# AST 364P: Planetary Systems

Spring 2022

TTh 11:00-12:15 PMA 15.216B (but apparently Zoom at the start)

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## Course Logistics

**Text:** There is no required textbook - the field is moving so fast that past attempts were obsolete almost immediately. I will assigning readings, both pop-science journalism and real journal articles, over the course of the semester. For advanced material, students might find "Exoplanets" by Sara Seager to be very useful. It is available for a relatively reasonable price due to NASA subsidies, or you can access it online for free (when on the UT network) at https://muse.jhu.edu/book/2540. If the students feel they need extra resources for background, they should contact the instructor and ask for recommendations on introductory astronomy or physics textbooks.

**Web page:** See Canvas for announcements, documents, readings, and assignments.

**Prerequisite:** Physics II (PHY 316 or PHY 303L) and at least one other astronomy class (AST 307, 352K, or 353, though I'm willing to entertain other options). The course will make extensive use of algebra, logarithms, and trigonometry. I don't anticipate too much calculus, but some might be seen. I've newly implemented the prereq because we'll be touching on a lot of basic astronomical topics, and we don't have the time to stack an entire introductory course on top of the topical course material.

## Course Description & Philosophy

This course used to be called "The Solar System", but in the modern era, this really means "Solar System**(s)**". My colleagues complained that this made no sense though, so we compromised on "Planetary Systems". We will talk about our own solar system in some cases, but this is 2022 and there are thousands of planetary systems known. Ours isn't anything special anymore!

The course is designed to emphasize conceptual understanding and an appreciation for the discovery process, rather than memorization of facts. The students will learn how scientific discoveries were (and are being) made, and in the process hopefully develop an appreciation for the universe.

The students should feel free to look up any numbers or equations that they need in order to solve a problem on the homework. In exams, complicated numbers and equations (anything beyond what you should remember from PHY 316) either will be given, or will be allowed to be written on self-made equation notecards. I'll let you know well ahead of each exam which option we'll use. It is the responsibility of the student to know how to use the equations, not to memorize

them. As a result of this philosophy, there will be a heavy emphasis on showing your work on math problems. The correct answer, if not justified by the appropriate mathematical work, will receive no credit.

We assume that most members of this class will go onward to work in some field of science, mathematics, or engineering, so this class should be regarded as practice in how to think like a scientist. Personally, I will consider this class a success if you develop the habit of asking one question: **Does this answer make sense?** Astronomy deals with some very large numbers, rapidly outgrowing a person's intuitive sense of scale. We want to build a new sense of intuition that encompasses large numbers, and the ability to ask if an answer is even on the right order of magnitude. Think logarithmically, not linearly!

## Class Structure

The class meets on Tuesday and Thursday at 11 AM, for 1h15m per lecture. We'll plan to cover one broad topic per week. Astronomy, as with all STEM classes, is fundamentally a cumulative topic. Once a topic is discussed, you shouldn't be surprised if it shows up again - yes, even if we've already had an exam on it!

In a normal week, Tuesday will be spent mostly introducing the broad topic, and then Thursday will be spent more on practical exercises with real data or discussing results in the current literature. If logistics permit, I plan to introduce in-class activities on a semi-regular basis, including regularly using the computer lab down the hall. We will very much be playing that by ear this semester, though, and I might frontload the me-talking aspects as long as we're on Zoom anyway. The expectation is that most readings will not be journal articles, but rather will be at the level of a pop-science article or a bloggy summary of a journal article. If I assign a bloggy summary of a journal article, you should at least go glance at the abstract/summary and look at the figures before class. You might see those figures again on exams, with instructions to interpret them!

## Grading

Course grades will use the plus/minus system, along with the standard cutoffs. There will be no rounding. The composition of the course grade is:

- Homework and In-Class Activities: 50%
- Exams: 30% = 3 $\times$ 10%
- Astrobites-style summary of a journal article: 15% = 10% for the paper, plus 5% for turning in a rough draft that is sufficiently complete for feedback and for providing substantive feedback to a classmate via peer review.
- (Pre-recorded) presentation on that journal article: 10%.

Yes, this adds up to 105%. That is by design. Note that the class will not be otherwise curved with respect to the final sum of these parts, though I reserve the right to curve the grade distributions for distinct assignments or exams upward if I decide the distribution isn't to my liking.

**Note on Class Participation:** If we use in-class exercises and discussions, then they don't work if only half the students are here. Besides, much of the class material will only be available in lecture, and so you'll find the exams and homework much more difficult if you miss class regularly. I don't plan to waste class time actively taking attendance, but every time homework is due or we have an in-class activity, those present will be noted and an absence will reduce your maximum possible final grade by 2%. Miss one check-in, and your cap is 103%. Miss two, and you won't get more than 101%. Your cap won't drop below 85% though. Translation: You can stay home the whole semester if you like, but if you do, you're not getting more than a B. If you know you'll be gone for excused university events, contact me to confirm *prior to the absence.*

There will be approximately 6–8 homework assignments given over the course of the semester. Many will be classical cases of solving problems with math, though I'm also working on more interesting homework options. Late homework can be turned in up until solutions are posted or an assignment is otherwise returned to the class, but the final score will be halved. **No homework will be accepted more than one week after the deadline, but this might be less if an exam is looming and I need to distribute solutions.**

We'll also have periodic in-class discussions of journal articles. or other readings I'll describe these more when I assign the first one, but they will also contribute to the homework grade. In an ideal world I'd have one per week, but the timing might work out closer to once every other week. We'll play it by ear on exactly how many we can fit in.

