

UNIVERSITY OF KANSAS
DEPARTMENT OF PHYSICS AND ASTRONOMY
ASTR 391 FALL 2025
INSTRUCTOR: PROF. IAN CROSSFIELD
[HTTPS://CROSSFIELD.KU.EDU/A391_2025B/](https://crossfield.ku.edu/A391_2025B/)

COURSE SYLLABUS AS OF AUGUST 14, 2025

This is a one-semester, calculus-based introduction to astronomy and astrophysics. Topics will include fundamental concepts used by astronomers, including planetary systems, the Kepler problem, stars, exoplanets; stellar structure and evolution; dead stars (white dwarfs, neutron stars, and black holes); radiation; classification and properties of our Milky Way galaxy and other galaxies; and cosmology and the large-scale structure of the universe.

The purposes of this class are threefold: (1) to provide potential astronomy majors (BA or BS) and Astronomy/Astrobiology minors with a better foundation in astronomy than one can normally obtain in ASTR 191; (2) to build your confidence in scientific arithmetical calculations involved in “order of magnitude” estimations; and (3) to provide those with a stronger background in math and/or science (MATH 125 is a prerequisite for this class) with a more challenging and inviting learning experience than can be found in ASTR 191. Hence, the designation as an Honors class.

The course is structured for students who have minimal previous exposure to astronomy (though previous experience will help). We will assume a background equivalent to a KU freshman or sophomore with at most minimal prior exposure to basic calculus and physics.

Crossfield’s **office hours are Wed 2-3pm and Thur 1-2pm in MAL 2058D**. Or email for an appointment – or try stopping by MAL 2058D.

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 online. It is your responsibility to read the associated readings *before* any course section touching on that topic. Other potentially useful texts include:

- *An Introduction to Modern Astrophysics* by B. W. Carroll and D. A. Ostlie, 2nd ed. (Addison-Wesley, 2007). The classic ‘BOB’ (Big Orange Book). Mostly comprehensive and with much astronomical lore, though scant detail to some topics, and at a slightly lower level.
- *Astrophysics in a Nutshell* by D. Maoz (Princeton University Press, 2007). A concise physics-oriented overview, similar to Choudhuri, but at a slightly more elementary level.

Grade Breakdown:

- **30%:** Problem sets and in-class short-answer quizzes. There will be roughly one problem set and/or quiz per week, with the total PSet+Quiz grade comprising 30% of the total grade. Posting dates and due dates will be posted on the ASTR 391 course website. Problem sets are to be turned in:
 - On time;
 - With your first and last name prominently displayed;
 - Showing complete work;
 - Using appropriate units and significant figures;
 - With answers circled, boxed, or otherwise highlighted.

Late assignments can be turned in anytime during the semester (up to the last day of lecture) for a maximum of 70% of their initial credit value. Late PSets can be accommodated for full credit **if notification of conflict or problem is provided in advance**. (E.g.: an email requesting extension sent the night before the PSet is due is not acceptable notice.)

- **10%:** Students will complete a five-page ‘review paper’ on a topic of interest that is relevant to the course. These papers will give you a chance to delve more deeply into one of the topics or questions covered in class. In the course of summarizing the background, current status, and open questions in your topic of choice, you will need to conduct a review of the topic using reference texts, technical articles (Scientific American: yes — BuzzFeed: no), or primary sources. journal articles. As part of the process, you will: submit a list of three topics of interest by the Sep 5th (1%), submit an outline on your preferred topic by Sep 29th, (2%), submit a rough but substantially complete draft by Oct 29th, (3%), and submit a final, revised paper on the last day of lecture (Dec 3rd; 4%). The full effort will therefore be worth 10% of the total grade. The rubric used for grading the final paper is online here.
- **5%:** Students will complete a CV/resume suitable for applying to technical internships or research positions. An initial document (1%) will first be due on Sep 15th, and a revised and final document due Oct 10th (4%).
- **5%:** Students will complete a 500-word summary and report on a professional **astronomy** research talk. This may be a talk given at KU’s Physics & Astronomy Department colloquium series, at the Astronomy/Space Seminar series, or an online presentation given during this semester (i.e., not some ancient recording) – examples include NASA ExoExplorers, NOIRLab FLASH talks, BOWIE seminar series, and many others.
- **5%:** Students will attend a theatre performance of KU’s “Silent Sky” play (scheduled October 3/4/5; we may try to go together as a class!) and submit a 500-word summary and report on their impressions of the play. Also note the date and time of which performance you attended.
- **5%:** Students will attend a public telescope night (at KU or elsewhere; see e.g. here or here) and submit a 500-word summary and report on their experience: what did you see, what kind of telescope did you use, how did your observations connect with ASTR391 topics, etc. Also note the date and location of your observing night. Due by the last lecture of the semester.
- **20%:** There will be two in-class midterms, each worth 10% of the total grade. They will be held on or around early October (tentatively Oct 8th) September and the start of November (tentatively Nov 5th).
- **20%:** There will be a comprehensive final exam worth 20% of the total grade on Friday, Dec 12 at 1030-1300.

Course Outline

The text below gives the planned topical schedule for ASTR 391 in Fall 2025. This is a general outline, with a more detailed and up-to-date schedule kept on the course web site.

- Weeks 1-2 : Introduction. Orders of magnitude, fundamental scales, distances. Basic stellar properties.
- Weeks 3-4: Orbits and the Kepler two-body problem. Binary systems. Introduction to radiation. Observations of stars via photometry and spectroscopy.
- Weeks 5-6 : Stellar structure, atmospheres, and interiors. Timescales characterizing stellar processes and the equations of stellar structure.
- Weeks 7-8 : Modeling stars. Stellar cores, nuclear fusion, and stellar evolution.
- Weeks 9-10 : End of stellar life, stellar remnants. Supernova energetics and observations; white dwarfs; neutron stars; pulsars; black holes. Exoplanets.
- Weeks 11-12 : Observations of galaxies. Dissecting the Milky Way. Interstellar medium. Galaxy classification and properties. Supermassive black holes.
- Weeks 13-14 : Active galactic nuclei. Local Group, galaxy clusters, and large-scale structure. Intergalactic medium. Expansion of the Universe. Fundamental principle of cosmology. The future of the Universe. Review.

Contacting the Professor

The best way to contact Prof. Crossfield is always via ianc@ku.edu. Emails should contain “ASTR 391” in the subject line so that I know to respond promptly to them. Note that “Hey” is not an appropriate, formal greeting.

General Advice for ASTR 391

If you don't already do so, get used to asking questions in and out of the classroom. My office hours are times when I can guarantee that I will be available; if you can't make it at these times, let me know what time would be best for you. Simply doing the readings will be insufficient many times when attempting to answer the questions. If that is the case, you might try looking at the same material in another textbook at Anschutz or you can see me and see if I can put you on the right track. If you are faced with a problem and are unable to get started, shrugging your shoulders, handing in a blank or negligible solution, and saying that you didn't understand the problem is not acceptable. In short, you should begin to have a more mature, professional attitude toward your education. What you do in class can, and often does, have a long-term impact on your future, despite what you may think. Don't waste the opportunity.

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