

ASTR-1200-001: Stars and Galaxies CU Boulder Syllabus (Spring 2019)

Class Times & Location: Mon./Wed./Fri., 9:00-9:50 am, Duane Physics G1B20

Instructor: Prof. Steven R. Cranmer (steven.cranmer@colorado.edu)

Office hours: Duane D111: Tues. 10:00–11:00, Fri. 10:00-11:00, or by appointment

Teaching Assistant: Elizabeth Butler (elizabeth.butler-2@colorado.edu)

Office hours: Duane D232: Mon., 10:00–12:00, and TBD time in Astronomy Help Room

OVERVIEW

In this course, non-science majors will learn about the birth and death of stars (including our own Sun), the nature of black holes and galaxies, and the structure and evolution of the entire universe. We will discuss what astronomers know today about each of these things, how we know it, and what we still don't yet know.

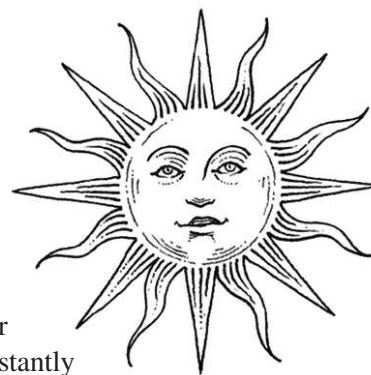
WHO SHOULD TAKE THIS CLASS?

There are no formal prerequisites. ASTR-1200 is designed as a stand-alone, single-semester course, and it does not count as part of the astronomy core sequence. If you have already taken ASTR-1010, please enroll in ASTR-1020 instead, which is the continuation of the sequence and covers the same material as this class. If you have already taken ASTR-1020 or 1040, you cannot receive credit for this class. ASTR-1200 does not count toward the ASTR major. If you are a physical sciences or engineering major, you are strongly encouraged to take the calculus-based ASTR-1030/1040 sequence instead.

COURSE GOALS

Our hope is that a graduate of this course will:

- Develop a sense of awe and appreciation about the physical universe.
- Understand how science allows us to confidently answer many questions that lie far outside the realm of what we experience in everyday life.
- Learn how we “stand on the shoulders of giants” by building on earlier discoveries. Science isn't a static set of rules and equations, but is constantly changing in response to new observations and interpretations.
- Develop some experience using skills such as critical thinking, problem solving, and quantitative reasoning (yes, there will be math) that are very useful for life beyond this course.
- Be inspired to share what you've learned with other people (friends, family, random strangers on the HOP bus).



COURSE WEB PAGES

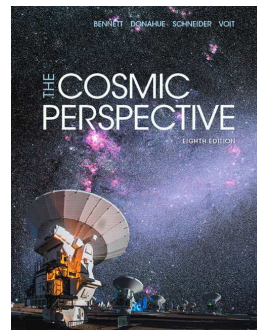


This semester, we will use CU Boulder's new system (*Canvas*) to post assignments, up-to-date schedules, and lecture notes. Just log in to <https://canvas.colorado.edu> with your CU IdentiKey and password. Once you're in, click on the link for *ASTR-1200, Stars & Galaxies*. There is also a Canvas app for your phone, and you can subscribe to notifications to be reminded of due-dates.

I will also be posting most of the course material onto my own web page: http://lasp.colorado.edu/~cranmer/ASTR_1200_2019/

REQUIRED MATERIALS

Textbook: *The Cosmic Perspective*, 8th edition, by Bennett et al. (required). We will assign regular readings from this book (see schedule). This is the same text that we use in all 1000-level astronomy classes. If you already have a copy from a previous course, that is fine. Older versions of this text (6th or 7th editions) are also acceptable, but note that some chapters have been renumbered—so it is your responsibility to make sure the material is the same as the assigned readings in the 8th edition.



