

# Astronomy 4: Black Holes and Cosmic Catastrophes

## Spring 2020

**Lectures:** Tuesday, Thursday 11:00 am - 12:15 pm, via Zoom (link on CCLE)

**Discussion Section 1A:** Thursday 4:00-4:50 pm, via Zoom (link on CCLE)

**Discussion Section 1B:** Thursday 5:00-5:50 pm, via Zoom (link on CCLE)

**Homepage:** <http://www.astro.ucla.edu/~aes/AST4>

**CCLE Homepage:** <https://ccle.ucla.edu/course/view/20S-ASTR4-1>

**Professor:** Alice Shapley

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Office Hours: Sunday, 5-6 pm, via Zoom (link on CCLE)

**TA:** Aidan Gibbs

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Office Hours: Monday, 10-11 am and Friday, 2-3 pm, via Zoom (link on CCLE)

**Text: The Cosmic Perspective: Stars, Galaxies & Cosmology, 9th Edition (2016)**, by Bennett, Donahue, Schneider, & Voit. The textbook may be purchased new or in digital form. The “Mastering Astronomy” CD is not required. Recent editions (e.g., 6th or 7th) of the textbook are perfectly acceptable.

**Calculators:** A simple one is **highly** recommended, though not required.

# 1 Introduction

We experience the effects of gravity in our everyday lives. This important force shapes our Sun and its evolution, along with all stars and their exotic end-states, galaxies, and the universe itself. In Astronomy 4, we study the effects of gravity and other competing forces on the nature of stars, black holes, galaxies, and the universe as a whole, including an introduction to special and general relativity.

# 2 Prerequisites

We will review all the basic physical concepts required for understanding the material in the course. However, we expect that students should feel comfortable performing *basic* calculations at the level of high-school algebra and, occasionally, geometry.

# 3 Grading

Final grades will be based on homework assignments (a total of 8 given during the quarter), the midterm exam, the final exam, and a final project. These factors will be combined in the following percentages to determine your class grade:

- 50% homework
- 20% midterm exam
- 20% final exam
- 10% final project

**Homework** will be assigned roughly every week (a total of 8 assignments). The homework problem set assignments will be available from the course CCLE site. Each assignment will be made available on a Tuesday morning, and then will be due by 5 pm on the following Tuesday. Completed homework is to be uploaded via the course CCLE site, and assignments should be handed in as scanned pdf files. Homework turned in after the deadline 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. Homeworks will be returned one week after they are turned in.

**The midterm exam** is scheduled for Tuesday, April 28th. It will test all material covered up to that point, and will be given during the regular class lecture time. **The midterm will contain a combination of multiple choice, true/false, short answer, and free response questions.**

**The final exam** is scheduled for Monday, June 8th, from 11:30 am - 2:30 pm. **It will be cumulative, drawing on all material covered in the course, and containing a combination of multiple choice, true/false, short answer, and free response questions.**

**The final project** is due Thursday, June 4th, by 5 pm. This is a 3-page paper (minimum 750 words, plus references) covering a topic in black hole current events. This paper must be turned in as a pdf file uploaded to CCLE. More details to follow during the quarter.

## 4 Special Instructions for Remote Learning in Spring 2020

Here is some information specific to the spring 2020 quarter of Astronomy 4:

**Digital tools and the internet:** In case you are having a hard time accessing remote learning tools, please note the following:

- Please let me know! If I know of the issues, I can work to make the course materials more accessible to everyone.
- UCLA is working to address this issue: see this Newsroom story for more information on obtaining devices (<https://newsroom.ucla.edu/stories/ucla-offers-undergraduates-emergency-financial-support-for-remote-learning-technology>.)

**Course Materials:** Our textbook can be purchased through ASUCLA (<https://shop.uclastore.com/c-1004-faqs.aspx>). It can also be purchased on Amazon. If you prefer a digital edition to hardcopy, that is completely fine.

**Course Communications:** Emails related to the course will be sent through MyUCLA. Assignments and exams will be posted on and turned in to CCLE.

**Joining Zoom:** The course will use the videoconferencing software Zoom for lectures, discussion sections, and office hours. Students will have a choice of watching lectures either live with Zoom or viewing recordings of lectures on CCLE. If you plan to join live (HIGHLY RECOMMENDED) please see the tutorial here ([https://docs.ccle.ucla.edu/index.php?title=Main\\_Page](https://docs.ccle.ucla.edu/index.php?title=Main_Page) and search for “How do I use Zoom to attend my instructor’s remote meetings”) to learn how to access the system. **Note that the Zoom links for lecture, section, and office hours will be available from the CCLE course website.** Also note that you’ll get a better connection if you download the Zoom desktop client as opposed to joining through your browser, plus the latter has more limited functionality.

**Recording:** Astro 4 lectures will be recorded through Zoom and made available to registered students through the CCLE course website. Please be aware of the following:

- From UCLA: “This program uses video recording or other personal information capture for the purpose of facilitating the course. Pursuant to the terms of the agreement with UCLA, the data is used solely for this purpose and any vendor is prohibited from redisclosing this information. UCLA also does not use the data for any other purpose.”
- If you do not want your image to appear in these recordings, please turn off your video camera.
- You may ask questions through the chat feature to preserve your anonymity.

**Online etiquette:** Here are some principles to follow to make the lecture part of the class more enjoyable:

- Be in a quiet place and use headphones.
- Video on, unless you have privacy concerns or unless you do not have privacy (in case you have small children running about, for example).

- Sign in with your real name, unless you have privacy concerns.
- Quit all other screens and apps so that you can focus on the (virtual) classroom.
- Mute your microphone unless you are asking or answering a question.
- Use the Raise Hand feature or the chat box to ask questions. (I recommend having the chat box open throughout the class.)

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## Schedule of Lectures

No.	Date	Title	Chapter
1	Mar 31	General introduction. Scale of the Universe. Our place in it.	1
2	Apr 2	Motion, force & energy.	4
3	7	Gravity!	4
4	9	Light and Thermal Radiation.	5
5	14	Matter and Energy Levels.	5
6	16	The Sun.	14
7	21	Properties of Stars.	15
8	23	More Properties of Stars, Star clusters.	15
	28	<b>Midterm Exam, in class</b>	
9	30	Evolution of Low- and High-mass Stars.	17
10	May 5	End states of stars.	18, S4
11	7	More End States of Stars, Supernova Explosions.	17, 18
12	12	Pulsars, Black Holes.	18
13	14	Special Relativity.	S2
14	19	General Relativity and Black Holes.	S3
15	21	AGNs, QSOs, and Supermassive Black Holes.	20, 21
16	26	Gravity in our own Milky Way.	19
17	28	The Galactic Center; Galaxies and the Distance Ladder.	19, 20
18	Jun 2	The Expansion of the Universe.	20, 23
19	4	Dark Matter, Dark Energy, the Origin and Fate of the Universe.	22, 23
	8	<b>Final Exam</b>	