GEO 180: Exoplanetary Science - Detection Techniques

- Professor: Stephen Kane
- Class times: Tues/Thurs 9:30am-10:50am
- Class location: Geology 1444
- Discussion: Wednesdays, 10:00am-10:50am
- Textbook: The Exoplanet Handbook, 2nd edition (Michael Perryman)
- Office: Pierce Hall 2360
- Phone: 951-827-6593
- Email: `skane@ucr.edu`
- Course website: `http://stephenkane.net/teaching/g180`

Prerequisites:

The course will be taught assuming knowledge of algebra, calculus, and computer programming. Pre-requisities include MATH 007B or MATH 009B, PHYS 040B or PHYS 002B, PHYS 117 / GEO 111, 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 literature review on a paper of your choice (and approved by the instructor) due in Week 10; one final exam at the end of the course.

Course description:

The past 20+ years has seen a rapid expansion of the subject of planets outside of our Solar System (exoplanets). The expansion is such that the number of known planets number in the thousands and include planets smaller than the Earth. The topics included in this class are: solar system formation, the history of exoplanetary science, orbital mechanics, detection methods, orbital ephemerides, host stars, and future exoplanet space missions.

The course will require a working knowledge of algebra, calculus, and coding. There will be a discussion component regarding class content and the latest exoplanet research as published in scientific journals. 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:

- **Attendence:** 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", 2nd edition 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 quarter. 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.
- **Literature Review (30%):** Students will be required to write a 4-page critique of a published paper. The chosen paper must be exoplanet-related and published in a refereed journal. The critique must include a summary of the paper, why the paper was chosen, and discuss aspects such as key results, their significance, and original ideas on future work.
- **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 solar system formation theory and how that relates to exoplanets.
2. Become familiar with Keplerian orbits and the relationship between orbital elements.
3. Know the various ways that exoplanets are discovered and how they quantify exoplanet properties.
4. Be able to estimate exoplanet properties from radial velocity and photometric data.
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 - Stars I
- Lecture 3 - Stars II
- Lecture 4 - The Solar System
- Lecture 5 - Exoplanet History I
- Lecture 6 - Exoplanet History II
- Lecture 7 - Keplerian Orbits
- Lecture 8 - Radial Velocities I
- Lecture 9 - Radial Velocities II
- Lecture 10 - Astrometry
- Lecture 11 - Timing
- Lecture 12 - Microlensing
- Lecture 13 - Transits I
- Lecture 14 - Transits II
- Lecture 15 - Imaging
- Lecture 16 - Ephemerides
- Lecture 17 - Host Stars
- 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.