

AST 309R – Galaxies, Quasars, & The Universe

Spring 2023 – Unique No. 47895

MWF 11:00 AM – 12:00 PM

Instructor: Prof. Danielle A. Berg
Email: daberg@austin.utexas.edu
Student Help: By appointment



Teaching Assistant: Yashvi Shah

Contact: Message on Canvas

Student Help Hours: Mondays 1:00 PM – 3:00 PM on Zoom
Thursdays 11:15 AM – 12:15 PM on Zoom

COURSE DETAILS

Course Meetings: We will be meeting M, W, F 11:00 – 11:50 AM in person.

Course Location: Welch 3.502.

Course Lecture Slides: Lecture slides will be provided before class on Canvas

Course Webpage: Your main source of information will be the course webpage on Canvas. This is where you will find announcements, homework and reading assignments, grades, deadlines, be able to ask questions, and more. It is your responsibility to check the Canvas course page on a regular basis. Please come to class prepared, having done the assigned pre-class readings and assignments, and be ready to participate in discussions and activities.

Course Materials: In this class we will use digital content. You will need:

1. The Cosmic Perspectives (CP), 9th edition text via Longhorns Textbook Access
 - a. This includes the Mastering Astronomy (MA) software
2. The [Stellarium](#) software. We will use this for group activities.

COURSE DESCRIPTION

How did the universe begin? How did the fiery gases of the Big Bang collect into “island universes” like our own Milky Way, even as the universe as a whole was expanding into the frigid emptiness of today? What processes led to the formation of stars, planets, and life? Where do we go from here?

This course presents modern observations and theories of the structure and evolution of the universe. Topics include the evidence for the Big Bang, the formation of galaxies, and the nature of bizarre stellar remnants such as black holes and quasars. We trace the evolution of the universe from the first moment through the creation of the primeval fireball radiation and the birth and evolution of galaxies. We examine the rich variety of

observations of quasars, the evidence for giant black holes, the accelerating universe, dark matter, and dark energy.

The course is divided into four interlinking parts that will review what astronomers have learned about the stars, the galaxies, and the Universe. Part one includes the history of how astronomers developed the physical ideas we use as the foundational tools to study and come to know things about distant objects throughout the cosmos. We will examine how astronomical ideas have been developed and tested against observations, and explore a few of the outstanding problems faced by current astronomical research. Part two will focus on the formation, life, and death of stars. Part three will expand to a view of our Galaxy and how galaxies in general form and evolve. Finally, we will look at the larger picture of how our Universe formed and evolved, and what major forces are responsible, including the role of Dark Matter and Dark Energy.

Course Objectives: By the end of this course, students should successfully be able to:

PART I – Developing an Astronomical Perspective:

- Understand the basic facts, principles, theories, and methods of modern science, and recognize that science is an evolving body of knowledge.
- Be able to outline our big-picture understanding of the cosmos, including the scale of space and time.
- Understand how the universality of key physics principles allow us to simultaneously explain the phenomenon of our everyday lives *and* the cosmos.
- Be able to describe the properties of light and how its interconnected nature with matter forms spectra, allowing astronomers to study the physical conditions in astronomical objects far away.
- Understand how telescopes work and how their technological advances are allowing the discovery of new astronomical phenomenon.

PART II – Stars and Stellar Life Cycles:

- Be able to describe the general properties of stars.
- Understand how the properties of stars are measured and how they are classified.
- Understand how stars form and how they evolve.
- Be able to describe how different stars end their lives as white dwarfs, neutron stars, or black holes, and why.

PART III – The Evolution of Galaxies and Cosmology:

- Be able to describe the history of our Milky Way.
- Understand the recycling process of stars and gas and how it shapes galaxies.
- Understand how properties of galaxies are measured, including distances & velocities.
- Be able describe how the study of galaxies and their evolution form the foundation of modern cosmology.