There will be three exams during the semester, scheduled for Feb 22, March 31, and May 5. I reserve the right to turn these into take-home exams if I think our class time is better spent on other things though. These will likely be a combination of mathematical problem solving and interpretation of real data. For example, I might give you a figure out of a paper and ask you to estimate some results and explain what they mean. Makeup exams for verified illnesses or certain university functions will be scheduled as needed, but I need to be notified beforehand, and will expect to see a doctor's note or official university documentation afterward stating you were physically unable to attend. All exams will be closed-book and closed-notes; the instructor reserves the right to give you any equations that are deemed too complicated to be worth remembering, as well as any physical constants. I might allow you to use a single self-created equation sheet instead - I'm still considering this policy.

There also will be a short paper due on May 3, in which the students are expected to summarize a journal paper at a level suitable for a senior-level undergraduate to understand. They will be expected to turn in a rough draft on April 14 that is substantively complete, so that the TA and instructor can provide feedback. There also will be a class (or at least part of one) devoted to peer reviewing outlines and ideas earlier in April. A list of acceptable journal papers will be provided, though students are also welcome to select their own (subject to instructor approval). I used to have people give presentations, but I think I'd rather see people describe the results on some form of social media. That might be talking about it for $\sim$10 minutes on Youtube, for example, though I'm open to requests for alternative formats. I'd like to see this made public for at least some length of time though - science popularization is good, and is something that we can all do!

**SHOW YOUR WORK.** The correct answer will earn no points if we can't see how you derived that answer. Conversely, if you follow all the correct steps and get the wrong answer due to an arithmetic error, we don't really care and will award most or all of the points. If you want partial credit, then help us to help you, and show what you did.

## Approximate Course Schedule

1. Week 1: Introduction and overview. Review: Gravity, orbits. How telescopes work, and the types of data we use.
2. Weeks 2–3. Planet searches (radial velocity method).
3. Weeks 3–4. Planet searches (more transits).
4. Week 5. Planet searches (direct imaging and microlensing methods).
5. Week 6. Cosmic debris (Dust disks, asteroids, and KBOs)
6. Week 7. Planet characterization (bulk composition).
7. Week 8. Planet characterization (spectra and atmospheres).
8. Week 9. Star formation (from molecular clouds to protostars).
9. Week 10: Planet formation (from protostars to protoplanetary disks)
10. Weeks 11–12: Planet formation (from disks to planets)
11. Weeks 13–14: How planetary systems evolve over time

The instructor reserves the right to change the course content or the content on exams as needed to match the pace of the class or to tell the class about breaking astronomical news.

## Class Policies

- Canvas will be updated with announcements, reading assignments, and deadlines. It is your responsibility to check these on a regular basis. Please come to class prepared, having read the required reading assignments, since understanding the lectures and being able to take good notes will be crucial for doing well on homework and exams.
- Do not pack up or leave class early unless you have talked to me in advance, as a consideration to me and your fellow students.
- Phones: Phone use and texting during class will not be tolerated. Make sure your phones are off, and keep them put away during class. Students using their phones will be asked to leave.

- Laptops/tablets: Though laptop and/or tablet use generally will not be a necessary part of the class, I might plan for some activities where they'll be helpful. I acknowledge that some students prefer to take notes electronically, and therefore their presence will be permitted. Students using their computers for non-class activities are a distraction to those around them, and will be asked to leave. I tend to wander around the room while talking, and I know what Facebook looks like - don't assume you can blend into the crowd! If laptop distraction becomes a problem, I reserve the right to reverse this policy. If we're down in the computer lab, we'll obviously adapt this policy as needed.

## Academic Dishonesty

*University of Texas Honor Code:* The core values of The University of Texas at Austin are learning, discovery ,freedom, leadership, individual opportunity, and responsibility. Each member of the university is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community. Students who violate University rules on scholastic dishonesty are subject to disciplinary penalities, including the possiblity of failure in the course and/or dismissal from the University. Standards for Academic Integrity are posted at http://deanofstudents.utexas.edu/sjs/acint_student.php.

In other words, you should turn in work that is your own.

## Documented Disabilities

Please notify me of any modification/adaptation you may require to accommodate a disability-related need. The University of Texas at Austin provides upon request appropriate academic accommodations for qualified students with disabilities. For more information, contact Services for Students with Disabilities at 471-6259 (voice) or 232-2937 (video phone) or http://www.utexas.edu/diversity/ddce/s

## Email

Email is recognized as an official mode of university correspondence, so you are responsible for reading your email for university and course-related information and announcements. Please check your email regularly and frequently.