

AST501 Stellar Interiors and Evolution

Course outline Fall Term 2026

Calendar entry: The physics of stars and stellar explosions. Interior structure and evolution including the origin of the elements. Stellar properties as a function of mass and metallicity. Computational simulations of stars and stellar physics processes, such as mixing, and corresponding observables.

Instructor: Falk Herwig (ferwig@uvic.ca)

Course repository: <https://gitlab.uvic.ca/ferwig/astr-501>

Shared NextCloud folder: — where the course readings are shared, under fair dealing.

Course communication: Mattermost, channel AST501–26 on the ASTR courses team. Join link and everything else you need accounts for: `SETUP.md`

Class times: Mon, Thu 9:30 to 10:50am

Course content

The structure and evolution of stars is the result of intricate interaction of different types of physics processes, such as

- Conservation laws of fluid dynamics and the macro physics of convection and rotation
- Atomic physics of radiation-matter interaction and the physics of radiation transport
- Thermodynamics and the equation of state of a wide variety of conditions from the dilute atmospheres of stars to the extreme high-energy-density conditions in the cores of late phases of stars, such as white dwarfs and neutron stars
- Nuclear physics of element formation and energy generation that fuels the life of stars

This interaction of a multitude of different physics components is quite typical for astrophysics, and the presentation in this course seeks to be general enough to be applicable to non-stellar research problems in astronomy. For each physics topic we cover we will not go into too much depth. The emphasis is on developing an understanding of how the different physics components interact with each other in the context of stellar objects.

We will apply the physics principles to a selection of the most interesting phenomena and stellar evolution phases, such as

- The evolution from the main sequence through subsequent stages, ending in white dwarfs, neutron stars or black holes
- Nuclear energy generation and the formation of the elements, neutron-capture nucleosynthesis to create heavy elements, the s, i and r process
- Supernovae
- Binary stars
- Asteroseismology and stellar pulsation

Emphasis will be guided by student interest.

Alongside the physics, this course is about how research in the field is done now. Work is optionally carried out in a **vela**, a governed environment for AI-augmented scientific work, including work with agents. A key element of the course is a student project in the second half of the term, written up as a short paper.

Course structure

This course consists of two parts.

Part I, weeks 1 to 6. The foundations of stellar physics and of scientific method. Nine lecture sessions build, one physical ingredient at a time, the closed system of equations that a stellar evolution code solves, and the last of them solves it. Two assignments, and a midterm on **Thursday 15 October** covering all of Part I.

Part II, weeks 7 to 13. The student research projects. **Thursday** meetings are given to discussing the projects as a group, with each student giving an update by sharing a slide or a plot. **Monday** meetings continue with lecture-style material on the specific topics related to student projects, so the specialised material is taught against real project needs.

Students give a presentation and submit a final project report in the form of a mini paper at the end of the term.

Final Grade

Specifics of the format and expectations regarding the graded items related to the project will be given in class.

Grade item	Due	Percent
Assignment 1	Oct 01	10
Assignment 2: paper presentations	Oct 19, Oct 22	10
Class presentations (several)	throughout	5
Mid-term	Oct 15	30
Student project proposal presentation	Oct 26	0
Student project proposal	Nov 02	5
Project presentations	Nov 30 (two), Dec 03 (three)	10
Project report	Dec 16	30

Policies

- Important dates: <https://www.uvic.ca/calendar/dates>
- Graduate calendar: <https://www.uvic.ca/calendar/grad/index.php#/home>
- UVic's policy of academic integrity applies:
 - <https://www.uvic.ca/students/academics/academic-integrity/>
 - https://www.uvic.ca/calendar/undergrad/index.php#/policy/Sk_0xsM_V?bc=true&bcCurrent=08%20%E2%80%90%20Policy%20on%20Academic%20Integrity&bcGroup=Undergraduate%20Academic%20Regulations&bcIte%20mType=policies
- The Libraries' guide on plagiarism: <https://www.uvic.ca/library/research/citation/plagiarism>
- All lecture notes and course materials that are made available to you, and all exams and assignments are the instructor's intellectual property, and are made available to students for instructional purposes only. The material is protected under copyright law, even if not marked with a ©. You may not distribute your lecture notes or any exams or assignments from the course without permission, and to do so, through note-sharing sites or other means, violates the Policy on Academic Integrity.