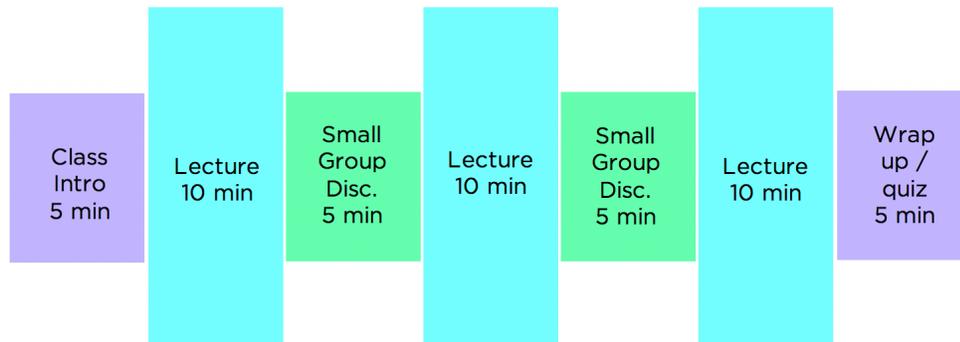
PART IV – The Formation and Evolution of the Universe

- Be able to describe the Big Bang model of the Universe.
- Understand the evidence that supports our current cosmological model, including what the cosmic microwave background is.
- Be able to describe what Dark Matter and Dark Energy are.
- Understand the geometry of space, expansion of the Universe, and the role of gravity.
- Be able to describe the ultimate fate of the universe.

COURSE STRUCTURE

Each week during our scheduled course times (M,W,F 11 AM – 11:50 PM), there will be 3 x 50-min meetings that will include lectures, discussions, and group activities. There will also be daily reading and/or homework assignments that are designed to aid your comprehension and explore some of the course topics in greater depth. There will be three comprehension exams, one for each part of the class. There will be no final exam but there will be a final project.

In a typical week, two classes will be lecture/discussion-based class and one will be an activity-based class. Each lecture/discussion-based class will be broken down into smaller 5-10 minute segments. You can expect something like this:



Course Communication: Here are some guidelines to help make sure we keep up good communication and that our interactions are enjoyable:

- **Questions:** I'm always happy to take questions during lecture; please raise your hand so that I can see that you have a question. For questions outside of class, please post to the Canvas discussion board for our class or message the TA.
- **Announcements:** I will regularly post information using the announcements page on Canvas. Please check your notifications settings in Canvas to ensure that you are receiving the email versions of those announcements frequently.
- **Environment:** I am committed to providing you with a friendly, productive, and effective learning. If you find the environment does not meet these standards, please come talk to me so we can make improvements.

Course Participation: Class participation is an important part of this class. Here is what you can expect:

- There will be polls, small group discussions, and activities to aid in learning, with an emphasis on more group work on Wednesdays.
- In class you should be ready to speak, at least with your small group.
- Try to be fully present when attending class - this means not using electronics during lecture besides for note taking.

Classroom Safety: To help preserve our in person learning environment, the university recommends the following:

- Adhere to university and CDC guidance for any relevant health concerns. Our class will be the most successful if we all protect and respect each other.

- Vaccinations are widely available, free and not billed to health insurance. Vaccines help protect against the transmission of viruses to others and reduce serious symptoms in those who are vaccinated. The vaccines are safe and effective.
- If you are experiencing any symptoms of a contagious illness, please stay home.

Modality: Class will be in-person learning plus online assignments.

In-person Etiquette: Please silence cell phones before you enter the classroom. No texting or using your cell phones during class except for use in specified classroom activities. Please do not pack up or leave class early unless you have talked to me in advance, as a consideration to me and your fellow students. Students may use laptops to take notes. Students found to be using their computers for non-class activities will be a distraction to those around them and will be asked to leave. If laptop distraction becomes a problem, I reserve the right to reverse this policy. Be respectful of others, especially during in-class peer discussion times, and even if you disagree with them.

Group Activities: Group discussions should be structured and on topic. Take turns sharing ideas without a single person dominating the discourse. Both myself and the teaching assistant will be moving around the room at random to listen in, promote discussion, and answer questions. You can work together as you see fit, but everyone must enter their own responses for the group work assignments on MasteringAstronomy.

