ASTR 792 Syllabus
Fall 2023
Professor Mills

Applied Physics of the Interstellar Medium
9:30- 10:45 TR

Office Hours:

- Scheduled by appointment

Class Github:

- https://github.com/eacmills/ASTR-792-2023

Class Slack group:

- prof-mills-group.slack.com

Anonymous Feedback:

- Form here

Overview:

This course will cover topics including:

- The theory of radiative processes relevant to astrophysical situations, including those acting on atoms, ions, and molecules and especially those relevant to material exterior to stars.
- The physics of the interstellar medium in and between galaxies, including fluid dynamics, the quantum mechanics of atomic and molecular spectra, and equilibrium and non-equilibrium thermodynamic processes.
- Observational diagnostics of interstellar gas, including microwave spectroscopy and radiative transfer modeling.

Throughout this course we will work to deepen our theoretical understanding of these topics in a way that will help you apply them to the practice of astrophysics research. The understanding of course concepts will be assessed in two primary ways: through regular written problem sets (where the material will be at a graduate level), and through blackboard problem solving in real time during lecture (where the material will be at an undergraduate level). The goal of this is to both encourage you to solve more difficult problems in a more real-life setting, when you have full access to resources, but also to challenge you to develop a deeper understanding of the material by putting you in a position where you must demonstrate (and explain!) a basic and fundamental knowledge of the course material .

Course Goals:

As an instructor:

- Maintain a supportive and welcoming classroom environment where students are comfortable asking questions, discussing topics, and solving problems
- Foster a community of learning in which students and professor support each other and challenge each other to listen, grow and succeed
- Listen to student needs and provide resources, guidance, and feedback that helps each student achieve their individual goals

For students:

- Practice and improve physics problem solving techniques, including recognizing when a challenging problem or concept has you stuck, and responding by finding and utilizing resources to get unstuck.
- Apply the methods and topics covered in this class to new scenarios, including current research problems.
- Improve your communication skills for working as part of a team, including listening to and validating classmates, and sharing your opinions and input.

Textbooks:

(1) Bruce T. Draine, 'Physics of the Interstellar and Intergalactic Medium'.
(2) Charles H. Townes & Arthur L. Schawlow, 'Microwave Spectroscopy'.

Draine is required, and will be the primary text for the course. For a more detailed treatment of molecular spectra I will also refer to Townes and Schawlow, and I recommend but do not require this text. Draine is currently in print, and there are many ways to obtain this text including the campus bookstore and online book vendors. Townes & Schawlow is not in print, however used copies are available, and an ebook version is available for $10. I will also provide scanned excerpts of sections listed in the course readings.

Classroom Environment:

Learning is not a competition, but rather a mutual endeavor where we all work to succeed together. Everyone in this classroom, including myself as a professor, is here to learn. Ignorance is a natural part of this process. During the semester we will all encounter situations that make us feel confused or lost. We may initially fail at something. We can support each other by asking questions, sharing our own understanding, respecting each other when we struggle with a new

idea or concept, and celebrating when we eventually ‘get it’. Listening to each other is key to learning, and as a professor I will regularly solicit student opinions and feedback about the course, in addition to the anonymous feedback form.

If you have any concerns about the class that you feel are not being addressed, please contact me by e-mail or in person. I will be available for regular office hours when you can talk to me about any topic (grades, homework, class structure, issues outside of the classroom, research, etc). Additionally, if you ever have a concern that you do not wish to discuss with me directly, please talk to the Department Chair (Dr. Fischer) as soon as possible.

Weekly Class Structure:

This class will be highly interactive with a mix of lecturing and board work, so I expect you to familiarize yourself with the assigned reading before coming to class. Each week, the goal is to devote the first 45 minutes of class to lecturing, with the last 30 minutes reserved for group problem solving. I expect students to attend class regularly in order to participate in all these activities.

Course Webpage:

Class materials, including problem sets and lecture notes, will be available in the shared Github repository. Please contact me if you encounter any difficulty accessing these materials.

