UNIVERSITY OF KANSAS
DEPARTMENT OF PHYSICS AND ASTRONOMY
ASTR/PHSX 792 — FALL 2021
INSTRUCTOR: PROF. IAN CROSSFIELD

COURSE SYLLABUS AS OF JULY 29, 2021

This is the a one-semester graduate course focusing on Extrasolar Planets – planetary systems found orbiting stars beyond our own Solar System. **No astronomy background is assumed or required,** and a general understanding of undergraduate physics will help significantly. The course will focus on a mix of observational and theoretical work in this rapidly-evolving and relatively young area of research. Although the field of exoplanet has historically been largely driven by new observations, models and theory play key roles in interpreting those observations.

The purposes of this class are threefold: (1) to expose graduate students (or high-level undergraduates) to a cross-section of the sub-fields exiting under the general 'Exoplanets' umbrella; (2) to develop familiarity and comfort in quantitative calculations, both computational and 'pen-and-paper'; and (3) to practice and strengthen professional scientific and technical skills, with a particular focus on reading, interpreting, and discussing articles from the scientific literature.

Office Hours: As this is a graduate-level course, Prof. Crossfield's office hours will be by appointment. You can find him most days during working hours in Mallott 2058.

Textbook and Readings

There is no single, ideal textbook for this course – the closest is the >$1,000 "Handbook of Exoplanets." Instead, we will make use of a wide array of reading selections that will be made available to you online. It is your responsibility to read the associated readings *before* the lecture in which we start to discuss that topic. A day-by-day course schedule is on the course website.

Other potentially useful texts include:

- *Exoplanet Science Strategy*, 2018 – a recent report commissioned by the National Academy of Sciences. Relatively non-technical, and free to download.
- *Exoplanets*, 2010 (ed.: S. Seager) – a compilation of chapters written by a variety of experts in the field. The basic science is still valid, though some details are a bit dated. Most chapters are available for free download at arXiv, e.g. a non-exhaustive list.
- Exoplanet Atmospheres: Physical Processes, 2010, by S. Seager.
- Exoplanetary Atmospheres: Theoretical Concepts and Foundations, 2017, by K. Heng.
- ... and likely many more!

Grade Breakdown: " P^3 "

- **One third**: Problem Sets. There will be roughly one problem set per 2–3 weeks, with the total PSet grade comprising one-third of the total grade. Posting dates and due dates will be posted on the course website. Problem sets are to be turned in:
  - On time;
  - On physical paper;
  - Typed;
  - Showing complete work;
  - With answers circled, boxed, or otherwise highlighted.

  Late PSets can only be accommodated for full credit **if notification of conflict or problem is provided in advance.** An email requesting extension sent at 1:00 am on the day PSet is due is not acceptable notice. Otherwise, late assignments can still be turned in anytime during the semester for a maximum of 70% of their initial credit value.

- **One third**: Participation and Preparation. Participating in discussions is an essential component of any technical or scientific career. You should prepare by reading any assigned course material (readings or literature papers) in time to come prepared for a frank discussion of that topic, including bringing up questions you may have. In addition, participation may include regular updates on 'EPOWs,' Exoplanet Papers of the Week – the process will be explained in class.
- **One third:** Presentations. By the end of the semester, students will give a professional-grade technical presentation on a topic relevant to the course. These presentations will give you a chance to delve more deeply into a course topic that particularly catches your interest or curiosity. This should be broader than a review of a single paper: possible components include topical background, current work, open questions, and future avenues. Your topic must be vetted by Prof. Crossfield. Further details on the presentations will be given during the semester.

Course Outline

The text below gives the planned syllabus for ASTR/PHSX 792 in Fall 2021. This is a general outline, with a more detailed and up-to-date schedule kept on the course web site.

- Weeks 1-4 : Solar System, dynamics, exoplanet discovery via radial velocity and transits.
- Weeks 5-6: Intro to radiation, exoplanet discovery via direct imaging, gravitational microlensing, and other methods.
- Weeks 7-8 : Planet formation, orbital migration, population synthesis, exoplanet occurrence.
- Weeks 9-13 : Planetary interiors and atmospheres. Structure formulae, equations of state, energy budgets, temperature. Overview of radiative transfer.
- Weeks 14-16 : Habitability, biosignatures, The Future. Final presentations.

Contacting the Professor

The best way to contact Prof. Crossfield is always by email at ianc@ku.edu. Emails should contain "ASTR 792 in the subject line so that I know to respond promptly to them. Office visits are also always welcome.