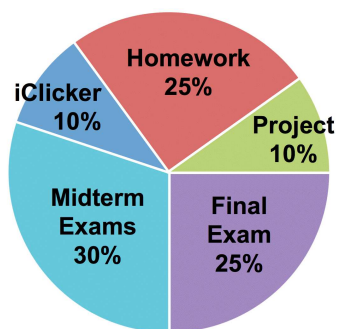
Clickers: Each of you will need to purchase a wireless student response system (*iClicker* or *iClicker+*) from the CU Bookstore. Several times during each class, I will ask questions to get you to think carefully about some of the concepts we have covered. Often, this will involve discussion with your neighbors, but you will need to answer on your own. Why are clickers important?

- They improve your grade! When you discuss and debate with others, your knowledge improves.
- They give *YOU* immediate feedback about what you do & do not understand.
- They tell *ME* what the class doesn't understand, so I can spend more time making things clear.

Clicker questions are graded (see below), and each class will usually start with one or two questions from the assigned reading. Students generally report that these are easy if they've done the reading, but hard if they haven't. *Moral:* Do your reading before class!

You must register your clicker online (<http://iclicker.com>). Using someone else's clicker for them is a violation of the Honor Code and both you and the person whose clicker you are operating will receive a zero for the entire clicker portion of your grade (and be reported to the Honor Code Office).

YOUR GRADE



- 25% Written homework assignments (lowest score dropped)
- 10% Independent Project
- 10% Participation/iClicker (worst 5 days dropped)
- 30% Midterm exams (three total, best 2 out of 3 counted)
- 25% Comprehensive final exam

More information about each part of your grade is given below.

HOMEWORK (25%)

There will be approximately 5 or 6 written homework assignments (problem sets) over the course of the semester. Details and due-dates will be posted on Canvas, and we will try to announce them in class as frequently as possible. These assignments will be more quantitative and mathematical than most other parts of the course. You are encouraged to work with classmates, attend help sessions, and come to office hours as needed (of course, all work must be your own; please read the statements about the Honor Code below).

Your lowest homework assignment grade will be dropped.

Written homework is due at the **beginning** of class on the day it is due. Solutions will be posted on Canvas within a week of each due date. Homework turned between the beginning of class on the due date and the posting of the solutions will receive up to 50% credit. Once the solutions are posted, late homework will not be accepted.

In addition to the usual assignments, there is also another one (call it “**Homework Zero**”) that you can do any time during the semester, and it cannot be dropped. For this, you need to complete *either* of the following:

- Attend an **observing session** at the Sommers Bausch Observatory (SBO) on campus. Observe three (or more) different types of objects in the sky, sketch and/or photograph them, and write a brief report. SBO dates are “weather-permitting” and will be announced during class and posted on Canvas. Details about the reports will also be posted online.
- Attend a **public science lecture** and write a 1–2 page essay on the subjects covered and your own reaction to the presentation. Most of these public talks will be at Fiske Planetarium. If you’re feeling adventurous, you can also attend an APS Department Colloquium (most Mondays at 4:00 pm in JILA Auditorium), but those can sometimes be more of a challenge to follow. Times and dates of public lectures will be announced in class as we hear about them. If you hear of other ones that you think would fit this assignment, please let us know and we will announce them as well. Details will also be posted online.

INDEPENDENT PROJECT (10%)

During the semester, you will complete one independent project on an astronomical topic of your choosing. Your final product can take on many different forms, but the default is an essay of about 1000 words, with proper references, in which you describe the result of your independent research. However, you can also create some other kind of multi-media (i.e., video, animation, musical piece, game, or art project) designed to get the public excited about a topic in astronomy. You could also make this more about journalism (i.e., interviewing a local expert, or reviewing a relevant book or movie). There will be a more extensive list of possible topics on Canvas, along with a list of due-dates and expectations.

