UNIVERSITY OF KANSAS
DEPARTMENT OF PHYSICS AND ASTRONOMY
ASTROPHYSICS I – ASTR 691 – FALL 2022
INSTRUCTOR: PROF. IAN CROSSFIELD
COURSE WEBSITE: HTTPS://CROSSFIELD.KU.EDU/A691_2022B/

COURSE SYLLABUS AS OF AUGUST 20, 2022

An introduction to radiation processes, thermal processes, and radiative transfer in stellar atmospheres and the interstellar medium.

This is the first half of a a two-semester, upper-division, calculus-based astrophysics sequence designed for students intending to pursue future studies in this area and/or for those interested in exploring a deeper, more rigorous treatment of the relevant subject matter. Topics will include an introduction to radiation processes, thermal processes, and radiative transfer in stellar atmospheres and the interstellar medium, stellar spectroscopy, and planetary atmospheres and related topics. The course also aims to set the groundwork for Astrophysics II (ASTR 692, which treats the formation and evolution of stars, nucleosynthesis of the elements, and the physical processes of high energy physics).

The course is structured and paced for undergraduate students who have already passed PHSX 313 (Introduction to Modern Physics), calculus and differential equations, and the usual prerequisites for those courses. Pending a survey of the course members, the course presentations assumes a general familiarity with basic astronomical concepts and background equivalent to a KU junior with previous exposure to the coursework described above. **You should never hesitate to reach out to Prof. Crossfield if you have questions about course material!**

Office hours will be in MAL 2058D on Mondays (1430-1530) and Tuesdays (1400-1500).

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.

Grade Breakdown:

- **45%**: There will be one problem set per one-to-two weeks, with the total PSet grade comprising 40% of the total course grade. Posting dates and due dates will be posted on the course website. Problem sets are to be turned in:
  - On time; typed; printed; showing complete work; and with final answers circled, boxed, or otherwise highlighted.

  Late PSets can only be accommodated **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 for a maximum of 70% of their initial credit value.
- **10%**: Talk review: you will turn in a one-page, double-spaced summary, review, and/or description of a professional astronomy talk. This could be a department colloquium, a department Astro-Space seminar, or a talk delivered through some other forum. Due on or before the last day of class.
- **10%**: Journal Club: you will give a 10-minute presentation ("slideshow") to the class briefly summarizing an astronomy paper of your choice that was posted on `https://arxiv.org/list/astro-ph/` during the semester.
- **20%**: There will be two cumulative midterms, each worth 10% of the total course grade.
- **15%**: A comprehensive final exam worth 15% of the total grade, held on 14 December from 0730-1000.
- **BONUS:** An additional 10% of course grade (i.e., a full letter grade) is available to any student who writes a quality, submittable application for a major scholarship or fellowship (e.g. NSF GRFP, Goldwater, etc.). The application must be submitted to Prof. Crossfield at least one week before the official submission deadline (so he can give you feedback to help improve it). Drafts for fellowships due after the last day of class must be turned in one week before the last day of class. A large list of such fellowships is available at `https://fellowships.ku.edu/search-fellowships-scholarships`.

Course Outline

The course will be divided roughly equally across four main topical areas. The text below lists the material to be discussed in each topic for ASTR 691 in Fall 2022. 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. **Radiative Transfer:** Flux, absorption, emission, and the equation of radiative transfer.
2. **Emission & Absorption Mechanisms:** Atomic and molecular transitions, line formation, line broadening.
3. **Stellar Atmospheres:** Basic photospheric quantities, gray atmospheres, limb darkening, turbulence and convection.
4. **Planetary Atmospheres:** Transmission and emission spectra, thermal profiles, the greenhouse effect, atmospheric circulation.

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 691" in the subject line so that I know to respond promptly to them. Note that "Hey" is not an appropriate salutation in formal communication

General Advice for ASTR 691

The design of the course and my approach to it are tied to the belief that your attitude toward the work is fundamentally different from that of the typical non-major. It is assumed that you are in this class because you look upon this course as an initial step toward a career in or related to astronomy, physics, or other technical fields. It is assumed that because of this, I can place more responsibility for your work in your hands, without the need to pressure or threaten you. This means that if I give a problem set, it will be done on time in advance of the class, not attempted and written up in the last hour before it is due. If I give a reading assignment, it will be read on time, hopefully more than once, and you will come to class prepared to ask and answer questions about the reading material. If we are to prevent this class from becoming simply another straight lecture class, it is crucial that you remain an active participant in the class. I expect that, unless you have a medical excuse, you will be in attendance at every class, arriving prepared and on time. In a class of this size, it is a trivial matter to take note of who attends and who doesn't. Failure to attend will seriously damage your grade.

To emphasize a fact of life that I make clear to all my classes: how much you learn or understand depends entirely upon you. Depending on how competent or incompetent you feel that I am, I can make your path to understanding easier or harder. Simply speaking, my only interest is in making sure that you leave this class with a much greater understanding and appreciation of science in general and astronomy in particular. However, in the end, I can't make you learn the material.

If you don't already do so, get used to asking questions. 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. The readings alone may 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, online, 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.