COURSE GRADING

Course grade will be evaluated on four components:

1. Homework – constitutes 60%.
2. Exams – constitute 15% (or 5% each).
3. In-class participation / Wednesday Small Group Activities – constitutes 20%.
4. Final project – constitutes 5 %.

Grading Scale: The grading scale is below. Note that this course will *not* be graded on a curve. Your grade is calculated to the nearest 1/100th of a percentage point.

A: 94.00 – 100%	B–: 79.00 – 82.99%	D+: 67.00 – 70.99%
A–: 91.00 – 93.99%	C+: 76.00 – 78.99%	D: 63.00 – 66.99%
B+: 87.00 – 90.99%	C: 73.00 – 75.99%	D–: 60.00 – 62.99%
B: 83.00 – 86.99%	C–: 70.00 – 72.99%	F: 0.00 – 59.99%

Homework: There will be regular (for each class) online reading and homework assignments, each of which has a low weight, but all together will make up **60%** of your grade. They will be due by the start (11:00 AM) of each class that they are assigned (see schedule below or week plan on CANVAS) and will be available to you one week prior to their due date. Homework assignments will be done in the online **Mastering Astronomy** portal; they can be found directly in Mastering Astronomy or via the assignment links in canvas, which will take you to Mastering Astronomy. Late homework will be accepted, but will lose 10% each day that it is late.

Exams: There will be 3 x 1-hour exams throughout the semester. Each exam will count for **5%** of your grade, or **15%** all together. Exams will be completed using the online **Mastering Astronomy** portal. You will have 5 days to begin the exam, but only 1

hour to complete it once you open the exam. We will not hold in person classes during exam days. There is no final.

Final Project: The final component of the class will be a project to describe/explain the most interesting thing you learned from the last chapters we cover in this class. You can complete your project in a group or individually. Projects must include some creative aspect such that you are presenting the concept in a non-standard format. For example, you could create a skit, a commercial, a song, a piece of artwork, etc. The sky is the limit! Final projects will be presented in class during the last two class periods and will be turned in by the **end of class on April 24th**. The final project will count for **5%** of your grade.

COURSE POLICIES

Communication Policy: For questions about class content or logistics you **must** post the question to the canvas discussion board or ask it during student help hours. If no one responds to your post within 24 hours, or the TA is unable to answer your question, you may email me, including a link to the discussion post or a screenshot of the TA's response. Please email me at any time for questions of a personal nature.

Homework and Exams: No late or makeup exams will be accepted. Late homework will incur a 10% deduction per day past the due date.

Exceptions: I understand that unpredictable life events happen, so exceptions may be made for special circumstances. If you are unable to submit homework or complete an exam on time, you must contact me in advance of the due date for your exception to be considered. If you experience a personal or family emergency (death in the family, protracted sickness, serious mental health issues) that prevents you from attending an exam or forces you to miss multiple days of class, you should contact [Student Emergency Services in the Office of the Dean of Students](#). They will work with you to communicate with your professors and let them know of your situation.

Accommodations for family responsibilities: I recognize the difficulty of being a full-time student with children, *especially* during this pandemic. If you have children, or other family commitments that may interfere with your work, please email me to discuss any modifications of the course policies that will help maximize your success in this course.

Accommodations for Religious Holidays: A student who is absent from a class or misses an exam for the observance of a religious holiday will be permitted to make up the missed work, if notice is given at least fourteen days prior to such an absence.

Accommodations for disabilities: If you have any kind of disability, whether apparent or non-apparent, learning, emotional, physical, or cognitive, please feel free to contact me to discuss reasonable accommodations for your access needs. Students with disabilities may also request appropriate accommodations from the university: The University of Austin provides upon request appropriate academic accommodations for qualified students with disabilities. For more information, contact the Office of the Dean of Students (471-6259, 471-6441 TTY) or [Division of Diversity and Community Engagement, Services for Students with Disabilities](#) (512-471-6259).



Uniqueness is powerful. Be yourself.

