

# 33-778

Basics:

Class Place: <https://cmu.zoom.us/j/94971708264?pwd=V3lBM3JETGowUm1QS2RYUVRaFkyZz09>

Note: Zoom link includes embedded password. The room is set to record automatically for all meetings.

Class Days/Times: Tuesday and Thursdays, 3:20-4:40pm Eastern Time

Instructors: Rachel Mandelbaum, Scott Dodelson

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Office: 8402, 7325 Wean Hall

Phone: 412-268-1714, 412-268-5432

Office hours: Given that this is a remote class, virtual office hours will be by appointment rather than at a fixed day/time.

Rachel is teaching the first half of the course and Scott is teaching the second half. Please contact whoever is teaching at any given time with questions/concerns (you don't have to reach out to both unless it's for a general question about the course, e.g. questions about enrolling). Also note that the above Zoom link may change once Scott starts teaching.

Course Description and Material Covered:

This is the second graduate course for students interested in cosmology, with the first being Introductory Astrophysics (33-777). The goal is to provide a more complete coverage of cosmology (which is covered for just a few weeks in 33-777).

Overview of the Concordance Cosmology (Chapter 1)

Homogeneous Expanding Universe (2)

Boltzmann/Einstein Equations (3)

Homogeneous Universe In the Past: BBN, CMB, and WIMPs (4)

Perturbations (5,6)

Inflation (7)

Large Scale Structure and the CMB (8,9)

Probes (10-13)

Analysis and Inference (14)

Course goals:

Students will develop an understanding of diverse concepts in cosmology, and the physics that governs them. By the end of the semester, students should be able to do all of the following:

- State the basic physical principles that are relevant for the aforementioned physical systems, and derive equations by applying those principles;
- Solve physical equations analytically and numerically, sometimes with the aid of basic mathematical software like Mathematica or Python packages such as NumPy or SciPy;
- Visualize quantitative results using plotting software like gnuplot or matplotlib; and
- Understand some of the scientific discussion in journal articles and astrophysics seminars.

What is required of you:

Weekly readings: We will be using the 2nd edition of "Modern Cosmology," by Fabian Schmidt and Scott Dodelson.

Homework: Most of the problems will come from the book. There will be roughly 3-5 problems per week.

Attend Class: Class will be recorded and shared once the recording is available, along with a PDF with any written notes shared during class.

Exams: There will be a final exam.

Grading

Homeworks will constitute 60% of the grade, the final exam 30%, and class participation the remaining 10%.

The cutoffs for grades are  $> 90\%$ ,  $80 - 90\%$ ,  $70 - 80\%$ ,  $60 - 70\%$ , and  $< 60\%$  for A, B, C, D, and F respectively.

## Communication

The course will use Canvas for distribution of assignments, announcements, etc. - but we'll use Piazza for discussion. Rather than emailing questions about material, I encourage you to post your questions on Piazza (anonymously, if you wish). The Q&A site is very handy and students can also answer or comment on each others' questions.

## Accommodations for Students with Disabilities:

If you have a disability and are registered with the Office of Disability Resources, we encourage you to use their online system to notify us of your accommodations and discuss your needs with us as early in the semester as possible. We will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, we encourage you to contact them at [access@andrew.cmu.edu](mailto:access@andrew.cmu.edu).

## Academic Integrity:

Students are welcome and encouraged to discuss the homework assignments but should ensure that the details of the solutions they submit are their own.

## Statement of Support for Students' Health & Well-being

Take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit <http://www.cmu.edu/counseling>. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

## Diversity statement

We must treat every individual with respect. We are diverse in many ways, and this diversity is fundamental to building and maintaining an equitable and inclusive campus community. Diversity can refer to multiple ways that we identify ourselves, including but not limited to race, color, national origin, language, sex, disability, age, sexual orientation, gender identity, religion, creed, ancestry, belief, veteran status, or genetic information. Each of these diverse identities, along with many others not mentioned here, shape the perspectives our students, faculty, and staff bring to our campus. We, at CMU, will work to promote diversity, equity and inclusion not only because diversity fuels excellence and innovation, but because we want to pursue justice. We acknowledge our imperfections while we

also fully commit to the work, inside and outside of our classrooms, of building and sustaining a campus community that increasingly embraces these core values.

Each of us is responsible for creating a safer, more inclusive environment.

Unfortunately, incidents of bias or discrimination do occur, whether intentional or unintentional. They contribute to creating an unwelcoming environment for individuals and groups at the university. Therefore, the university encourages anyone who experiences or observes unfair or hostile treatment on the basis of identity to speak out for justice and support, within the moment of the incident or after the incident has passed. Anyone can share these experiences using the following resources:

Center for Student Diversity and Inclusion: [csdi@andrew.cmu.edu](mailto:csdi@andrew.cmu.edu), (412) 268-2150

Report-It online anonymous reporting platform: [www.reportit.net](http://www.reportit.net) username: tartans password: plaid

All reports will be documented and deliberated to determine if there should be any following actions. Regardless of incident type, the university will use all shared experiences to transform our campus climate to be more equitable and just.