Homework:

There will be a single problem, due weekly. You are encouraged to work together, however each student must turn in their own version of solutions. I strongly prefer that homework assignments be typed: typed homework is easier for me to read and grade, can more easily be revised in the future by you, and allows for additional self-assessment and reflection as it is transcribed from your original notes. Ultimately however I leave it to your discretion. Unless otherwise specified in class, ***homework is due at midnight on the date shown in the lecture schedule.*** If you cannot make a deadline, please contact me in advance.

Final Project:

There will be no traditional exams in this course. Instead, a final problem solving session will take place during the final exam slot. Each student will bring in a problem, and we will randomly assign problems to class members (including me!) to then solve at the board.

Grades and Assessment:

We will use contract-based grading in this course. Your grade will be assessed using the following set of expectations:

	A range	**B range**	**C range**	**D/F range**
	(1 pt)	**(0.75 pt)**	**(0.5 pt)**	**(0.25 pt)**
Problem sets	Fully completes all problems and rarely turns them in late	Mostly completes all problems (no more than one missing problem) and regularly turns them in on time	More than one assigned problem is not completed, and/or problems are not regularly turned in on time (more than half of problems are late)	More than half of assigned problems are not completed
Lecture participation*	Always attends class and is rarely late.	Regularly attends class (no more than one lecture is missed and not made up) and is regularly on time	Misses more than one lecture without making up the absence and/or is late to more than half of lectures	More than half of lectures are missed and not made up.
In-class problem solving**	Present for in-class problem solving sessions and attempts*** all assigned problems	Regularly present for problem solving sessions. No more than one assigned question is not attempted	Present for less than half of problem solving sessions and/or does not attempt more than half of problems	Absent for more than half of in-class problem solving sessions
Classroom Citizenship	Actively encouraging to peers and instructors in the classroom and on Slackl	Always respectful to and considerate of peers and instructors.	Mostly respectful to and considerate of peers and instructors.	Actively disrespectful or discouraging to peers or instructors

*The requirement that students attending class can be satisfied by attending via zoom. If not able to attend via zoom, this requirement can still be satisfied by watching the recorded lecture AND asking a question about the lecture in the class Slack channel within a week of the missed lecture.

**The requirement that students be present for in-class problem solving can be satisfied by participating in real-time via zoom. If unable to participate in real time, this can also be satisfied

by submitting a solution to the in-class problem in the class Slack channel within a week of the missed lecture.

***Attempting assigned in class problems means that if you are called to work at the board, you spend at least 5 minutes exploring/explaining approaches to solve the problem and, if needed, soliciting suggestions from the class.

Your final grade will be translated into a letter grade using the combination of the points earned in each of these areas.

A	>3.7	B-	2.3 - 2.7
A-	3.3 - 3.7	C+	2.0 - 2.3
B+	3.0 - 3.3	C	1.7 - 2.0
B	2.7 - 3.0	C-	1.3 - 1.7

How to Succeed in this Class:

A successful student in this class looks like you! I have high expectations about what we can learn and accomplish this semester, and I believe each of you has the ability to meet these expectations and succeed. Some tips:

- Take notes on reading & lectures, and spend some time outside of class summarizing them (daily or weekly). Try to make connections in your notes to topics from other lectures (have we discussed anything similar already in this class?)
- Ask questions! If you encounter a question you really don't want to ask in the lecture, or on Slack, submit them anonymously through the google form, or send me an e-mail!
- Take advantage of your classmates: we can all learn from each other, and sharing our questions and ideas will make all of us better problem solvers.
- Don't leave problems blank on homework (or the board blank for in-class work!)-- always try something and write a description of your thought process (if you think you are doing something wrong or have the wrong answer, say why. Reflecting on problems is a valuable skill!)
- If something isn't working for you, let me know! I value your perspective and feedback, and while I can't fix or change everything, I will be working to improve the class over the course of the semester.