I am committed to inclusion across race, gender, age, religion, identity, and experience, and believe it fosters a culture of creativity and drives innovative research. I seek to cultivate open, authentic workspaces and avenues of communication. I believe we do our best work in environments that foster acceptance of our differences and supports individuality. I am a resource, ally, and friend to those who seek one.

Expectations regarding mutual respect: Astronomy belongs to all people, independent of race, religion, gender, gender identity, gender expression, or sexual orientation. Incidents of discrimination, assault, harassment, threats, intimidation, profiling, or coercion based on membership or perceived membership will not be tolerated. Show each other respect no matter perceived knowledge or performance in this class, or any other.

Zero-tolerance of harassment/assault: Harassment of any sort will not be tolerated in this class or related workspaces. Title IX and Title VII makes clear that violence and harassment based on sex, gender, race, or national origin are Civil Rights violations subject to investigation and disciplinary action on behalf of the University. The same kinds of accountability and support will be applied to offenses against other categories such as sexual orientation and gender identity. If you or someone you know has been harassed or assaulted, either in the classroom or outside of the classroom space, you can find the appropriate resources through the University Title IX Coordinator (512-232-3992), UT Austin Campus Police (512-471-4441), the Student Ombuds Services (which can provide *confidential* advice, resources and help; 512-471-3825), and the UT Counseling and Mental Health Center (512-471-3515).

Mental Health Services: College life can be challenging and stressful. **Your first priority should be taking care of yourself and your own health, and those around you. If you experience diminished mental health, please seek help.** Diminished mental health, including significant stress, mood changes, excessive worry, or problems with eating and/or sleeping can interfere with optimal academic performance. Similarly, problems with relationships, family worries, loss, or a personal struggle or crisis can also contribute to decreased academic performance. [UT Austin's Counseling and Mental Health Center](#) (512-471-3515) provides mental health services to support the academic success of students. This includes counseling services, wellness workshops, free and confidential therapy groups, and general information. I encourage you to browse their website and actively seek support if you're experiencing any of these difficulties.

Academic Dishonesty: The minimum penalty for cheating — in any way whatsoever — is receiving a zero on the assignment on which you cheated. The instructor reserves the right to seek a penalty the instructor deems appropriate for the given case of academic dishonesty, including failing the class and being reported to Student Judicial Services. If the academic honesty is sufficiently serious, the instructor will proceed by filing a formal report to the Judicial Services in the Dean of Students Office as is policy. Judicial Services would decide the final penalty after a hearing on the matter. For more information, read in the General Information Catalog about scholastic dishonesty.

Sharing of Course Materials is Prohibited: No materials used in this class, including, but not limited to, lecture hand-outs, videos, assessments (quizzes, exams, papers, projects, homework assignments), in-class materials, review sheets, and additional problem sets, may be shared online or with anyone outside of the class unless you have my explicit, written permission. Unauthorized sharing of materials promotes cheating. It is a violation of the University's Student Honor Code and an act of academic dishonesty. I am well aware of the sites used for sharing materials, and any materials found online that are associated with you, or any suspected unauthorized sharing of materials, will be reported to Student Conduct and Academic Integrity in the Office of the Dean of Students. These reports can result in sanctions, including failure in the course.

