Final Project Guidelines

Your final assignment in C249 is to conduct an independent investigation of an exciting topic in planetary astrophysics. If you have previous programming experience, your project should include computational simulations or data analysis. Novice programmers can use the final project as an opportunity to gain programming experience or omit the computational section and write a longer paper.

Possible Topics *(This list is just a starting point. Feel free to develop your own ideas!)*

1. Follow the instructions on Jason Wang's bitbucket page (https://bitbucket.org/pyKLIP/pyklip) and use PyKLIP to reduce data from the Gemini Planet Imager. Investigate how changes to your data analysis techniques affect the estimated planet properties.
2. Download and install Xavier Dumusque's Spot Oscillation And Planet 2.0 code (http://www.astro.up.pt/resources/soap2/). Use SOAP 2.0 to explore how stellar activity complicates planet detection.
3. Use Kat Deck's TTVFast (https://github.com/kdeck/TTVFast) and Laura Kriedberg's BATMAN code (http://astro.uchicago.edu/~kreidberg/batman/) to simulate transit timing variations in multi-planet systems. Estimate the number of multi-planet systems for which the NASA TESS mission might detect TTVs.
4. Our treatment of microlensing in class was very brief. Read more about microlensing, develop your own code to simulate microlensing events, and fit published light curves to determine planet masses.
5. Lee & Chiang (2017, ApJ, 842, 40) predicted that the break in the planet occurrence rate distribution for A stars would occur at roughly 1 day instead of roughly 10 days because A stars rotate more quickly than lower mass stars. Is it possible to test this prediction using currently available data from Kepler and K2? If so, do the data support their theory? If not, will TESS provide an answer?
6. Code up a representative simulation of planet formation.
7. The New Horizons mission revolutionized our view of Pluto in 2015 when the spacecraft flew less than 12,500 km from the dwarf planet's surface. Discuss key findings from the mission and pursue your own investigations of the data.
8. Download archival transmission spectra, emission spectra, or phase curves and reduce the data using publicly available tools or your own code. Compare your results to previous analyses and study how changes in data reduction techniques affect your results.
9. The James Webb Space Telescope will launch in October 2018. Plan a JWST observing program dedicated to improving our understanding of exoplanets.
10. There are several publicly available K2 planet detection pipelines. Interestingly, each pipeline detects a slightly different set of planets. Download the pipelines, run them on K2 data, and compare the resulting sets of planets. You will likely need to characterize the sensitivity of each pipeline by injecting fake transits into the K2 data and attempting to recover the transits with each pipeline.
11. Discuss the prospects for detecting life on Titan, Enceladus, Europa, Mars, or another world in the Solar System.

Project Milestones

- **9/29/17: Topic Due**. Send an email to dressing@berkeley.edu containing a short 1-2 sentence description of your proposed project.

- **10/27/17**: **Abstract Due.** Email your 100-200 word abstract to dressing@berkeley.edu. Your abstract should describe the motivation for your project, outline the proposed approach, discuss the anticipated results, and explain why those results are meaningful. If you are writing a literature review, your abstract should summarize the main findings of the field and place them in context.

- **11/27/17 & 11/29/17**: **Final Presentations.** All students will share the results of their projects by delivering final oral presentations to the rest of the class. Presentations will be held during the normal class time (10 – 11:30am). The time allotted to each presentation will depend on the final course enrollment, but will most likely be 10 minutes of presentation + 5 minutes of Q+A per speaker. Any form of presentation is acceptable as long as the motivation, methodology, results, and conclusions of the project are clearly described.

- **12/15/17**: **Final Paper Due.** Email your final paper to dressing@berkeley.edu.
  Papers describing new investigations should be roughly 10 pages long. Literature reviews should be roughly 15 pages long.
  Papers describing new investigations should follow the format of typical astronomy journal articles and include the following sections:
  - *Abstract*: Summarize the motivation, methodology, results, and conclusion of the project. You may base your final abstract on the earlier version submitted on 10/27/17.
  - *Introduction*: Describe previous work in the field and establish the motivation for conducting a new analysis.
  - *Observations/Data* (if applicable): If your project involves observational data, explain how, when, and where the data were acquired.
  - *Analysis*: Discuss how you completed the project.
  - *Results*: Present the major findings of your project.
  - *Discussion*: Comment on your results and theorize about possible explanations. (You might choose to combine this section with the results section or the conclusions section.)
  - *Conclusions*: Summarize your project and place your results in the broader context of planetary astrophysics.
  - *References*: Provide citations to previously published work.

  Papers that do not incorporate new analyses might benefit from a different layout, but they should still include the following sections:
  - *Abstract*
  - *Introduction*
  - *Discussion*
  - *Conclusion*
  - *References*