AST 10C : Introduction to Cosmology
Spring 2023

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Instructor: Professor Lori Lubin
Email: Contact through Canvas mail tool or Piazza
Website: See course website at canvas.ucdavis.edu
Lectures: TR 3:10 - 4:30 PM, RESSLR 66
Office Hours: W 11-12 PM, PHYSIC 432

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Office Hours : T 11-1 PM & R 9:45-11:45 AM, PHYSIC 432

Course Description:

This class will be an introduction to cosmology. In it, we will cover the history, content, and fate of the universe. Unfortunately, the universe is really, really big, and ten weeks is not nearly enough time to cover everything! Instead, we're going to try to cover some of the really cool stuff and provide you with the background to understand some of the crazy things that you have read about in the news -- the birth of galaxies, the expansion of the universe, the nature of dark matter and dark energy, and the big bang.

In this class, you will learn all the clever ways that astrophysicists have come to understand the cosmos so well (despite sitting on some small rock!) -- all the way from posing the relevant scientific questions, determining what observational data to collect, interpreting that data, and finally to developing theories (Hint: It is not "just" a theory!). You will try your own hand at interpreting astronomical images (not just pretty pictures!) and graphs (is that a correlation?) to see how astrophysicists use these critical visual tools to understand our Universe. Finally, science does not progress in a vacuum, so you will learn how cosmology research over the past century was crucially aided by, and contributed to, significant technology and engineering gains (just look at the new James Webb Space Telescope!).

In order to get the most out of class, you should read the textbook chapters before hand so that you are familiar with the material that I will be covering. In addition, I will be using well-tested and effective educational technology in your class. There will be weekly online quizzes and

homework given through the the Expert TA, an indepedent online homework and tutorial system. In addition, each student will use the iClicker Student Mobile App on your mobile device to participate (with me) in the lectures. So come, have fun, and be awed by the wonders of the universe.

e-Textbook:
(Required) Stars, Galaxies & Cosmology
The Cosmic Perspective (Volume 2), Ninth Edition
Bennett, Donahue, Schneider, and Voit
Addison-Wesley, 2020

(Recommended) Openstax Astronomy, a free astronomy textbook available at https://openstax.org/details/books/astronomy or through the Expert TA.

Additional information, websites, and tutorials are available on the course website at canvas.ucdavis.edu (under "Pages")

Grading:
20% First Midterm
20% Second Midterm
20% Final Exam
30% Homework
10% Online Quizzes
3% Extra Credit (In-class iClicker and Piazza Participation)

Your lowest quiz and homework grade will be dropped when calculating your final grade.

Code of Academic Conduct:
Any evidence of cheating on quizzes, homeworks, or exams will be reported to Student Judicial Affairs. This includes the use of any "answer sharing website" (such as Chegg) to search for the solutions to your problems. You should review carefully my instructions concerning the Code of Academic Conduct on the course website at Know the Code of Academic Conduct (under "Pages") and be very familiar with the Student Responsibility and Conduct Standards in general.

UC Davis Code of Academic Conduct.

Students are required to acknowledge their responsibilities regarding the Code of Academic Conduct for each registered course at participate.ucdavis.edu, reinforcing our campus culture of honesty. Remember that students who violate the Code of Academic Conduct are subject to disciplinary sanctions that include Censure, Probation, Suspension, Deferred Separation or Dismissal from the University of California.

Course Discussion Board (Piazza) and Email Protocals:
This quarter, we will be conducting all out-of-class related discussions and Q&A through Piazza available through the course navigation toolbar in Canvas or directly at https://piazza.com/ucdavis/spring2023/ast010c001sq2023/home.

Piazza is a way for you to interact with your fellow students, exchange ideas, ask questions (anonymously if you wish), and get help from me, your TA, and your fellow students with the course material. Rather than private emails to me and your TA (as we may be slow), try posting your questions first on the Piazza discussion board. Other students likely have the same questions and/or know the answers!

Before starting, you should review the rules governing the use of the Piazza discussion board on the Canvas course site at Rules of Course Discussion Board Piazza (under "Pages"). Students who participate in the Piazza discussion board can earn extra credit points.

Note that your TA and I will do our best to answer your private emails as soon as possible, with the goal of answering within 48 hours.

In-class iClicker Participation:
I plan to use the iClicker Cloud system, which allows for electronic polling of the student audience through the iClicker Student Mobile App available on mobile devices. Note that as of Fall 2020, the UC Davis Bookstore acquired a campus-wide license for all students to use the iClicker Student Mobile App at no cost. So come to class and try out this freebie with me! During lectures, I will periodically ask questions which can be answered using the iClicker app on your mobile device. Your answers will be recorded, tallied, and displayed by the computer. All in-class responses will be displayed anonymously, so click without fear! Right answers are not necessary! You will earn extra credit just for participating.

If you have not already downloaded the app, you can get information on the mobile app and download it through the iClicker webpage at iClicker Student App. You will also need to have an iClicker Student Acccount, which should be set up using your offical UC Davis (kerberos) email address. To see a demonstration video, go to Create an iClicker Student Account. I have setup a Roster & Grade Sync (RGS) iClicker integraton with our Canvas site. If you have an existing iClicker student account that uses an official university email address and/or Student ID, you will

automatically get added to the iClicker course. For more information on finding the course on your app, see Student Guide: iClicker Roster & Grade Sync Integration. All this information, as well as the benefits of students teaching each other ("peer instruction"), is also available on the course website at canvas.ucdavis.edu (under "Pages").