COURSE SCHEDULE

CLASS #	TOPIC	MA DUE PRECLASS	READING DUE PRECLASS
1	Introduction	--	--
2	The Science of Astronomy	<ul style="list-style-type: none"> • Intro to MA • Syllabus quiz 	<ul style="list-style-type: none"> • Syllabus • CP 3.1 & 3.1
3	The Science of Astronomy	<ul style="list-style-type: none"> • HW 3.1+3.2 	<ul style="list-style-type: none"> • CP 3.3 & 3.4
4	A Modern View of The Universe <i>Week 2 Activity</i>	<ul style="list-style-type: none"> • HW 3.3+3.4 	<ul style="list-style-type: none"> • CP 1.1-1.4
5	A Modern View of The Universe	<ul style="list-style-type: none"> • HW 1.1-1.4 • <i>Week 2 Activity</i> 	<ul style="list-style-type: none"> • CP 4.1—4.3
6	Motion, Energy, & Gravity	<ul style="list-style-type: none"> • HW 4.1-4.3 	<ul style="list-style-type: none"> • CP 4.4 & 4.5
7	Motion, Energy, & Gravity <i>Week 3 Activity</i>	<ul style="list-style-type: none"> • HW 4.4+4.5 	<ul style="list-style-type: none"> • CP 5.1 & 5.2
8	Light and Matter	<ul style="list-style-type: none"> • HW 5.1+5.2 • <i>Week 3 Activity</i> 	<ul style="list-style-type: none"> • CP 5.3 & 5.4
9	Light and Matter	<ul style="list-style-type: none"> • HW 5.3+5.4 	<ul style="list-style-type: none"> • CP 6.1 & 6.2
10	Telescopes <i>Week 4 Activity</i>	<ul style="list-style-type: none"> • HW 6.1+6.2 	<ul style="list-style-type: none"> • CP 6.3 & 6.4
11	Exam 1 Review	<ul style="list-style-type: none"> • HW 6.3+6.4 • <i>Week 4 Activity</i> 	<ul style="list-style-type: none"> • Review
12	EXAM 1: Ch 1-6	<ul style="list-style-type: none"> • Practice Exam 	<ul style="list-style-type: none"> • None
13	Space and Time	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • CP S2.1 & S2.3
14	Spacetime and Gravity	<ul style="list-style-type: none"> • HW S2.1-S2.3 	<ul style="list-style-type: none"> • CP S2.4, S3.1, & S3.2
15	Spacetime and Gravity	<ul style="list-style-type: none"> • HW S2.4+S3.1+S3.2 	<ul style="list-style-type: none"> • CP S3.3—S3.6
16	Star Stuff <i>Week 6 Activity</i>	<ul style="list-style-type: none"> • HW S3.3+S3.4 	<ul style="list-style-type: none"> • CP 17.1 & 17.2
17	Star Stuff	<ul style="list-style-type: none"> • <i>Week 6 Activity</i> 	<ul style="list-style-type: none"> • CP 17.3 & 17.4
18	Star Stuff	<ul style="list-style-type: none"> • HW 17.1+17.2 	<ul style="list-style-type: none"> • None

