness**

In case of inclement weather, a natural disaster, or a campus emergency, the University communicates through email and text message. Students are encouraged to sign up for alerts through <http://alert.uconn.edu>. Students should be aware of emergency procedures, and further information is available through the Office of Emergency Management at <http://publicsafety.uconn.edu/emergency/>

**Sexual Assault Reporting Policy:**

To protect the campus community, all non-confidential University employees (including faculty) are required to report assaults they witness or are told about to the Office of Diversity & Equity under the Sexual Assault Response Policy. The University takes all reports with the utmost seriousness. Please be aware that while the information you provide will remain private, it will not be confidential and will be shared with University officials who can help. More information is available at:

<http://sexualviolence.uconn.edu/>