Astronomy 364P: Planetary Systems

Spring 2021, Unique Number: 48065
TTh 9:30am, virtual

Professor:
Dr. Caroline Morley
Email: cmorley@utexas.edu
"Office" hours: W 1-2pm; Th 10:45am-11:45am, or by appt. Online on Zoom, connect on Canvas.

Teaching Assistant: Katie Chworowsky
Email: k.chworowsky@utexas.edu
"Office" hours: M 1-2pm; F 1-2pm. Online on Zoom; connect on Canvas.

Prerequisites: PHY 316 or 303L (E&M) and an astronomy core class (AST 307, 352K, or 353). We will use some of the math built in your math/physics courses, and some of the astronomy jargon built in your earlier astro class will be assumed.

Class Website: This course will be primarily run through the Canvas system, at canvas.utexas.edu. All class communication will be done through Canvas. You are responsible for checking Canvas daily. I recommend setting up email alerts to be notified when I send messages or post assignments. You may also wish to download the mobile app.

Course-Level Learning Goals: Our understanding of extrasolar planets has advanced at a remarkable pace — from the first discovery of a planet orbiting a Sun-like star in 1995, we now know of thousands of exoplanets orbiting the stars in our galaxy. We will embark on a journey to understand the alien worlds orbiting other stars. Topics covered will include exoplanet detection, exoplanet demographics, planet formation and evolution, planetary atmospheres and interiors, and habitability. You will complete the semester by developing, writing, and presenting a proposal for your own novel exoplanet research project. At the end of the course, you are expected to be able to:

1. Understand the techniques used to find and characterize exoplanetary systems
2. Write scientific analysis scripts
3. Communicate scientific ideas in written and oral forms

Required Texts and Other Items: The recommended textbook is Extrasolar Planets and Astrobiology by Caleb A. Sharf. The field of exoplanets moves very quickly and this book was published in 2009, so it will be supplemented as needed with other materials. The alternate text, The Exoplanet Handbook by Michael Perryman, is more recently updated (~2018) and is a good reference book. You may use EITHER book.

Class Structure: The class will be a mix of lecture, small-group discussions & problem solving, and full-class discussions & problem solving. Paying attention to a Zoom class for more than 20-30 minutes at a time is challenging; the course will involve active learning methods designed to have you engaging in each topic. Each course will involve something interactive, and we will utilize a few different modes over the course of the semester, including but not limited to: Zoom breakout rooms; UT Instapoll; shared Google docs; Canvas discussion boards (for non-anonymous discussion), Google Forms (for anonymous questions/feedback).

Communication: Please use either ***Canvas*** or ***email*** to send a message to your TA or to Professor Morley. We will aim to respond during normal working hours (M-F, 9-5pm) within 24 hours.

Grading Components and Policies:

You will receive the grade you earn. The composition of the course grade is:

1. Problem sets = 25% (7 problem sets; drop lowest score)
2. Computational problem sets = 25% (5 computational problem sets; drop lowest score)
3. In-class participation = 15% (5 absences allowed)
4. Reading questions and other preparation for class (10%)
5. Final Project = 25% (no drops)

1. **Problem Sets**: There will be 7 standard ("pen and paper") problem sets. These will be posted as assignments on Canvas and should be turned in as a PDF on Canvas. You may either hand-write and scan, or LaTeX your solutions. Your work should be legible and your answer should be boxed. Your **lowest problem set grade will be dropped.** Typically due on Fridays at 5pm.

2. Computational Problem Sets: Much of Astrophysics requires coding, for both theoretical and observational astrophysics. These will give you a chance to practice these skills. These computational problem sets will be varied. Some may include working with data and doing data analysis. In some, you'll start from a blank page and write your own scripts from "scratch". In others, you'll download an existing tool and use it. All of these are things we do as professional astronomers, so all are useful skills to practice. Depending on your coding background, these may be challenging, so please reach out if you're feeling challenged: we are here to help you learn! Instructions for turning these in will be given on each assignment; you'll turn in both your code and a specific set of outputs. Typically due on Fridays at 5pm.

3. **In-Class Participation:** The course will require active participation during class. Typically, 1/3 to 1/2 of each class session will consist of problems and derivations that you will work out in small groups or as a class. While I can present material, I cannot make you learn, and without your help this class will not be a success. Because of this, I will be grading on participation. Students who receive an "A" in participation will do the following things:

- Attend class
- Ask questions (before, during, or after class)
- Answer questions (being correct is not important)
- Attempt in-class problems
- Work effectively, respectfully, and collegially with their fellow classmates

4. **Reading and preparation for class:** Your first introduction to the material is through the readings from the textbook or from handouts that I will provide. Readings will be assigned for each class session. You are to complete the reading assignment in advance of class. The night before class, you will post one thoughtful question you have about the reading on our Canvas discussion board by 5pm. Occasionally I may ask you to do an alternative reflective exercise on the reading. The purpose of this exercise is for you to identify which aspects of the reading you did not understand, were confused by, or want to hear more about.