	<i>Week 7 Activity</i>		
19	The Bizarre Stellar Graveyard	<ul style="list-style-type: none"> • HW 17.3+17.4 • 	<ul style="list-style-type: none"> • CP 18.1+18.2
20	The Bizarre Stellar Graveyard	<ul style="list-style-type: none"> • HW 18.1+18.2 • <i>Week 7 Activity</i> 	<ul style="list-style-type: none"> • CP 18.3+18.4
21	EXAM 2 REVIEW <i>Week 8 Activity</i>	<ul style="list-style-type: none"> • HW 18.3+18.4 	<ul style="list-style-type: none"> • Review
22	EXAM 2: Ch S2, S3, 17, 18	<ul style="list-style-type: none"> • Practice Exam 2 • <i>Week 8 Activity</i> 	<ul style="list-style-type: none"> • None
23	Our Galaxy	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • CP 19.1 & 19.2
24	Our Galaxy	<ul style="list-style-type: none"> • HW 19.1+19.2 	<ul style="list-style-type: none"> • CP 19.3 & 19.4
25	Our Galaxy <i>Week 9 Activity</i>	<ul style="list-style-type: none"> • HW 19.3+19.4 	<ul style="list-style-type: none"> • CP 20.1 & 20.2
26	Galaxies and The Foundation of Modern Cosmology	<ul style="list-style-type: none"> • HW 20.1+20.2 • <i>Week 9 Activity</i> 	<ul style="list-style-type: none"> • None
27	Galaxies and The Foundation of Modern Cosmology	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • CP 20.3
28	Galaxies and The Foundation of Modern Cosmology <i>Week 10 Activity</i>	<ul style="list-style-type: none"> • HW 20.3 	<ul style="list-style-type: none"> • None
29	Galaxy Evolution	<ul style="list-style-type: none"> • <i>Week 10 Activity</i> 	<ul style="list-style-type: none"> • CP 21.1 & 21.2
30	Galaxy Evolution <i>Week 11 Activity</i>	<ul style="list-style-type: none"> • HW 21.1+21.2 	<ul style="list-style-type: none"> • CP 21.3 & 21.4
31	EXAM 3 REVIEW	<ul style="list-style-type: none"> • HW 21.3+21.4 • <i>Week 11 Activity</i> 	<ul style="list-style-type: none"> • None
32	EXAM 3: Ch 19 - 21	<ul style="list-style-type: none"> • Practice Exam 3 	<ul style="list-style-type: none"> • Review
33	The Birth of The Universe	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • CP 22.1 & 22.2
34	The Birth of The Universe	<ul style="list-style-type: none"> • HW 22.1+22.2 	<ul style="list-style-type: none"> • CP 22.3 & 22.4
35	The Birth of The Universe	<ul style="list-style-type: none"> • HW 22.3+22.4 	<ul style="list-style-type: none"> • CP 23.1 & 23.2
36	Dark Matter & Dark Energy	<ul style="list-style-type: none"> • HW 23.1+23.2 	<ul style="list-style-type: none"> • None
37	Dark Matter & Dark Energy <i>Week 13 Activity</i>	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • CP 23.3 & 23.4
38	Dark Matter & Dark Energy	<ul style="list-style-type: none"> • HW 23.3+23.4 • <i>Week 13 Activity</i> 	<ul style="list-style-type: none"> • None
39	<i>Week 15 Activity</i>	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • None
40	Ch 22+23 Review	<ul style="list-style-type: none"> • <i>Week 15 Activity</i> 	<ul style="list-style-type: none"> • None
41	Presentations	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • None
42	Presentations	<ul style="list-style-type: none"> • Final Project 	<ul style="list-style-type: none"> • None

FREQUENTLY ASKED QUESTIONS:

What about technical difficulties?

If you have a recurring computer or internet problem, please email me to help find a solution. If my internet goes out during class, don't leave! I will log back in via my phone and continue the class.

Do you record in-class lectures?

Only under certain circumstances upon request. This is to help ensure the privacy of all students and encourage participation. If a recording is made generally available, it will be under the Zoom tab on the Canvas page for this class. You will find this tab along the left side navigation in Canvas. I will also post a PDF of the lecture slides.

How do I succeed in this class?

The best way to succeed is to prepare and participate. Do the readings ahead of time and complete all homework on time (and take multiple attempts if needed). When in class, buy in and participate!

How do I study for exams?

1. Study the lecture pdfs. Don't just read them, re-do any problems in them! Cover your old answers, then check your new answers against them. Work in a group if you can!
2. Review past homework. Again, can you resolve the problems?
3. Do the practice exams.
4. Come to student help sessions!!!
5. Keep organized notes so that you can easily find information during the time exam.

If I miss an exam, can I make it up?

There are no makeup exams. You will have 5 days to complete the exam on your own, so plan accordingly. The only exception to this will be:

1. If you have a major life event, and you notify me ahead of time. Depending on the situation, I may ask you to contact Student Emergency Services for assistance.
2. I am contacted by Student Emergency Services, and they request a makeup.
3. You are absent for a university-sponsored event, and you notify me ahead of time.

I'm sick and cannot come to class today. What do I do?

You don't need to email me! Stay home and get better. Still do the reading and assigned homework, and download the lecture PDF to see what you missed. If you miss a Wednesday, do the missed group exercise or on your own. If you have to miss multiple consecutive classes, please contact Student Emergency Services, and they will let me know if they feel you should be allowed to make up for missed participation.

I forgot to do the homework before class. Can I turn it in this afternoon?

Don't let this be you, complete homework assignments early! Late homework carries a penalty of 10% per day!

I have a zero in the Canvas gradebook for something I completed. What do I do?!

We can make mistakes when inputting/scaling ~200 grades! If you believe there is a mistake in the gradebook, stay calm, just send myself or the TA an email/message, and we'll investigate.