

UNIVERSITY OF KANSAS
DEPARTMENT OF PHYSICS AND ASTRONOMY
INTERIORS AND ATMOSPHERES – ASTR 794 – SPRING 2025
INSTRUCTOR: PROF. IAN CROSSFIELD
COURSE WEBSITE: [HTTPS://CROSSFIELD.KU.EDU/A794_2025A/](https://crossfield.ku.edu/A794_2025A/)

COURSE SYLLABUS AS OF JANUARY 21, 2025

Topics: *energy generation, flow, hydrostatic equilibrium, equation of state in stars and exoplanets, including the dependence of stellar parameters (central surface temperature, radius, luminosity, etc.) on stellar mass and its relation to physical constants. Other topics may include the relationship of these parameters to stellar evolution; stellar and exoplanet interiors, opacity sources, radiative and convective energy flow; nuclear reactions in stars; and the atmospheric structure of exoplanets.*

This is the first of KU's new 3-unit Astronomy graduate courses to be taught. We will proceed carefully, teaching at a graduate level but doing our best not to leave anyone behind. Motivated upper-division undergraduates should also be able to handle the course. Pending a survey of the course members, the course presentations assumes a general familiarity with basic astronomical concepts and background. **You should never hesitate to reach out to Prof. Crossfield if you have questions about course material!**

We meet in person Tuesday/Thursday from 0930-1045. The nominal course location is Wescoe 4011 (up the hill from Malott), but maybe we can find an empty room in Malott during the semester instead.

Office hours are by appointment, or whenever you swing by Prof. Crossfield's office (MAL 2055) and he is available.

Textbook and Readings

There is no single, ideal textbook for this course. We will therefore make use of a wide array of reading selections that will be made available to you on the course website. It is your responsibility to read the associated readings *before* any course section touching on that topic.

Grade Breakdown:

- **40%**: There will be roughly one problem set per two weeks, with the total PSet grade comprising 50% of the total course grade. PSets and due dates will be posted on the course website. Problem sets are to be turned in:
 - On time; showing complete work; and with final answers circled, boxed, or otherwise highlighted.

Late PSets can be accommodated for full credit **only if notification of conflict or problem is provided in advance**. An email requesting extension sent at 1:00 am on the day PSet is due is not acceptable notice. Otherwise, late assignments can still be turned in anytime during the semester (up to the last lecture) for a maximum of 70% of their initial credit value.

- **20%**: Participation. This means not merely attending lecture, but participating in discussions there – as well as attending, participating in, and presenting (≥ 2 star/planet papers) at Astro-Coffee, and attending & asking questions (to ≥ 3 speakers) at any star- or planet-themed colloquia and seminars.
- **40%**: A comprehensive final exam worth 40% of the total grade. This is nominally scheduled for 16 May from 0730-1000, but we may try to agree on a different time.

The grading scale is nominally the usual ($\geq 90\%$ for an A, $\geq 80\%$ for a B, etc.) but we retain some flexibility to deal with extenuating circumstances.

Course Outline

The goal of the course is to familiarize you with and give you a firm physical foundation in the fundamentals of stellar and planetary interiors and atmospheres. The course will be divided roughly equally across three main topical areas. The text below lists the material to be discussed in each topic for ASTR 794 in Spring 2025. This is a general outline and will likely be updated from time to time to adjust depending on how well we cover the material that I am initially planning to cover.

1. **Stellar Interiors:** Structure equations, equations of state, energy transport, nuclear fusion, interior modeling.
2. **Stellar Atmospheres:** Radiative transfer, opacity the gray plane-parallel atmosphere, Eddington Approximation, and chromospheres & coronae.
3. **Planets:** Planetary interiors, temperatures and thermal profiles, spectra, global circulation, and chemistry.

Learning Outcomes

At the conclusion of this course, students will be able to:

- 1) Undertake and interpret stellar interior modeling
- 2) Qualitatively and quantitatively Explain stellar atmospheric phenomena
- 3) Describe and calculate planetary and exoplanetary properties

Contacting the Professor

The best way to contact Prof. Crossfield is always by visiting his office hours in MAL 2058D (hours above), and/or by email at ianc@ku.edu. Emails should contain "ASTR 794" in the subject line so that I know to respond promptly to them. Note that "Hey" is not an appropriate salutation in formal communication

Other Resources

Finally, KU also has a large number of additional resources available; see KU Syllabus Policies for more info. As of Jan 2025, this includes:

- Explanation of instructional time expected for out-of-class student work per credit (see Credit Hour Definition policy)
- Statement on accommodations and/or information for students with disabilities (see or use):
 - KULC: Student Access Center Syllabus Statement
 - KUMC: Syllabus Statement for Accommodations
- Links to the following policies:
 - Sexual Harassment
 - Nondiscrimination, Equal Opportunity, and Affirmative Action
 - KU Statement on Diversity and Inclusion
 - Academic Misconduct
 - * KULC: Academic Misconduct (USRR 2.7.1)
 - * KUMC: Academic Misconduct
 - Change of Grade
 - * KULC: Change of Grade Policy and Change of Grade (USRR 2.4.1) (i.e., grade appeal)
 - * KUMC: School of Health Professions Grade Policy; School of Nursing Grade Policy; School of Medicine (MD) Grade Policy; and Graduate Studies Grade Policies
 - KULC: Code of Student Rights and Responsibilities
 - KULC: Commercial Note-Taking
 - KULC: Mandatory Reporting
 - KULC: Racial and Ethnic Harassment Policy