PARTICIPATION/CLICKERS (10%)

See above for other information about clickers. **Your worst 5 days of clicker scores will be dropped.** This should cover you if you are sick, have a family emergency, or need to miss class for any other reason. This will also cover technical problems with your clicker. Most questions will be scored as follows:

0 points	No answer
0.6 points	Wrong answer
1 point	Correct answer

However, not all clicker questions will be graded right/wrong. We’ll have some “opinion” questions with 0 points for no answer and 1 point for any answer, and we’ll do our best to label them clearly.

If you are using a clicker from a previous semester, please *REPLACE YOUR BATTERIES!*

MIDTERM EXAMS (30%)

There will be three in-class midterm exams during the semester (dates: Feb. 13, Mar. 13, Apr. 17). Your best two out of three exams will count for 30% of your final grade. Some students may have to miss an exam

during the semester, and we accommodate this by dropping the lowest exam score. For this reason, **there are NO makeup exams for any reason** including excused absences. (If you know ahead of time that you may miss more than one exam, for a legitimate reason, contact Prof. Cranmer as soon as possible!)

Each midterm will focus primarily on material covered during the preceding 4–5 weeks of class, but they may also require understanding of material covered during the semester so far. We'll have (at least) a half-class review session prior to each exam, and you'll have a chance before *that* to submit a list of topics or questions that you're most concerned about.

FINAL EXAM (25%)

A comprehensive final exam will be held at the university-assigned time & place. The final exam score cannot be dropped. Do not make travel arrangements that conflict with the final exam, as there can be no late or make-up exams given. If you have been certified to take an exam under special circumstances, please notify us to make necessary arrangements in advance of the exam date.

For the final exam, you will be allowed to bring in one sheet of handwritten notes (8.5" × 11", both sides). Any material from the homeworks, lectures, or assigned readings is potential exam material.

QUESTIONS & CONCERNS

We're here to help! Please don't hesitate to get in touch with your professor or the TA if you have questions about any aspect of the class, or if you start running into difficulties following the material or keeping up with assignments. There are many resources, including office hours, the Astronomy Help Room, and tutors available for hire. Please let us know if you need help on any aspect of the course.

How much math will there be? Some familiarity with basic algebra, geometry, and scientific notation will be helpful. However, we will spend several classes reviewing these concepts. For a more thorough review, see: <http://lasp.colorado.edu/~bagenal/MATH/main.html>

Is there a curve? YES. I *start* with a standard scheme for converting numerical scores to letter grades: A > 90%, B > 80%, C > 70%, and so on. But then, at the end of the semester, I will add some constant number of points to everyone's scores (never subtract!) to take account of how challenging the course has been. At some point mid-semester, I will make available an assessment of how that process is likely to go, and I can provide approximate letter-grade progress-reports to students who want them.

CHECKLIST FOR SUCCESS IN THIS CLASS

- Attend class regularly. Sit up front and ask questions. (There are no 'dumb' questions!)
- Buy and read your textbook.
- Put away your phone and laptop.
- Turn in *every* assignment. Partial credit is a lot better than no credit.
- Don't settle for being confused. If you don't understand something, I guarantee there will be at least 10 other students in class who also don't. Help them out by asking a question.

You will receive the grade you work for.

PRELIMINARY CLASS SCHEDULE ASTR-1200-001: Stars and Galaxies (Spring 2019)

The chapter numbers listed here are for readings in *The Cosmic Perspective* (8th ed.) that ought to be done prior to each class. However, the exact schedule is likely to change throughout the semester. The most up-to-date schedule for readings—as well as homework & project due-dates— will be on *Canvas*. Each day’s lecture notes will also contain the correct information.

