

Spring 2025
Physics 172: Stellar Astronomy & Cosmology

Syllabus

MWF 9:00-9:50 am
Small Hall, room 110

Undergraduate prerequisites: None ... interest in space & the natural world.
(Necessary math skills: algebra, trigonometry.)

Instructors

Prof. Seth Aubin

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Lab: room 069, new wing of Small Hall, tel: 1-3532
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Noah Donald

Office: Room 220 (in entrance open area ... knock on door for access)
e-mail: nldonald@wm.edu

Office hours: Aubin: T & Th noon-1 pm, or anytime (open office hours policy).
Donald: Th 4-5 pm.

Course Objectives

The primary purpose of this course is to introduce the basic concepts, science, and methods in planetary and stellar astronomy. The course will cover the following topics:

- Basic physics: motion, gravity, light, matter, fusion, tidal forces.
- The night sky: constellations.
- Spectroscopy: identifying atoms and molecules from their light.
- Telescopes: optical, radio, x-ray, and gravitational telescopes.
- Solar systems: Sun, solar system, stars, and exo-planets.
- Main sequence stars, stellar evolution.
- Special stars: dwarfs, Cepheids, neutron stars, black holes.
- Exploding stars: novae, supernovae, mergers.
- Einstein's relativity: Special & general relativity.
- The Milky Way galaxy, galaxy types, dark matter.
- The expanding universe, galaxy clusters, dark energy.
- Big Bang, inflation, the cosmic microwave background.
- Future of the universe, multiverse.

Course Materials

Text: Most of the course materials and problem sets will be taken from the following required text:

Astronomy, 2nd Edition., by A. Fraknoi, D. Morisson, S. C. Wolff, OpenStax (Rice U.), 2022.

→ Download for free at <https://openstax.org/details/books/astronomy-2e/>

Evaluations

Your final grade for the course will be determined from the following grading weight distribution:

| | |
|-----------------------|-----|
| Participation: | 10% |
| Problem Sets: | 20% |
| Interlude Papers (2): | 25% |
| Midterms (2): | 25% |
| Final Exam: | 20% |

Participation: The classroom presentation of course material will involve class discussions. All students are expected to participate in these discussions and ask questions, since they will help elucidate the course material. Participation also reflects class attendance and quiz performance. We will use PollEv for in-class participation polls and quizzes:

<https://polleverywhere.com/login>

Note: Upon entering a W&M email address, users will be prompted to sign in via Single-Sign On (SSO) with their W&M credentials.

Problem sets: The problem sets are the main method for learning the course material. Students are expected to do the problems on their own (not as a team effort with other students), though discussion and limited “verbal” (oral/texting/e-mail) consultation with other students is encouraged (but not numerical equation-based discussion). The solution manual for the main text or solution sets from past courses are not acceptable sources for solving problem sets before they are due.

There will be weekly problem sets (roughly five problems). The problem sets will be done via the ExpertTA website platform (\$35 USD); you will need to purchase access to this online grading system. You can sign up on the ExpertTA web platform at the following link:

<https://reg.theexperta.com/USA48VA-465B21-3NZ>

Note: You can also expect exercises on the problem sets to be selected for tests.

Papers: The course features two interludes (weeks 8 & 12) during which we will investigate a broad topic that reaches out to other academic domains, i.e. Cultures, Societies, and Individuals (CSI) and Arts, Letters, and Values (ALV). Students will write up short papers (4-5 pages) on the interlude topics.

Interlude I: Humanity and the stars. Topics related to humanity’s understandings and observations of stars and their role in history, technology, and art.

Interlude II: Humanity and the universe. Topics related to humanity’s understandings of the universe and its place in it.

Midterms: There will be two midterm tests, each worth 12.5% of your overall final grade.

Final exam: The final exam will cover all the material in the course, with an emphasis on topics covered after the second midterm test.

E-mail policy

Feel free to communicate with S. Aubin or N. Donald via e-mail. We cannot guarantee that we will read e-mails sent in the evening until the next day.

