ASTR 191 – Special Topics: Research Methods in Astrophysics
ASTR 291 – Special Topics: Exoplanets
Spring 2025
LL 511 MW 3:00–4:15

Instructors:

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Course Objectives:

This course will apply methods for data analysis in python while surveying the field of exoplanet science. We will explore the scope of exoplanet discoveries and apply the methods used to detect and measure worlds beyond the solar system. Broadly, these lectures will cover the history of exoplanet discoveries over the past few decades; observational techniques for their discovery and characterization; current research directions and open questions; relevant planetary science/geoscience topics; implications and limits for detecting life beyond the solar system.

Specifically, in ASTR 191/291, students will learn:

1. How exoplanets are detected and characterized;
2. How to explore the catalog of known exoplanets;
3. How to analyze spectra and images of exoplanet host stars to discover evidence of their planets;
4. How to determine the error bars in your measurements; and
5. Additional techniques of data science that are useful for understanding exoplanets and other physical systems.

Materials:

- A Python programming tool with visualization capabilities (Anaconda with JupyterLab or Google CoLab are the recommended tools. Both are free to use.)
- A scientific calculator with trigonometric and logarithmic functions

Grading:

Homework – 50%
Projects – 50%

Despite the fact that ASTR 191 and ASTR 291 are cross-listed to be taught together, they still represent different courses. The assignments for students will be slightly different to reflect the more advanced level of ASTR 291 relative to ASTR 191.

Attendance is strongly recommended but not required. Late homework will be penalized by 5% per day late (up to 30% maximum penalty), and makeup exams are not allowed, without a valid excuse. If you have a valid excuse, I will work with you to set a reasonable deadline to complete the work.

Academic Integrity:

Academic dishonesty will not be tolerated on any assignment. Copying work from other students or outside sources is considered plagiarism. Outside references (other than the class textbook) must be properly cited if used on any assignment. If I have evidence of copying, cheating, plagiarism, or any other dishonest behavior, I will not hesitate to report my suspicions to the Office of Student Conduct. Their penalties may range from assigning a zero for that assignment, assigning an F for the final course grade, and even expulsion from the university. Please consider this your final warning.

For every assignment, please ensure that the work that you turn in is your own work. When you collaborate on homework assignments with your classmates, you may discuss the problem solving strategy together. Working together is encouraged when it is used as a learning tool. But, at no time should you share your paper or your answers with anyone else. Allowing someone to copy your answers makes you just as guilty as the copier. If someone asks you something like, "What did you get for Problem 2?" you should not provide the final answer. You may, however, tell them what equation you used or refer to the textbook or notes together and discuss the general topic. When you write your solutions, all mathematical calculations and written explanations must reflect your own work. Showing all of the steps of your calculations and explaining your reasoning throughout a problem is an excellent way to guard your independent work and remove suspicions of academic dishonesty.

Accommodations for Students With Disabilities:

Lehigh University is committed to maintaining an equitable and inclusive community and welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact Disability Support Services (DSS), provide documentation, and participate in an interactive review process. If the documentation supports a request for reasonable

accommodations, DSS will provide students with a Letter of Accommodations. Students who are approved for accommodations at Lehigh should share this letter and discuss their accommodations and learning needs with instructors as early in the semester as possible. For more information or to request services, please contact Disability Support Services in person in Williams Hall, Suite 301, via phone at 610-758-4152, via email at indss@lehigh.edu, or online at https://studentaffairs.lehigh.edu/disabilities.

The Principles of Our Equitable Community:

- We affirm the inherent dignity in all of us, and we maintain an inclusive and equitable community.
- We recognize and celebrate the richness contributed to our lives by our diverse community.
- We promote mutual understanding among the members of our community.
- We confront and reject discrimination in all its forms, including that based on age, color, disability, gender identity, genetic information, marital status, national or ethnic origin, political beliefs, race, religion, sex, sexual orientation, socio-economics, veteran status, or any differences that have been excuses for misunderstanding, dissension, or hatred.
- We affirm academic freedom within our community and uphold our commitment to the highest standards of respect, civility, courtesy, and sensitivity toward every individual.
- We recognize each person's right to think and speak as dictated by personal belief and to respectfully disagree with or counter another's point of view.
- We promote open expression of our individuality and our differences within the bounds of University policies.
- We acknowledge each person's obligation to the community of which we have chosen to be a part. We take pride in building and maintaining a culture that is founded on these principles of unity and respect.

We expect each member of this class to acknowledge and practice these Principles. Respect for each other and for differing viewpoints is a vital component of the learning environment inside and outside the classroom.

Tentative Outline of Topics:

- Intro/Overview of Exoplanets
- Overview of our Solar System
- Timeline of Discoveries
- Detection Methods:
  - Radial Velocity
  - Transits
  - Others: Astrometry, Direct Imaging, Microlensing
- Formation & Evolution
- Atmospheres
- Life Detection & Looking Ahead

This syllabus is only a tentative outline of the course. The grading policy, lab schedule, or the topics covered in class may change as needed.