Online Homework:

There will be weekly homework assignments to help you digest the material, apply the scientific method yourself to specific problems in cosmology, using real and simulated data, and learn how to interpret key astronomical images and diagnostic diagrams. The three exams will be based on similar problems to those covered in the homework assignments. It is extremely important to do the homework assignments; it gives both of us feedback about how well you understand what's going on before the exams! You should expect to spend 2-3 hours per week reading the textbook chapters and related materials, in addition to the time required for the homework.

All homework must be completed by logging into the Expert TA. The link to the Expert TA is also available through the course navigation toolbar in Canvas. For more information, see Registering and Using the Expert TA (under "Pages") on the Canvas course site.

The homework will be available on the Expert TA every FRIDAY. The homework will be due the following THURSDAY at 3:00 PM before the scheduled class time. Late homework will be penalized by 25% or more so do your homework on time. There will be no homework due during an exam (or holiday) week.

Online Quizzes:

To encourage you to do the **upcoming week's** readings, there will be a short online quiz (only a few multiple choice questions) each week that must also be completed by logging into the Expert TA. The quizzes will be available on SUNDAY and due the following TUESDAY at 3:00 PM before the scheduled class time (unless it is an exam week). The quiz questions will help you solidify the lecture materials.

Exams:

The three exams will test your knowledge, understanding, and comprehension of the course material. The questions will come from the text, lecture notes, and exercises. Exams will be multiple choice plus short answer, will cover specific chapters, and will be cumulative only in the sense that most lectures build on the materials in the previous lectures. All exams will be given IN PERSON in RESSLR 66. There are no make-up exams (except for documented emergencies), so make sure that you are there.

The exam dates are:

Midterm I: Tuesday, 25 April 2023. 3:10-4:30 PM

Midterm II: Tuesday, 23 May 2023. 3:10-4:30 PM

Final Exam: Monday, 12 June 2023. 6:00-8:00 PM

Study guides for each exam will be available on the course website at canvas.ucdavis.edu (under "Files/Exam Study Guides").

Syllabus : Note content is subject to change!

Topic	Description	Associated Reading	Relevant Links
1. Overview	Introduction to the Universe Scale and Appropriate Units Characteristic Sizes, Masses, and Velocities	**Chapter 1**	
2. Light and Matter	Properties of Light The Electromagnetic Spectrum Properties and Phases of Matter Types of Spectra Interaction between Matter and Light Light & Temperature Thermal Radiation The Doppler Effect	**Chapter 4.3 & 5**	The Science of Light
3. Telescopes & Observational Techniques	Design and Characteristics of Telescopes Imaging and Spectroscopy Ground versus Space Based Observatories	**Chapter 6**	See the Big Scopes Where is Webb? US Extremely Large Telescope Program European Extremely Large Telescope
4. The World of	Island of Stars - A Brief Introduction Stellar Orbits	**Chapter 15.1-15.2** **Chapter 19.1**	All about Stars Understanding Spectra of Stars Hipparchos H-R Diagrams Luminosity Primer (PDF)

Galaxies	Star Formation Measuring Luminosities and Distances Galaxy Types	**Chapter 19.2** **Chapter 15.1 & 20.2** **Chapter 20.1**	Look up! Our Milky Way Structure of the Milky Way Our Local Group of Galaxies Galaxies Galore
5. The History of Galaxies	Galaxy Formation Galaxy Mergers, Interactions & Evolution The Role of Supermassive Black Holes	**Chapter 19.3 & 21.1** **Chapter 21.2** **Chapter 18.3, 19.4 & 21.3** **(Optional Chap. S3)**	The Fate of the Milky Way Galaxy Merger Simulations Facts about Black Holes Journey into a Black Hole The Event Horizon Telescope
6. Dark Matter	Gravity & The Orbital Velocity Law Weighing Galaxies Galaxy Clusters and Ways To Measure Their Mass Dark Matter Candidates Large Scale Structure Formation	**Chapter 4.4 & 23.2** **Chapter 23.1-23.2** **(Optional Chap. S3)** **Chapter 23.2** **Chapter 23.3**	Help with Gravity (PDF) Rotation Velocity vs. Mass Images of Galaxy Clusters How to Weigh a Cluster Simulation of a Gravitational Lens
7. The Cosmic Expansion	Measuring Distances (again) Cosmic Distance Ladder The Cosmological Redshift The Hubble Law The Age of the Universe The Curvature of Spacetime	**Chapter 20.2-20.3** **Chapter 22.3**	History of the Expanding Universe Visit the Astronomy Cafe
	Cosmic Microwave		

8. The Early Universe	Background The Big Bang Cooling Universe and the Four Forces of Nature The Formation of Nuclei Cosmic Inflation and Resolving Cosmological Puzzles	**Chapter 22** **Chapter S4.2**	Cosmic Microwave Background Beyond the Big Bang More about the Big Bang
9. The Fate of the Universe	The Curvature of Spacetime (again) Key Cosmological Parameters of the Universe The Existence of Dark Energy Cosmic Acceleration	**Chapter 22.3 & 23.4**	Fire and Ice