Astronomy S110E: Planets and Stars

Summer 2024

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https://yale.zoom.us/my/mfaison?pwd=QVlvMVhqQjVzR3Z6L24zNGMyT25LZz09)
Office Hours: Tuesdays 2pm – 4:30pm
(also at other times over zoom, just send me a proposed date and time)

Class: Mondays and Wednesdays, 7pm - 8:30pm EDT, on zoom (links on canvas)
Discussion Section TBA

Note: All class materials are posted in the "Modules" section of canvas.yale.edu.

Introduction

Astronomy is a branch of physics used to try to figure out how the Universe works. In this course, we will focus on stars and the planetary systems that form around them. We will talk about how stars work, how stars are born and how they die, how planets form, and the similarities and differences between the planets in our Solar System. Based on what we know of how stars form, planetary systems are thought to be very common in the Universe, and new techniques have allowed us recently to actually detect planets around other stars.

As with almost everything else in the Universe, the formation and evolution of stars and planets is governed by the balance of gravity pulling “in” versus some type of energy of motion pushing “out”. We will also discuss the scientific method and the importance of developing critical thinking skills. This will include discussing astronomy news throughout the semester. This course also satisfies the college quantitative proficiency requirement, and consequently we will spend some time practicing core quantitative skills including using proportions, estimation, error analysis, probability, and statistics.

We will have three big questions for the course that we will return to over and over:
- How do astronomers measure the distances to stars and planets?
- How do stars form, shine for millions or billions of years, and then die?
- What have we learned about our Solar System through robotic exploration?

Required Textbook

Astronomy, by Fraknoi, Morrison, and Wolff. Published for free under a Creative Commons license by OpenStax: https://openstax.org/details/books/astronomy/

You can download a PDF from here, or there are links here to buy printed copies.

Online Video Lectures and Online Classes

The lecture content for this course will be delivered by online videos posted on canvas. We will also meet online twice a week for 90 minutes to discuss the course material and work through sample exercises in small groups.

For each class meeting, there will be a reading and viewing assignment. You are expected to complete the viewing assignment and reading assignment before the online class. I will check the participation statistics in canvas for each student to confirm that you have viewed the videos, and this will count towards half of your "Participation" score for the course. Attendance and participation in class exercises make up the other half of the Participation score for the course.

Problem Sets, Observing Exercise, Exams

The "Class" modules on canvas.yale.edu will have the reading assignments, video watching assignments, and problem sets. Problem Sets will typically be due on Saturdays at 11:59pm EDT. Problem Sets must be turned in using the gradescope tool on canvas.yale.edu or in person at the Leitner Observatory at 355 Prospect St, if you are in New Haven. There is a firm deadline for submitting your problem set solutions on canvas which is precise to the second, so turn your problem sets early to avoid a late penalty. A 0.1 percentage point per minute penalty will be applied to problem sets turned in after the deadline.

You are encouraged to discuss the problem sets with fellow students, the Teaching Assistant and the instructor-- don't spin your wheels if you are stuck on a problem. However, you must turn in your own work. The solutions you submit must represent your own understanding of the problem and must be written out in your own words. A practical interpretation of this rule is that it is OK to discuss problems and their solutions with instructors and with other students, but you should never copy the written work of anyone else, nor should you share your written work with another student. This includes sharing calculators and copying the same numbers off the display. This also means that you may use online sources to help you work through the problems (including ChatGPT, if you want to risk it!), but you may not cut and paste answers from online sources. *Apparent copying on any assignment for the course will be considered a violation of the academic integrity policy and will be submitted to the College Executive Committee for possible disciplinary action.*

In addition to the problem sets, students will complete a naked-eye observing exercise at some point during the 5-week session on a clear night. Students will write a report about the exercise and submit it before the end of the session. We will also do some informal remote observing using the telescopes at the Leitner Observatory during the session.

We will have a one-hour, written, online midterm exam at 7pm EDT on Sunday, June 16, 2024. Our second exam will be at 7pm EDT on Sunday, June 30, 2024. The exam format will be a

short-answer essay exam that everyone takes at the same time, followed up with an online, one-on-one oral exam.

Grading

At the end of the session, all students scores on all assessments will be added together with the following weights:

5 Problem Sets + 1 Observing Exercise: 40%
Participation (watching assigned videos, attending and participating in class): 20%
Midterm Exam: 20%
Final Exam: 20%

I will then plot a histogram of these final, weighted scores, and final course grades will be assigned based on a normal distribution, with the most frequent score assigned a grade of “B”. There are two exceptions to this “grading on a curve” scheme, which is that any score greater than 92% results in an “A”, and any score greater than 60% results in a passing grade of “D” or higher. My hope is that all students will score > 92% on all assessments and therefore all students will receive an “A” for this course.

Lecture Topics by Week

More details and specific reading/viewing assignments will be posted in the "Modules" section for the course on canvas.yale.edu.

Week 1

- Angles, Scientific Notation
- How Things Move in the Sky, the Earth-Sun-Moon System
- Gravity, Orbits, Kepler’s Laws

Week 2

- Physics of Light, Telescopes
- The Sun as a Star, Nuclear Fusion
- How we Know What We Know about Stars

Week 3

- How Stars Form
- Low-mass Stellar Evolution
- High-mass Stellar Evolution

Week 4

- Black Holes, Neutron Stars, and White Dwarfs
- Solar System Overview, Planetary System Formation
- The Earth and other Terrestrial Planets
- Jupiter, Saturn, and their Terrestrial Moons

Week 5

- The Ice Giants, Dwarf Planets, Asteroids, Comets
- Exoplanets

- Search for Extraterrestrial Life