	<i>Monday</i>		<i>Wednesday</i>		<i>Friday</i>
Week 1 (Jan. 14-18)	Course introduction		Scales & some math Ch. 1.1, 1.2, 1.4		What is astronomy? Ch. 2.1, 3.1 (1st page), 3.2
Week 2 (Jan. 21-25)	MLK Holiday, no classes		What is astronomy? Ch. 3.3, 3.4		Motion & Energy Ch. 4.1, 4.3 (pp. 119-123)
Week 3 (Jan. 28 - Feb. 1)	FISKE PLANETARIUM		Light & Atoms Ch. 5.1, 5.2		Light & Atoms Ch. 5.3
Week 4 (Feb. 4-8)	Light & Atoms Ch. 5.4		Telescopes Ch. 6.1, 6.2		The Sun Ch. 14.1
Week 5 (Feb. 11-15)	The Sun Ch. 14.2	<i>Exam Prep Session</i>	<i>Midterm Exam 1</i>		The Sun Ch. 14.2
Week 6 (Feb. 18-22)	The Sun Ch. 14.3		The Sun TBD (video?)		The Stars Ch. 15.1
Week 7 (Feb. 25 - Mar. 1)	The Stars Ch. 15.2, 15.3		How Stars are Born Ch. 16.1, 16.2, 16.3		How Stars Evolve Ch. 17.1, 17.2
Week 8 (Mar. 4-8)	How Stars Evolve Ch. 17.3, 17.4		How Stars Die Ch. 18.1, 18.2		Spacetime & Relativity Ch. S2
Week 9 (Mar. 11-15)	Spacetime... Ch. S3	<i>Exam Prep Session</i>	<i>Midterm Exam 2</i>		FISKE PLANETARIUM
Week 10 (Mar. 18-22)	Spacetime & Black Holes Ch. S3, 18.3, 18.4		Black Holes	Our Galaxy Ch. 19.1	Our Galaxy Ch. 19.1, 19.2
Spring Break (Mar. 25-29)					
Week 11 (Apr. 1-5)	Our Galaxy Ch. 19.3, 19.4		Other Galaxies Ch. 20.1, 20.2 (up to p. 614)		Galaxy Evolution Ch. 21.1, 21.2, 21.3
Week 12 (Apr. 8-12)	How the Universe was Born Ch. 20.2 (p. 615-), 20.3		How the Universe was Born Ch. 22.1		How the Universe was Born Ch. 22.2
Week 13 (Apr. 15-19)	Universe... Ch. 22.3	<i>Exam Prep Session</i>	<i>Midterm Exam 3</i>		Fate of the Universe Ch. 22.3, 23.1, 23.2
Week 14 (Apr. 22-26)	Fate of the Universe Ch. 23.3, 23.4		Fate... Ch. 23.4	Life... Ch. 24.1	Life in the Universe Ch. 24.2, 24.3
Week 15 (Apr. 29 - May 1)	Life in the Universe Ch. 24.4, 24.5		Life...	<i>Final Exam Prep</i>	Reading day, no classes
Finals Week (May 4-8): our final date/time is TBD					

CLASS POLICIES

You are all mature and responsible adults, and I'll do my best to treat you with respect. On your part, I hope you will do the same for your peers and instructors. For example:

- Please show up to class on time, and be ready to learn when class starts.
- Please don't leave class early, and don't start packing up before class is dismissed. If you know you'll need to leave early, please sit near the back of the room and leave as quietly as possible.
- **Laptops and tablets** can be used in class *ONLY* for note-taking, but it is discouraged. If you use a laptop, you need to sit on the left side of the room in the front three rows, to minimize the distraction to others. ("*Laptops on the Left.*")
- **Phones** should not be used in class for any reason (this includes texting).

I try to provide a positive and supportive learning environment for everyone, and it's always helpful for me to hear what works best for you.

ACADEMIC INTEGRITY

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the [academic integrity policy](#) and [Honor Code](#) of this institution. Violations of this policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu; 303-492-5550). Students who are found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the [Honor Code Office website](#).

What constitutes plagiarism / cheating?