5. **Final Project:** In addition to teaching you all about exoplanets, this class also aims to develop your skills at presenting scientific content and identifying novel scientific questions. To that end, each

student will complete an independent project, which will take the place of a more traditional final exam. The project will entail writing up a well-motivated research proposal, as an extension of the topics we cover in class this semester. There will be several intermediate deadlines throughout the semester to scaffold your proposal-writing progress. Each student will also present their work in a video presentation. Additional handouts describing the details of this project will be provided at a later date.

Common questions:

No Exams: A class like this would typically have ~2 midterms and a final that would provide the bulk of your grade, but I don't think the online format is particularly well-suited to big high-stakes exams. Note that this heavily rebalances your grades to rely on problem sets, computational problem sets, and project grades.

Extra credit: There will be opportunities to get additional points in this class by volunteering to present about new papers "in the news". These are the only extra credit points available. More details will be available later! 😊

Late work: If you submit late work (without first discussing the reason for the late work with Professor Morley), 10% will be subtracted *per day* for the first 5 days (e.g. 2 days late = maximum of 80% on the problem set). After 5 days the late work will not be accepted and you will receive a zero.

Two important policies:

Excused Absence Policy: You are allowed up to 5 absences "no questions asked". This may include times that you are ill. You are expected to make up the work on your own time to understand the course material. If you have extenuating circumstances that will cause you to miss more than 5 classes (e.g., hospitalization, family emergency, etc.) please reach out and we will come up with an alternate plan for you to succeed in the course.

Collaboration Policy: I encourage you to collaborate in class and on homework assignments, including standard problem sets and computational problem sets. The course is graded on an absolute scale, so you won't reduce your grade by helping others. Your fellow classmates are an important resource to help you understand the course material in order to complete the homework. The best strategy is to first attempt to complete an assignment on your own, before consulting with your fellow students. If you are having trouble completing a homework problem, you may wish to consult with any of the following resources: your textbook, your class notes, your professor, or your classmates. Other resources are not allowed unless I specifically approve them. If you have any questions about appropriate use of outside resources, please come speak with me directly. If you collaborate on a homework assignment, **you must (1) state the names of the students with whom you collaborated, and (2) submit your own individual, original solutions and code**, which you write without consulting someone else's solutions.

Accommodations:

Accommodations for disabilities: The University of Austin provides upon request appropriate academic accommodations for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-6441 TTY or Division of Diversity and Community Engagement, Services for Students with Disabilities, 512-471-6259, www.utexas.edu/diversity/ddce/ssd. **Your SSD letter will be sent to me by SSD; we can discuss any necessary accommodations via Zoom so that you can succeed in the course.**

Accommodations for other things: Taking courses online means that many students have additional other responsibilities and/or distractions during class time. While I expect professional behavior from students, I recognize that the environment is currently extremely challenging. My goal is for all students to be given the opportunity to be successful: please talk to me if you are concerned and feel like you need accommodations.

Two other important items:

Regarding harassment/assault: Harassment of any sort will not be tolerated in this classroom or related workspaces. Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights violations subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, etc. If you or someone you know has been harassed or assaulted, you can find the appropriate resources through the University Title IX Coordinator (512-232-3992), UT Austin Campus Police (512-471-4441), the Student Ombuds Services (which can provide *confidential* advice, resources and help; 512-471-3825), and the UT Counseling and Mental Health Center (512-471-3515).

Academic Dishonesty: The minimum penalty for cheating — in any way whatsoever — is receiving a zero on the assignment on which you cheated. I reserve the right to seek a penalty I deem appropriate for the given case of academic dishonesty, including failing the class and being reported to Student Judicial Services. In this class, cheating would include plagiarism (e.g., cutting and pasting sentences from a website or paper), copying a classmate's problem set or code, utilizing "cheat sheets" of any form or fashion either paper or digitized, getting an advance copy of an assessment. If the academic honesty is sufficiently serious, I will proceed by filing a formal report to the Judicial Services in the Dean of Students Office as is policy. Judicial Services would decide the final penalty after a hearing on the matter. For more information, read in the General Information Catalog about scholastic dishonesty (i.e. cheating).

Course Schedule

Day	Topic
Jan 19	Introduction, Logistics, intro
Jan 21	Review of Stars, and Kepler's Laws
Jan 26	Detecting exoplanets: radial velocities
Jan 28	Detecting exoplanets: astrometry

Day	Topic
Feb 2	Detecting exoplanets: transits
Feb 4	Detecting exoplanets: transit timing, pulsar timing
Feb 9	Detecting exoplanets: microlensing
Feb 11	Detecting exoplanets: direct imaging
Feb 16	Comparison and future of detection techniques
Feb 18	Exoplanet demographics 1
Feb 23	Exoplanet demographics 2
Feb 25	Planet formation 1
March 2	Planet formation 2
March 4	Orbital evolution & migration
March 9	Terrestrial planet interiors
March 11	Giant planet interiors
	(spring break from March 15-March 19)
March 23	Theory of atmospheres, 1
March 25	Theory of atmospheres, 2
March 30	Transmission spectroscopy
April 1	Eclipse spectroscopy
April 6	Phase curves and atmospheric circulation
April 8	Peer review day for projects
April 13	Direct imaging spectroscopy
April 15	Brown dwarfs
April 20	Life and habitability
April 22	Habitable zones
April 27	Biosignatures
April 29	Final projects due!
May 4	Future missions
May 6	**Last class day!**