**Spring Research Project Outline**

Mentor Name(s): Kiersten Boley

Mentee Name(s): Hannah Eggenschwiler

Project Title: Determining Composition of TRAPPIST-1 Planets

In a short paragraph, explain the project and its learning objectives:

This project will use mass and radius data of exoplanets to determine their composition. The learning objectives will be to

1. Understand how the mass and radius/ density of a planet can give insights into the materials that it is made out of and where they come from
2. Learn basic coding skills in python (i.e. using variables, writing a function, plotting)
3. Learn statistical methods to determine the likelihood of a result (i.e. )
4. Learn about what degeneracies are and how they impact our understanding of planet compositions

What are the deliverables? (i.e. plot/figure/image/equation mentee will reach)

1. Mass-Radius plot including planets from our solar system and the TRAPPIST-1 planets
2. Plot showing the best-fit compositions for TRAPPIST-1 planets

The final presentation will have some information about planet interiors and composition

1. Basic planet interior plot showing the core, mantle, and crust for rocky planets
2. Information on how compositions can change the planet

Project Calendar: Indicate what the mentee will be expected to do each week. Work days are indicated in the left column. Include estimated time, resources, in/out of class work, and whether it is completed on their own or with you. The project should take 8-10 hours in total.

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| Dates: | Tasks: |
| Week 1 (2/14-2/20) Intro to Project & Work Day | Out of class: Set up python and ExoPlex on laptop (w/ mentor)  In class: Introductory readings on planet interiors/compositions and how mass and radius are measured. Also looking at the nasa interactive TRAPPIST-1 widget |
| Week 2 (2/21-2/27) In Class Work Day | In class: Find the masses and radii for the planets and create a function to determine their densities  Create mass-radius plot |
| Week 3 (2/28-3/6) In Class Work Day | In class: Running ExoPlex to fit for water for 4 of the planets. Use to determine best fit starting with an earth-like composition  Discuss why we assume an earth-like composition |
| Week 4 (3/7-3/13)  Careers In STEM | In class: Running ExoPlex to fit for water for the 3 other planets. Use to determine best fit starting with an earth-like composition  Create best-fit water % plot |
| Week 5 (3/21-3/27) In Class Work Day | In class: Running ExoPlex adjust to composition to determine other degenerate compositions. Use to determine best fit using the water values already determined |
| Week 6 (3/28-4/3)  In Class Work Day | In class: Catch up on any parts that we are behind on.  Discuss plots and talk about the intro to poster |
| Week 7 (4/4-4/10) How to Make a Poster | In class: Work on poster intro methods and conclusion sections |
| Week 8 (4/11-4/17) Poster Work Day | In class: Finish poster and practice presentation |

Reading List: (Make sure material is level appropriate.)

* Article on why Trappist-1 planets are interesting similar to earth
  + <https://astrobites.org/2021/11/03/earths-seven-cousins/>
* Article on liquid water and Trappist 1 planets
  + <https://astrobites.org/2017/02/22/trappist-1-just-right/>
* Video and Article on planet-types and planet systems
  + <https://exoplanets.nasa.gov/what-is-an-exoplanet/planet-types/overview/>
* Excerpt about how planets form and how that ultimately controls their composition
  + <https://exoplanets.nasa.gov/what-is-an-exoplanet/stars/>
* I will also add information within the jupyter notebook on degeneracies and planet composition that is at the undergrad level

Resource List: (This should include lab space, instruments, and software. Note that mentees are not allowed to complete research projects that require safety training operation of lab equipment. If you feel this is detrimental to your project, please petition Polaris leadership.)

* Laptop
* Python
* ExoPlex (free)

Other Notes:

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