

ASTRONOMY 410

Radio Astronomy

Fall 2022

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Office Hours: by e-appointment, virtual or in person

Supplemental Texts (NOT required):

Introduction to Radio Astronomy by Burke and Graham-Smith

Student's Guide to Fourier Transforms by J.F. James

(Student's Guide is generally useful because it includes application in a number of fields)

1 Overview

Astronomical observations at radio wavelengths play a key role in the discovery and study of certain classes of astronomical objects and radio observations play complementary roles in the study of nearly all objects in the Universe. Examples of the discovery role include pulsars, the cosmic background radiation, and complex molecules in space. More generally, radio wavelength observations provide insights into the very low temperature Universe (temperatures below 20 K), the highly obscured Universe (where dust obscures optical and even infrared wavelength emission) and the very high energy Universe of strong magnetic fields and relativistic particles associated with flares, neutron stars, and black holes.

This course is an introduction to radio astronomy covering the basic techniques, the types of measurements and telescopes, and the science. There is a focus on the basic physics and the mathematics of Fourier Transforms because there are central to understanding radio astronomy. You are expected to have a background knowledge of the physics of wave and mathematics at the level of calculus, vector analysis, and simple differential equation. Those of you without a background knowledge on astronomy should expect to do some background reading to catch-up. For example, what is a neutron stars? What is a galaxy's rotation curve? What is a flare? A basic astronomy book or internet searches can help you with the basics.

I am happy to meet with any individual or small group to help with background material or class material. I will not be on campus every day but I am usually on-line or near-line every weekday and we can arrange a time for a zoom or in-person meeting.

2 Course Structure

ASTR 410 has two weekly lectures, and weekly homework sets. The classes will combine lecture, question/answer, and class problem solving. The lectures present material and provide a forum for general questions. There will be parallel notes that are handed out in class and are available electronically on ELMS. You will be responsible for all material covered in class; you are not responsible for material in the notes that is not covered in class.

It is expected that you will attend classes. There will be regular in-class group exercises which will count toward your grade. The purpose of these exercises is to get you thinking and help you understand the material. They are also meant to “reward” you for attending class. You need to contact me with a reasonable excuse to be able to make-up an in-class assignment.

There will be one midterm and a final exam. The midterm will cover material up to the week before the week of the midterm. The final will cover all material for the semester.

3 Homework, In-class Work, Exams, and Grading

Homework will be assigned on Thursday of most weeks and is to be turned in at the beginning of class on the following Thursday. Homework turned in after the beginning of class on the due date will be considered late. Late homework may be turned in up to 1 week after the due date, at a penalty of 20% reduction in score. One week after the due date, I will return graded homework and hand out solution sets; no homework is accepted after that. It is expected that each homework assignment will take 2-4 hours to complete if you are attending lecture and are up-to-date on your reading of the notes. I welcome questions on the homework but I will not do the homework for you.

Please remember that it is an honor code violation to post homework questions on the internet and copy answers from the responding trolls. You should not provide a copy of your completed homework to a classmate. You are allowed to work together on the homework in small groups BUT each person must contribute to the work and write the answers in their own words. There may be numerical mistakes in common within a group so I ask that you list on your

paper the people that you worked with on each homework.

There will be in-class exercises most lectures. These will be group assignments. To make my life a little easier, I require each person to turn in an individual exercise paper. It is ok if the words on the paper are nearly identical. These exercises will be graded liberally. The point of the exercises is to get you talking to each other and thinking about radio astronomy. A blank paper with just your name on it tell me that you did not really participate in the exercise, and score a zero.

The mid-term exam is scheduled for Thursday October 18. The exam will cover all material presented in lecture and notes up to but not including the start of interferometry (Oct 13 lecture). The exam will occur during the regular class lecture time in the same room

The final exam will be a cumulative exam covering on all material. The final will be given at the time, and in the room, listed in the University course schedule, **Monday December 19 from 1:30-3:30 pm**. Please note that this is late in the exam schedule. I am required by the University to give the final in the designated time slot. Please plan accordingly. If you have an urgent need to leave for the semester before December 19, we can discuss giving you the exam earlier on the 19th or perhaps on the 18th. The exam will not be given remotely as that is currently against university policy.

Your final grade will be based on the homework, in-class work, the mid-term exam, and the final exam. These factors will be combined in the following percentages to determine your class grade:

25% homework

15% in-class work

25% mid-term exam

35% final exam

Finally, a word to the wise, the grading structure of this class makes it mathematically impossible to get an 'A' grade (or most likely even a high B) for the course without doing reasonably well on the homework and in-class work. In my experience, students who do no homework seldom get better than a 'C' course grade; don't count on being the exception. On the other hand, excelling in the homework and in-class work can significantly improve your class grade compared to your grade on exams alone.

4 Missed Exams and Homework

The University recognizes only three excuses for missing exams: religious holidays, University-approved travel, and illness. Except for sudden illness, you should provide a valid written excuse in advance of the scheduled exam. If you have an emergency, you must provide a valid written excuse (as defined in the University Handbook) within ONE WEEK after the midterm exam. Make-up exams will be scheduled at a mutually acceptable time and may be written or oral, at my discretion. If you do not have a valid written excuse, you will NOT be allowed to make-up the exam.

If you miss the *final exam*, a valid written excuse must be provided within one day after the missed final exam (remember this is up against Christmas so little time is available). In addition, you must arrange with me a time for a make-up exam within 2 days. This is fixed because course grades are due 48 hours after the final exam has been held.

If you miss a due date for a homework assignment and wish to receive full credit, you must present a valid excuse the next time that you are able attend class. You should be prepared to turn in the homework then or have a plan for when you will complete the work. I will accept electronic copies as a place marker for the real thing – which you turn in at the next class, when you have a valid excuse.

5 The Honor System

University academics operate on the basis of the Code of Academic Integrity. Acts of academic dishonesty include cheating, fabrication, facilitating academic dishonesty, and plagiarism. Specifically, activities such as cheating on exams or quizzes, copying homework, knowingly permitting your homework or exam to be copied, and submitting forged excuses for absences from exams or classes are violations of this code. All cases of suspected academic dishonesty will be turned over to the Student Honor Council to investigate and resolve. The normal sanction for academic dishonesty is a course grade of 'XF', denoting failure due to academic dishonesty. The Code of Academic Integrity is printed in full in the Undergraduate Catalog.

There are a couple of potential gray areas that naturally arise in this class so let's try to draw some dividing lines between right and wrong. For homework, you are permitted to work with other students in the class on the homework. This includes discussion of the problem and solution in a cooperative, mutually contributing fashion. However, you should write out your answer in your own words. You should NOT, under any circumstance, simply copy someone's homework and call that "working together." You should NOT seek out or use "solution sets" from previous students. You may seek help on homework problems from me, but not at midnight or the last minute before class. In fact, I will not be available from noon until class time on Thursdays due to existing commitments.

Just before the beginning of this semester, the faculty received a summary report of academic dishonesty case statistics. Surprising to me at least, a good fraction of the cases were for "facilitating academic dishonesty". This is where you give another person a completed assignment and they copy it, even without your knowledge of their copying.

If you have questions regarding what is appropriate and what is not regarding gray areas, please talk to me.