Astronomy 364P: Planetary Systems

Fall 2023, Unique Number: 48315
TTh 11-12:30, PMA 15.216B

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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

Textbook: The field of exoplanets moves very quickly and texts have quickly gone out of date. The Exoplanet Handbook by Michael Perryman is a good reference book if you like to have a book to follow, but is not required. I will post relevant review papers and readings as needed.

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

Communication: Please use ***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. Pen-and-paper problem sets = 25% (5 problem sets; drop lowest score)
2. Computational problem sets = 25% (5 computational problem sets; drop lowest score)
3. Midterm exams = 30% (2 exams; no drops)
4. Final project = 20% (no drops)

1. **Pen-and-paper problem sets**: There will be 5 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 Thursdays 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. Your **lowest problem set grade will be dropped.** Typically due on Thursdays at 5pm.

3. **Midterm exams:** We will have two (non-cumulative) midterm exams, conducted in-class and requiring written answers.

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. 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 research and 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:

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

Late work: My philosophy for this course is mutual respect, flexibility, and grace. You are all adults with complicated lives and competing responsibilities. All due dates are "target dates". If you will miss a target date, you must email me **before the assignment is due** and let me know when you will be able to complete the assignment by; we will confer and mutually choose a date that works for you. I would prefer that you do the work and learn the material than rush the assignment and turn in something half-finished (or, worse, plagiarized).

If you **miss a due date without contacting me**, you cannot turn the assignment in late for credit.

Three important policies:

Excused Absence Policy: I am not grading attendance this semester, but in general 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. 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.

ChatGPT Policy: The rapid adoption of openly available Large Language Models like ChatGPT provides both opportunities and problems. We will occasionally explore this in class, including looking at some of the pitfalls of using these tools for research, as well as some of the potential use cases. That said, you're at university to learn a broad set of skills, including writing, and using ChatGPT to create passable text does not teach you how to write. If you use ChatGPT for any problem sets or computational problem sets, please attach: 1) an explanation of *why* you used ChatGPT, *how* you used Chat GPT, and if it was useful and 2) include a link to your chat (there's a "Share Chat" button in the top right). We'll discuss more about appropriate and inappropriate use of ChatGPT for your final project.

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, Disability and Access (formerly "SSD"), 512-471-6259, https://diversity.utexas.edu/disability **Your D&A letter will be sent to me by their office; we can discuss any necessary accommodations so that you can succeed in the course.** If you're having a hard/slow time getting set up with D&A, feel free to start that process and talk to me about accommodations concurrently.

Accommodations for other things: Every student is in a different situation; some can spend 100% of time focused on school, while others are balancing families, working jobs, significant sports team commitments, or other life things. I want you to succeed! Come talk to me if you need accommodations to aid in your success in this course.

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). Know that I (and all your professors and TAs) are mandatory reporters.

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, or using ChatGPT without credit or explanation. 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
Aug 22	Week 1: Introduction, Logistics, Review of Stars, and Kepler's Laws
Aug 24	
Aug 29	Week 2: Detecting exoplanets: radial velocities, astrometry
Aug 31	***Pen and Paper Problem set 1 due***
Sep 5	Week 3: Detecting exoplanets: transits, transit timing, pulsar timing
Sep 7	***Computational Problem set A due***
Sep 12	Week 4: Detecting exoplanets: direct imaging, microlensing
Sep 14	***Pen and Paper Problem set 2 due***
Sep 19	Week 5: Exoplanet demographics
Sep 21	***Computational Problem set B due***
Sep 26	Week 6: Planet Formation
Sep 28	**Midterm 1 (weeks 1-5)**

Day	Topic
Oct 3	Week 7: Orbital evolution & migration
Oct 5	***Pen and Paper Problem set 3 due***
Oct 10	Week 8: Planetary interiors
Oct 12	***Computational Problem set C due***
Oct 17	Week 9: Theory of atmospheres: 1D
Oct 19	***Pen and Paper Problem set 4 due***
Oct 24	Week 10: Spectroscopy of directly imaged planets
Oct 26	***Computational Problem set D due***
Oct 31	Week 11: Spectroscopy of transiting planets
Nov 2	***Pen and Paper Problem set 5 due***
Nov 7	Week 12: Theory of atmospheres (3D) and phase curves
Nov 9	**Midterm 2 (weeks 6-11)**
Nov 14	Week 13: Life and Habitability
Nov 16	***Computational Problem set E due***
	Thanksgiving break 
Nov 28	Week 14: Catch up and class choice
	Final Project Due
Nov 30	Last Class Day!