While I encourage you to discuss the assignments and topics with your fellow students, the answers you submit must be your own independent work. If you do collaborate with other students, a good time to split off from the group is when you start to write up your answers. Use the motto "**work together, write separately**" to guide your actions. Every semester, we receive a number of homeworks with nearly-identical answers. When those are found, both students will receive zero credit for the entire assignment and may be reported to the Honor Code Office. Don't be that person!

In written work (essays), it is expected that you utilize outside sources in your research. Quoting sources is acceptable with proper attribution, however copy/pasting text from another source as your own is plagiarism and constitutes serious academic misconduct.

ACCESSIBILITY AND LEARNING NEEDS

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment, but please contact me to discuss how I can help even for conditions not on their list. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or by email at dsinfo@colorado.edu for further assistance. If you have a temporary medical condition

or injury, see the guidelines for [Temporary Medical Conditions](#) on the Disability Services website.

RELIGIOUS OBSERVANCES

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments, or required attendance. If you have religious obligations that result in schedule conflicts, please contact me in the first two weeks of class to make alternate arrangements. For full details, see the [campus policy regarding religious observances](#).

DISCRIMINATION AND HARASSMENT

The University of Colorado Boulder (CU Boulder) is committed to fostering a positive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (including sexual assault, exploitation, harassment, dating or domestic violence, and stalking), discrimination, and harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or by email at cureport@colorado.edu. Information about the OIEC, university policies, [anonymous reporting](#), and the campus resources can be found on the [OIEC website](#). Please know that faculty and instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

CLASSROOM BEHAVIOR

Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. For more information, see the policies on [classroom behavior](#) and the [Student Code of Conduct](#).

READING FOR FIRST DAY OF CLASS

“Disorientation”

a Twitter poem, by Dr. Katherine Mack ([@AstroKatie](#))

1. I want to make you dizzy.
I want to make you look up into the sky and comprehend, maybe for the first time, the darkness that lies beyond the evanescent wisp of the atmosphere, the endless depths of the cosmos, a desolation by degrees.
2. I want the Earth to turn beneath you and knock your balance off, carry you eastward at a thousand miles an hour, into the light, and the dark, and the light again. I want you to watch the Earth rising you up to meet the rays of the morning Sun.
3. I want the sky to stop you dead in your tracks on your walk home tonight, because you happened to glance up and among all the shining pinpricks you recognized one as of the light of an alien world.
4. I want you to taste the iron in your blood and see its likeness in the rust-red sands on the long dry dunes of Mars, born of the same nebular dust that coalesced random flotsam of stellar debris into rocks, oceans, your own beating heart.
5. I want to reach into your consciousness and cast it outward, beyond the light of other suns, to expand it like the universe, not encroaching on some envelope of emptiness, but growing larger, unfolding inside itself.
6. I want you to see your world from four billion miles away, a tiny glint of blue in the sharp white light of an ordinary star in the darkness. I want you to try to make out the boundaries of your nation from that vantage point, and fail.
7. I want you to feel it, in your bones, in your breath, when two black holes colliding a billion light years away sends a tremor through spacetime that makes every cell in your body stretch, and strain.
8. I want to make you nurse nostalgia for the stars long dead, the ones that fused your carbon nuclei and the ones whose last thermonuclear death throes outshined the entire galaxy to send a single photon into your eye.
9. I want you to live forward but see backward, farther and deeper into the past, because in a relativistic universe you don't have any other choice. I want the stale billion-year-old starlight of a distant galaxy to be your reward.
10. I want to utterly disorient you and let you navigate back by the stars. I want you to lose yourself, and find it again, not just here, but everywhere, in everything.
11. I want to make you wonder what is out there. What dreams may come in waves of radiation across the breadth of an endless expanse. What we may know, given time, and what splendors might never, ever reach us.
12. I want to make it mean something to you. That you are *in* the cosmos. That you are *of* the cosmos. That you are born from stardust and to stardust you will return. That you are a way for the universe to be in awe of itself.