ASTR 589 – Physics of Astrophysics

Fall 2020
MoWe 2:00-3:15 pm
Online instruction

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Course Description. —
This is a foundational course in Theoretical Astrophysics that will serve as a basis for numerous core classes in the graduate program and for research in astronomy and astrophysics. During this class, we will cover the basic elements of radiative transfer, radiative processes, fluid mechanics, gas physics, and some elementary dynamics. We will aim to develop a basic understanding and formulation of these topics and also apply it to a number of problems in the forefront of current research.

Prerequisites.— Undergraduate level physics is the most important preparation for this class. Two semesters of quantum mechanics (at least through the hydrogen atom), two semesters of E+M, and one semester of upper level mechanics is a solid preparation for a PhD in astronomy.

Introductory astronomy classes (e.g., the equivalent of 300A/B) are recommended but not required. Recognizing that some of you were not astronomy majors and almost definitely not majors at the University of Arizona, I will be posting the syllabi for those classes on D2L to give you a sense of what a typical undergraduate sees in those classes. We will cover a lot of this here but I will be very happy to recommend textbooks to read in parallel.

Course Objectives —
During this course you will learn to work with the radiative transfer equation analytically and solve some simple cases numerically. You will be able to calculate radiative processes appropriate for various conditions encountered in stars, planets, galaxies, and compact objects. You will learn the equations of hydrodynamics and magnetohydrodynamics, as well as the basics of shocks, waves, instabilities, ionization fronts, and accretion. Time permitting, we will cover some basic dynamics concepts.

Learning Outcomes —
Upon completing this course, you will be able to
1. Solve simple radiative problems using analytic and semi-numerical methods;
2. Perform calculations of radiative processes that are relevant for the variety of conditions found in the Universe;
3. Solve simple hydrodynamics problems and carry out complete stability analyses of equilibrium systems;
4. Understand mass loss from and accretion onto stars and compact objects
5. Apply basic concepts in dynamics to stellar systems

Textbooks —
There are several textbooks we will use for this class. We will be using different chapters from each one as well as some recent articles that will be posted on the class website. I recommend that you obtain the first book on the list; it is always a good go-to later in your career. I will also have it as an online library reference book for this class. The second one is unfortunately out of print, so I will share a pdf copy with you.
• Radiative Processes in Astrophysics by Rybicki & Lightman.
• Stellar Atmospheres by Mihalas.
Don't be surprised by the name of the second book. Even though the second half does cover radiation in the atmospheres of stars, the first half is still the best way to learn radiative transfer that's out there.

Lectures notes, in the form of a handwritten or typed draft, will be available on the class web page.

Suggested texts:
In addition to the class textbooks, I recommend the following books in your library.
• The Physics of Astrophysics Volume I: Radiation by Shu.
• The Physics of Astrophysics Volume II: Gas Dynamics by Shu.

Course Website —
Course material including handouts and notes will be posted on the D2L course website. You can find the syllabus, the schedule for the term (including any changes or updates to the schedule), assignments, handouts, any zoom recordings, and information about papers there.

Meeting Times.— The class will meet Mondays and Wednesdays at 2:00-3:15pm via Zoom. The link and password are
`https://arizona.zoom.us/j/95661910648`
Password: astr589
You can also find this information on D2L.

Assignments —
There will be three different types of independent work and assessments in this class, each of which will help you improve different types of skills that you will need in your careers.
(i) In-class independent work: We will use some of the class time to solve problems and examples. Almost none of these are for grade, but some homework problems will build on the in-class examples.
(ii) Homework: this will require solving detailed, quantitative problems that will involve analytic calculations, simple numerical calculations, qualitative inferences, etc. 6-8 sets of homework problems will be assigned, about once every week to 2 weeks. Homework will be due at the beginning of class on the due date.
For each student, the set with the lowest grade will be dropped, and the remaining best sets will count for 50% of the total grade.
(iii) Exams: There will be a take-home midterm and final exam that will each account for 25% of the total grade.

Grading Policy —
A total score of 90% will guarantee an A. The final distribution of scores will determine the exact grade breakdown but you need 70% to pass the class.

Policies —

Attendance.— Class attendance is optional but highly recommended. If you feel that you already know all the material and can complete all the work on your own, you are free to not join. However, if you do join the class, please give your full attention and participate in the discussion.
All holidays or special events observed by organized religions will be honored for those students who show affiliation with that particular religion.

Classroom environment.— This is an inclusive classroom environment that is welcoming to students of all genders, races, ethnicities, ages, and backgrounds. You are expected to treat each other with respect and civility. No discriminatory language or behavior of any kind is welcome.

Absences.— If you feel sick, or may have been in contact with someone who is infectious, stay home. Except for seeking medical care, avoid contact with others and do not travel.
Please let me know if you will not be able to attend because of health reasons.
Campus Health is testing for COVID-19. Please call (520) 621-9202 before you visit in person.
Visit the UArizona COVID-19 page for regular updates.
Absences (or difficulty turning in assignments on time) that are pre-approved by the UA Dean of Students (or Dean's designee) will be honored.
There will be make up assignments or special arrangements with a well documented valid excuse.
Life challenges.— If you are experiencing unexpected barriers to your success in your courses, please note the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office can be reached at 520-621-2057 or mailto:DOS-deanofstudents@email.arizona.edu.
Physical and mental-health challenges.— If you are facing physical or mental health challenges this semester, please note that Campus Health provides quality medical and mental health care. For medical appointments, call (520-621-9202. For After Hours care, call (520) 570-7898. For the Counseling & Psych Services (CAPS) 24/7 hotline, call (520) 621-3334.
Academic Integrity.— Cheating or any other form of unethical or threatening behavior will not be tolerated. You can find more information on these issues in the following two web sites of the university:
http://deanofstudents.arizona.edu/policies-and-codes/code-academic-integrity
http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students
Accessibility and Accommodations.— At the University of Arizona we strive to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, illness, or pregnancy, you are welcome to let me know so that we can discuss options. You are also encouraged to contact Disability Resources (520) 621-3268 to explore reasonable accommodations.
Incompletes.— Incompletes will only be given if a student has satisfactorily completed the majority of the work in the class and has a valid reason, such as medical, for not completing the remainder of the course. Students must make arrangements with the instructor in order to receive an incomplete.
Other than grade and absence policies, the information contained in this syllabus may be subject to change with reasonable advance notice.