Student Accessibility Services

William & Mary accommodates students with disabilities in accordance with federal laws and university policy. Any student who feels that's/he/they may need an accommodation based on the impact of a learning, psychiatric, physical, or chronic health diagnosis should contact Student Accessibility Services staff at 757-221-2512 or at sas@wm.edu to determine if accommodations are warranted and to obtain an official letter of accommodation. For more information, please see www.wm.edu/sas.

Honor Code (from W&M website)

William & Mary has had an honor code since at least 1779. Academic integrity is at the heart of the university, and we all are responsible for upholding the ideals of honor and integrity. The student-led honor system is responsible for resolving any suspected violations of the Honor Code, and I will report all suspected instances of academic dishonesty to the honor system. The Student Handbook (www.wm.edu/studenthandbook) includes your responsibilities as a student. Your full participation and observance of the Honor Code is expected. To read the Honor Code, see www.wm.edu/honor.

Academic dishonesty includes cheating, plagiarism, unauthorized collaboration, and the use of unauthorized materials and artificial intelligence systems (e.g., ChatGPT).

Important academic deadlines

***Add/drop deadline: Friday, January 31, 2025**

****Withdraw deadline: Monday, March 24, 2025**

Weekly Schedule (tentative)

Week 0: Jan. 22-24

Intro to Astronomy [Ch. 1, 2]

Overview, units, distance scales, time, atoms to galaxies, radius of the Earth.

Week 1: Jan. 27-29-31*

Basic Physics I: Motion and Orbits [Ch. 3]

Constellations, gravity, orbits, Kepler's laws, seasons, precession, parallax.

Week 2: Feb. 3-5-7

Basic Physics II: Newton and Gravity [Ch. 3]

Kepler's laws, Galileo, Newton's laws, conservation laws, gravity, circular motion, tides.

Week 3: Feb. 10-12-14

Basic Physics III: Light and Matter [Ch. 5, 16.1-2]

Electromagnetic waves, blackbody radiation, photons, atoms, fusion, Doppler effect.

Week 4: Feb. 17-19-21

Astronomy Instruments [Ch. 6]

MIDTERM #1. Telescopes, resolution, adaptive optics, interferometry, space telescopes.

Week 5: Feb. 24-26-28

Stars I: Our Sun & Main Sequence Stars [Ch. 15, 16, 17]

Structure, solar wind, sunspots, fusion, star brightness and temperature.

Week 6: Mar. 3-5-7

Stars II: Stellar Evolution [Ch. 17, 18, 19, 22]

Luminosity vs mass, H-R diagram, spectroscopy, star types, stellar birth & exo-planets.

----- Spring Break -----

Week 7: Mar. 17-19-21

Stars III: Stellar Death [Ch. 22, 23]

Helium fusion and beyond, red giants, white dwarfs, novae, supernovae, neutron stars.

Interlude I paper: Humanity and the stars.

Week 8: Mar. 24-26-28**

Black Holes & Einstein's Relativity [Ch. 24]

Special & general relativity, spacetime, gravitational redshift, black holes.

Week 9: Mar. 31-Apr. 2-4

Galaxies I: Milky Way and Galaxy Types [Ch. 25, 26]

MIDTERM #2. The Milky Way galaxy, Shapley-Curtis debate, galaxy types, dark matter.

Week 10: Apr. 7-9-11

Galaxies II: Galaxy Structures [Ch. 26, 27]

Galaxy types, distance ladder, expanding universe, quasars, supermassive black holes.

Week 11: Apr. 14-16-18

Galaxies III: Galaxy Clusters and Evolution [Ch. 28]

Galaxy mergers, distribution of galaxies in space, dark matter again, dark energy.

Week 12: Apr. 21-23-25

The Big Bang Theory [Ch. 29]

Birth and age of universe, cosmic microwave background, inflation hypothesis.

Interlude II paper: Humanity and the universe.

Week 13: Apr. 28-30-May 2

The Universe [Ch. 29]

Future of the universe, multiverse, limits of science, philosophy, and religion.

----- Classes Finish -----

May 8, 2025, 9am-noon

FINAL EXAM