

Astrophysics of Exoplanets

ASTR 25800 / ASTR 35800 / GEO 32080

Spring 2021 at UChicago

Daniel Fabrycky and Jacob Bean

T/Th 9:40-11:00am, location: Zoom (log in through Canvas)

Website on Canvas

Extrasolar planets, a.k.a. exoplanets, are planets orbiting other stars. First definitively detected in the mid 1990s, the planet count has rapidly expanded and their physical characterization has sharpened with improved observational techniques. Theoretical studies of planetary formation and evolution are now attempting to understand this statistical sample. The field also aspires to address questions about life in the universe. Topics are the radial velocity, transit, and other discovery and characterization techniques; statistical distributions of known planets; comparisons among planet structure and planetary system types; formation in a protoplanetary disk and subsequent dynamical evolution; the goal of finding life on an exoplanet; colonization of exoplanets and the Fermi paradox.

Optional texts: Exoplanets, 2010, edited by Sara Seager <[amazon](#) \$35>,
How do you find an exoplanet? 2016, by John Asher Johnson <[library link](#)>

Required Readings posted to Canvas --

Arxiv numbers xxxx.yyyy listed below format as <https://arxiv.org/abs/xxxx.yyyy>

Office hours: Mondays, 4-5pm on the class zoom or by appointment: fabrycky@uchicago.edu, jacobbean@uchicago.edu

Schedule:

Mar 30 History and Context - Bean

Apr 1 Planetary orbits - Fabrycky

Reading – Murray & Correia arxiv:1009.1738

Apr 6 Solar System overview to compare observable properties of exoplanets - Bean

Apr 8 techniques: radial velocity / Doppler - Bean Assignment 1 due.

Fischer et al. arxiv:1602.07939, section 3

Apr 13 techniques: transits - Bean

Winn arxiv:1001.2010

Apr 15 techniques: microlensing, astrometry, timing - Fabrycky

3 readings, see “Assignments” on Canvas

Apr 20 techniques: direct imaging and gas-giant atmospheres - Bean

Johnson Chapter 5, Biller & Bonnefoy arxiv:1807.05136

Apr 22 Statistical distributions of exoplanets - Bean

Assignment 2 due.

Reading: Winn & Fabrycky 2015 ARA&A

<https://www.annualreviews.org/doi/full/10.1146/annurev-astro-082214-122246>

Apr 27 System Architectures - Fabrycky
 Reading: Winn & Fabrycky 2015 ARA&A

Apr 29 Non-Keplerian Dynamics chapter + Kepler-TTV - Fabrycky
 Fabrycky arxiv:1006.3834, Agol & Fabrycky 2018, arxiv:1706.09849

May 4 Internal structure, composition of terrestrial & giants - Fabrycky
 Spiegel, Fortney, & Sotin, arxiv:1312.3323

May 6 Midterm (and short project proposals due, for graduate students)

May 11 protoplanetary disks - Fabrycky
 Armitage arxiv.org/abs/astro-ph/0701485 , skim Section II, *reading* A; B0,1; C0,4

May 13 formation of terrestrial and giant planets - Fabrycky
 Armitage, section III, intro and parts A:1,4,7; B:1,5,6; C

May 18 interactions with the natal disk – migration - Fabrycky
 Armitage, section IV parts

May 20 interactions among planets - Fabrycky Assignment 3 due.
 paper by Ford & Rasio, arxiv.org/abs/astro-ph/0703163

May 25 life and biosignatures - Bean
 Seager 2003, Science review

May 27 colonization of exoplanets and the Fermi paradox - Bean Assignment 4 due.
 Kite & Howard Physics Today article

May 29 – June 1 Reading-period. Review. Discussions with prof and TA.

June 3 Final (undergraduates)

June ~4 Project due and Presentations (for grad students)

Grades – ASTR 25800 (undergrads): Each assignment is 15%, midterm is 15%, final is 25%.
 Grads: Each assignment is 15%, Proposal=10%, Project=30%.

Assignments - 4 total assignments due at the beginning of class on the listed due date. Please submit your work through Canvas.

Policy on Late Work – The assignments can be turned in late with a 10% deduction per day late. The number of days late is rounded up from the time the assignment is due. For example, an assignment that is turned in on Saturday at 6pm (electronically) and that was due on the preceding Friday (at class time, 9:30am) would be counted as 2 days late, so 20% off. Incorrect answers take their full effect, from there.

Policy on Group Work – Collaborative work on the assignments is encouraged, but each person must submit a complete report in their own words, any coding/plotting should be done separately by each person, and the report must say who else collaborated on the work.

Attendance – The course is being offered synchronously with the lectures recorded and posted afterwards. If you can attend the class at the regularly scheduled time then please do so as it will be more engaging for everyone. Bonus points for having your camera on! But mute your audio unless you want to ask a question. Both professors will be at all of the lectures and will

monitor the chat window for questions. Otherwise (re-)watch the lecture videos in a timely manner so you stay up to date with the class.

COVID-19 protocols can be found at <https://goforward.uchicago.edu/health-requirements/>

Students who have been exposed to or who are experiencing symptoms of COVID-19 should contact [UChicago Student Wellness](#) immediately to be tested, and reach out to their area Dean of Students to request accommodations for classes until:

- At least 10 days have passed since symptoms first appeared and;
 - At least 3 days (72 hours) have passed since recovery- defined as resolution of fever without the use of fever-reducing medications and improvement in respiratory symptoms (e.g., cough, shortness of breath).

If you were potentially exposed to COVID-19 or your COVID-19 test results come back positive, reach out immediately to C19HealthReport@uchicago.edu.

The University of Chicago is committed to ensuring equitable access to our academic programs and services. Students with disabilities who have been approved for the use of academic accommodations by [Student Disability Services](#) (SDS) and need a reasonable accommodation(s) to participate fully in this course should follow the procedures established by SDS for using accommodations. Timely notifications are required in order to ensure that your accommodations can be implemented. Please meet with me to discuss your access needs in this class after you have completed the SDS procedures for requesting accommodations.

Phone: (773) 702-6000

Email: disabilities@uchicago.edu

If personal issues arise for you this term, that you feel you can't or shouldn't bring to me, please contact your area's Dean of Students:

Graduate Students: <https://physicalsciences.uchicago.edu/academics/dean-of-students/>

Undergraduate Students: <https://college.uchicago.edu/student-services/college-dean-students>

The Recording and Deletion Policies for the current academic year can be found in the Student Manual under [Petitions, Audio & Video Recording on Campus](#).

- Do not record, share, or disseminate any course sessions, videos, transcripts, audio, or chats.
- Do not share links for the course to those not currently enrolled.
- Any Zoom cloud recordings will be automatically deleted 90 days after the completion of the recording.