

GEO 181: Exoplanetary Science - Characterization

- Professor: Stephen Kane
- Class times: Tues/Thurs 10:00am-11:20am
- Class location: Geology 1444
- Textbook: The Exoplanet Handbook (Michael Perryman)
- Office: Pierce Hall 2360
- Office hours: Tuesdays, 11:20am-1pm
- Phone: 951-827-6593
- Email: skane@ucr.edu
- Course website: <http://stephenkane.net/teaching/g181>

Prerequisites:

The course will be taught assuming knowledge of algebra, calculus, and computer programming. Pre-requisites include MATH 007B or MATH 009B, PHYS 040B or PHYS 002B, PHYS 117 / GEO 111, GEO 180, or consent of instructor.

Format:

4 units; two 1 hour 20 minute lectures and one 1 hour discussion section per week; four homeworks throughout quarter; a data project of your choice (and approved by the instructor) due in Week 10; one final exam at the end of the course.

Meeting times:

Every Tuesday and Thursday, 10:00am-11:20am, in Geology 1444.

Course description:

Discoveries of planets outside of our Solar System (exoplanets) have provided deep insights into the diversity of planetary systems. For example, we are now able to study how planetary systems form and evolve and also measure the compositions of atmospheres. The topics included in this class are: orbital dynamics and architectures, tidal effects, planet formation, circumbinary planets, phase variations, planetary atmospheres, exomoons, and future exoplanet space missions.

The course will require a working knowledge of astronomy and coding. There will be a discussion component regarding class content and the latest exoplanet research as published in the scientific literature. Exoplanetary science is a very active research field and we will frequently read and discuss new research papers.

Discussion Section:

There will be regular (weekly) discussion sessions that include discussions of class material and homework problems. Special attention will be given to new research papers and press releases regarding exoplanets with relevance to the class. The discussions will also include summaries and study guides to be used for the final exam.

Requirements and Textbook:

- **Attendance:** Attendance is recommended for every lecture. Much of the assessment will be carried out in class and exams may contain questions covered in lectures but not elsewhere.
- **Textbook:** The textbook for the course is “The Exoplanet Handbook” by Michael Perryman. I also recommend “Exoplanets” edited by Sara Seager.
- **Electronic Devices:** In general, the use of electronic devices such as laptops, tablets, and cellphones is not allowed in class.

Course Assessment:

- **Homework (40%):** There will be four homeworks during the semester. Most problems will require analytic solutions, however there will usually be one problem per assignment that will involve graphing and numerical solution with computer software such as Mathematica, MATLAB, or any programming language. The homework solutions must be provided in a legible format such that it is possible to read and grade.
- **Data Project (30%):** Students will be required to complete a project using exoplanet data from the NASA Exoplanet Archive, the Exoplanet Data Explorer, or the Habitable Zone Gallery. The written report may be up to 5 pages long (including plots).
- **Final Exam (30%):** The final exam will test on all material covered during the quarter. The exam will be closed book but an equation sheet will be provided. The exam will be held in class at the conclusion of the quarter.

Final grades will be assigned as follows:

A = 90% to 100%

B = 77% to 89%

C = 65% to 76%

D = 50% to 64%

F = below 50%

Student Learning Outcomes:

After successfully completing this course, students will:

1. Understand the diversity of planets and how it relates to formation theories.
2. Grasp planetary orbital architectures and the dynamics of planetary systems.
3. Know how exoplanets form and dynamically interact.
4. Learn how exoplanet atmospheric properties are determined.
5. Master new scientific and technical methods with application to exoplanets and related fields.
6. Be much better prepared to carry out research in this field.

Class Schedule:

- Lecture 1 - Introduction
- Lecture 2 - The Star-Planet Connection
- Lecture 3 - Keplerian Orbits
- Lecture 4 - Architectures
- Lecture 5 - Tidal Effects
- Lecture 6 - Hill Radius and Roche Limit
- Lecture 7 - Orbital Dynamics
- Lecture 8 - Planet Formation
- Lecture 9 - Stellar Multiplicity
- Lecture 10 - Circumbinary Planets
- Lecture 11 - Phase Variations
- Lecture 12 - Planetary Atmospheres I
- Lecture 13 - Planetary Atmospheres II
- Lecture 14 - Statistics and Diversity
- Lecture 15 - Mass-radius relationship
- Lecture 16 - Super-Earths
- Lecture 17 - Exomoons
- Lecture 18 - Space Missions
- Lecture 19 - Summary/Discussion
- Lecture 20 - Final Exam

Medical Matters and Disability:

If you have a disability or believe you may have a disability, you can arrange for accommodations by contacting Services for Students with Disabilities (SSD) at 951-827-4538 (voice) or specserv@ucr.edu (email). Students needing academic accommodations are required to register with SSD and provide required disability-related documentation. This course does require students attend field experiences for credit. If you need specific disability-related accommodations to participate in the field experiences, please contact Services for Students with Disabilities and notify the instructor within the first two weeks of the course beginning. Similarly, if you have a pre-existing medical condition that affects your ability to participate in required class activities, you are responsible for informing the instructor, along with documented evidence of the condition, within the first two weeks of the course beginning.

Campus Resources:

There are an incredible variety of campus resources available to assist and support your academic experience at UC Riverside including writing support, tutoring, counseling, and wellness support. Do not hesitate to take advantage of them. A quick search of the campus website will usually point you the right direction.