ASTR 360: Introduction to Galaxies and Cosmology

Spring 2016

Course Information and Syllabus

Instructor: Dr. Andrea Isella, HBH 354, Phone: X5491
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Class Website: Owl Space
Lectures: Tuesday and Thursday, 1:00pm-2:15pm, HBH 254
Office Hours: Thursday from 2:30pm-3:30pm, and by appointment

Course Description

This course is intended to provide an introduction to the fundamentals of galaxy formation and evolution, and cosmology. The course is designed for students majoring (or intending to major) in astronomy / astrophysics. Students currently undecided about their major might be better served by ASTR 201 (Stars, Galaxies, and the Universe) and ASTR 202 (Exploration on the Solar System).

Introduction to Galaxies and Cosmology starts with a brief overview of the fundamentals of astronomic observations and stellar evolution (these topics are covered in greater details by the companion course ASTR 350 – Introduction to stellar astrophysics), before embarking upon an exploration of the properties of galaxies. We will discuss the structure and dynamics of galaxies, starting from our own galaxy, the Milky Way. We will explore the processes that characterize the innermost parts of galaxies and study how these processes allows us to probe the evolution of galaxies over cosmic time scales. The second part of the course focuses on a brief introduction of modern cosmology, which span from the discovery and interpretation of the Cosmic Microwave Background radiation (CMB) to the observational evidence for Dark Energy.

Learning Outcomes

The student learning outcomes of this course encompass a variety of knowledge and skills that apply scientific reasoning to an understanding of the universe, the bodies of which it is comprised, and the means by which we gather and interpret the information that lead to this understanding. In particular, the students will be able to:
- Demonstrate and understanding of the basic principles of science and scientific investigation, with a focus on the formation and evolution of the Universe;
- Show how observations can inform our understanding of astronomical phenomena that are very far away from us both in time and space;
- Explain the basic properties of galaxies and of their evolution;

- Discuss the fundamental concepts of modern cosmology and relate them to observations;
- Explain the basic processes that govern the evolution of the universe;

Texts:
Carroll & Ostlie, "An Introduction to Modern Astrophysics" 2nd ed. For the last 40% of the class we will supplement with *Ryden* "Introduction to Cosmology". You can probably get by with just the first book, but I recommend the second. A good 100-level introductory text if you have had no astronomy is "Discovering the Universe" by *Comins and Kaufmann*. The similar book by Bennett is ok for the easiest things. Auditors must attend class, but need not do problems or exams.

Grading: Based on a midterm oral exam (30%), homework (40%), and a final oral exam (30%).

Problem Sets, Honor Code: Problems are an important component to this class, and I will assign them periodically. We may not have time to cover all the solutions in class, so if necessary we may meet at some other time to discuss problems.
The honor code applies to the problems in the following way. If the student cannot solve a problem on their own in an hour, the student can keep working on it alone or ask for hints from a classmate who has done the problem. After writing up the problem, students should describe the level of help they required in doing it. Problems are due on the day we discuss them in class. No credit is given for late problems. You should not be meeting as a group the night before they are due to work on them together, as is the current practice in some physics classes.

Oral Exams: Midterm and final oral exams will be conducted in my office, covering the basic material we study in class. Although sometimes painful, all students need to learn how to handle oral exam situations without panicking or freezing up, because that is how job interviews are like. There really is no better way to find out what someone knows than to see what they write on the board.

Material on the orals is pledged in the sense that no one may discuss the contents of the exams or provide any hints as to what to study until all class members have taken it. Scheduling the exams will be a work in progress and something we will figure out as the semester progresses. At the risk of stating the obvious, no aids of any kind are allowed during the oral exams - just the student, professor, white board, and marker.

Cell Phones, Texting, Email, Surfing, Tweeting, Blogging: Do this on your own time. If you must have your cell on for emergency purposes you may place it on vibrate and leave the class to take any call or message. Otherwise, no electronic devices are allowed in class. Even without sound they are simply too distracting to those around you, and to me. Laptops and tablets must be used only for taking notes.

Syllabus (the schedule is indicative and may be subject to changes)

DATE	TOPIC
T 1/12	I. Background: Astronomical Observations; Physics of Radiation
Th 1/14	I. Background: Stellar Structure and Evolution

T 1/19	II. Milky Way: Star Counts; Olber's paradox; Distance Scales; Scale Heights
Th 1/21	II. Milky Way: Virial; ISM Phases; Galactic Stellar content;

T 1/26	II. Milky Way: Galactic Rotation; Velocity Ellipsoids; Oort A and B
Th 1/28	II. Milky Way: Rotation curves; begin Galactic Center
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T 2/2	II. Galactic Center; Galactic distance ladder
Th 2/4	III. Normal Galaxies: Classification; Spirals, Tully-Fischer
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T 2/9	III. Normal Galaxies: Ellipticals, Fundamental Plane; Luminosity function
Th 2/11	III. Normal Galaxies: Spiral density waves; resonances
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T 2/16	III. Normal Galaxies: Spiral density waves; resonances
Th 2/18	IV. Galactic Evolution: Tidal friction; ring galaxies, mergers, Formation
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T 2/23	V. Large Scale Structure: Extragalactic distance scale, clusters, voids
Th 2/25	V. Active Galaxies NLR, BLR, radio galaxies, Seyferts
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T 3/1	--SPRING BREAK (No CLASS)--
Th 3/3	--SPRING BREAK (No CLASS)--

T 3/8	VI. Active Galaxies: Jets; Blazars; QSOs
Th 3/10	VI. Active Galaxies: Ly-alpha Forest; GRBs

T 3/15	Oral Exam scheduled throughout the day -- COSMOLOGY --
Th 3/17	Exam review; Begin Cosmology

T 3/22	VII. Basic Cosmological Observations; Temperature and Blackbodies
Th 3/24	VII. Curvature; RW Metric; Distances; Redshift
F 3/25	-- 1st homework due

T 3/29	VII. Lambda; Newtonian cosmology, Friedmann, Acceleration, and Fluid Equations; EOS
Th 3/31	--MIDTERM RECESS (No Class)--

T 4/5	VII. Our Universe; Milne; Single Component Flat Universes
Th 4/7	VII. Cosmology: Multiple Component Universes, the Benchmark Model
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T 4/12	VIII. Observations : Acceleration, Dark Matter, Cosmic Microwave Background

Th 4/14	IX. Early Universe: CMB, Recombination

T 4/19	IX. Early Universe: Nucleosynthesis
Th 4/21	IX. Early Universe: Flatness, Horizon, Monopole Problems, Inflation
F 4/22	-- 2nd homework due --

W 4/27 - W 5/4	Final Exam Period

Disabled Students: Students with a documented disability that impacts their work in this class should contact me to discuss their needs. Disabled students should also register with the Disability Support Services Office in the Ley Student Center.