PHYS 4750 - Galaxies and Cosmology

Fall 2025
Department of Physics
College of Science, University of North Texas

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Office Hours	M 12:00 to 1:30 PM, or by appointment
Class Times and Venue	MW 3:00 to 4:20 PM, Phys 311

Course Description: This course provides an overview of the properties, formation, and evolution of galaxies, and the current standard model of cosmology. Students will gain a deeper understanding of the following topics: galaxy morphology, structure, kinematics, stellar populations, and spectra; Galaxy space distribution, luminosity function, mass function; Galaxy formation and evolution; galaxy clusters; supermassive black holes and their roles in galaxy evolution; the intergalactic and circumgalactic media; Modern cosmology and its history; basics of general relativity and cosmological models; the distance ladder; the age of the universe and the universal expansion; Cosmic Microwave Background (CMB); early universe and the big-bang nucleosynthesis; the contents of the universe— baryons, dark matter, and dark energy; structure formation of the universe. Furthermore, students can expect to get some experience working with astronomical data throughout the semester (both images and spectra).

Math and Physics Prerequisites (or, is this course for you?): PHYS 4650 - Introduction to Modern Astrophysics, or permission of the instructor. Students are expected to be proficient with standard college Calculus, Algebra, basic Trigonometry and Geometry, basic Classical Mechanics and Electricity and Magnetism. Proficiency and familiarity with the basics of Modern Physics is assumed. Additional math and physics knowledge beyond this level is useful, but not required. During this course, some differential equations may be introduced, and they will be explained in class. Furthermore, a number of basic results from Special and General Relativity, Statistical Mechanics, Atomic Physics, and Quantum Mechanics will be introduced without proof.

Office Hours: *Students are encouraged to attend office hours and reach out to Dr. Zahedy if they require assistance with some of the aforementioned physical concepts and topics.* Those who are considering further work (research/grad school) in physics or astronomy are especially encouraged to attend regularly. If you envision me writing a letter of reference on your behalf for a job/internship/grad school application in the future, it's especially important that you establish a presence in my class and office hours. If all I know about you is your grade in my class, then my reference letter will not be very helpful.

Required Course Material:

1. "Introduction to Modern Astrophysics", B. W. Carroll & D. A. Ostlie (Cambridge University Press, 2nd ed., 2017)
2. "Galaxies in the Universe", L. S. Sparke & J. S. Gallagher III (Cambridge University Press, 2nd ed, 2018)
3. "Extragalactic Astronomy and Cosmology", P. Schneider (Springer, 2nd ed, 2015)

Recommended Course Material:

1. "Introduction to Cosmology", Barbara Ryden (Cambridge University Press, 2nd ed., 2017)
2. "Foundations of Astrophysics", Barbara Ryden & Bradley M. Peterson (Cambridge University Press, 2021)

These books are available for purchase or rent through the University bookstore, through this link.

Online Resources: All course contents such as announcements, slides, problem sets, grades, and other required reading material not described below will be made available on Canvas as the course progresses.

Grading Policy Three components determine your grade: Problem Sets, Midterm Exam, and Final Exam. The relative weights are as follows:

Weekly Problem Sets (average of 10 problem sets)	40%
90-minute Midterm Exam	25%
120-minute Final Exam (Comprehensive, Wed Dec 10, 2025)	35%
Total	100%

Problem Sets: 10 Problem sets (PSets) will be assigned throughout the course, and collectively they account for a significant portion (40%) of your final course grade. These PSets are designed to help you internalize the concepts learned in class and assigned reading, and apply your math and physics knowledge to solve observational astrophysical problems. You can expect these problems to be challenging, such you will need to work with each other to solve them. *This is good practice: collaboration is a cornerstone of the scientific endeavor.* You are therefore encouraged to collaborate with each other on the PSets, and I will set up a discussion board on Canvas to facilitate collaboration. **While everyone is welcome to collaborate on their problem set, the expectation is that you will use the opportunity to learn from each other. For that reason, copying answers will not be tolerated, and you are required to list your collaborators with each PSet submission.**

Exams: There will be one in-class midterm exam (scheduled tentatively for October 15), and one comprehensive final exam (December 10 at 1:30 pm). For the exams, you are responsible for mastering materials covered in class, the assigned reading, and PSets. **Makeup exams or exam corrections will not be offered**.

Class Participation: Up to 10% of extra credit may be distributed based on student participation in the academic life of the class. What does this entail? As a general rule, be a good citizen of the class. Attend lectures regularly. Demonstrate curiousity by asking questions, and answering them in class. Keep up with the weekly reading. Show up to office hours as much as you can. Above all, be professional and respectful of your fellow students and the instructor. There will also be a chance for students to do optional, short (15-minute) in-class presentation on various topics of their choice (to be discussed with the instructor) for extra credit.

Late Work Policy: Students are expected to submit all assignments on time. Extensions will only be granted on a case-by-case basis, and **must be requested in advance of deadlines**.

Academic Integrity: In this course, I expect you to engage deeply with the materials in order to continue developing your own critical thinking and problem solving skills. For that reason, the use of Generative AI (GenAI) tools, including but not limited to Claude, ChatGPT, and Gemini, is not permitted. While these tools can be helpful in some contexts, they do not align with our goal of fostering the development of your independent thinking. Using GenAI to complete any part of an assignment, exam, or coursework will be considered a violation of academic integrity, as it prevents the development of your own skills, and will be addressed according to the Student Academic Integrity Policy. Furthermore, while collaboration is strongly encouraged (and in many cases, necessary) to complete all assignments, it is intended to help you learn and not to replace your independent work. As such, copying answers will not be tolerated (see section on Problem Set). All work must be your own, and you are required to list your collaborators with every submission.

Tentative Course Schedule: The schedule below is tentative and subject to change. Any changes to the schedule will be announced in-class or on Canvas as the course progresses, and the syllabus will be updated accordingly. Note: each problem set (PSet) will be posted on Monday night, and is due the following Monday, in-class. Reading material for the following week will be assigned with each PSet.

Week of	Topics covered	Notes
Aug 18	Introduction	
Aug 25	Galaxies: The Milky Way	
Sep 1	Galaxies: morphology, structure, and kinematics	
Sep 15	Galaxies: Dynamics and orbits	
Sep 8	Galaxies: stellar populations, spectral properties	
Sep 22	Galaxies: space distribution, luminosity and mass functions	
Sep 29	Galaxies: groups and clusters	
Oct 6	Galaxies: Formation and Evolution	
Oct 13	Review and Midterm	Midterm (10/15)
Oct 20	Galaxies: the Intergalactic and Circumgalactic Media	
Oct 27	Cosmology: Historical Context, Hubble's Law, the Cosmic Expansion	
Nov 3	Cosmology: Cosmological Models	
Nov 10	Cosmology: Big Bang, The Early Universe, Inflation, and Big-bang Nucleosynthesis	
Nov 17	Cosmology: The Cosmic Microwave Background (CMB); Structure Formation	
Nov 24	Fall Break and Thanksgiving (No Class)	
Dec 1	Special Topics and Final Review	Final (12/10)