Foundations of Modern Cosmo
PHYS 6368 001C
Physics Department
Spring 2023

Instructor Information

Instructor: Joel Meyers
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Office Hours:
By appointment
Preferred Method of Contact:
Email

Course Details

Meeting Days/Times/Locations:

Start Date	End Date	Location	Meeting Day	Start Time	End Time
01/17/2023	05/02/2023	EMBY0129	TR	09:30 AM	10:50 AM

Credit Hours: 3.00
Course Description: Principles and concepts of modern cosmology including the geometry of the universe, cosmological models, nucleosynthesis, inflation, dark energy, dark matter, the cosmic microwave background and baryonic acoustic oscillations. Prerequisites: MATH 2339 and MATH 2343 or equivalent.

Student Learning Outcomes

Course Objectives (4368/6368): After taking this course, all students should be able to:

- Identify and explain the observational evidence in favor of the big bang model of cosmology
- Understand the expansion history of the universe

- Describe the thermal history of the universe
- Outline the motivation for and principles of cosmic inflation
- Explain the context and goals of modern cosmological surveys

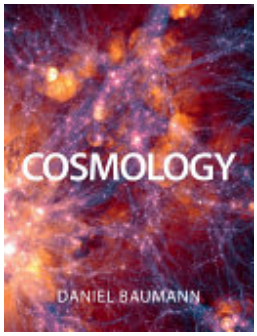
Course Objectives (4368): Undergraduate students should be able to:

- Interpret and discuss outstanding issues in modern cosmology
- Investigate and report on a cosmology-related topic not directly covered in class

Course Objectives (6368): Graduate students should be able to:

- Apply techniques of general relativity to solve problems in cosmology
- Distinguish the physical effects of changes to cosmological parameters

Required Texts and Materials



Cosmology
ISBN: 9781108838078
Authors: Daniel Baumann
Publisher: Cambridge University Press
Publication Date: 2022-06-30

Grading Policies/Grading Scale

Grades will be based on the following:

- Homework - 30%
- Quizzes - 20%
- Midterm exam - 20%
- Final project - 30%

Grading Scale: Final grades will be assigned according to the following scale, though grades may be adjusted upward (never downward) at the discretion of the instructor. For example, a final score of 83.1 would earn a B in the course, but it may be adjusted to an A- with a particularly good final project performance.

Letter Grade	Score Range
A	93-100
A-	90-93
B+	87-90
B	83-87
B-	80-83
C+	77-80
C	73-77
C-	70-73
D+	67-70
D	63-67
D-	60-63
F	0-60

Assignment Group Descriptions

Homework: Students are allowed and encouraged to work in groups on homework, but each student must submit unique and individual answers to be graded. Undergraduate students will typically have fewer and less demanding problems to complete than graduate students. All homework will be submitted electronically via Canvas. Homework submitted after the due date will be receive a score reduction of 10% per day late and will receive no credit after solutions are posted. Students enrolled in 6368 will be asked to complete more challenging problems than students in 4368.

Quizzes: Short quizzes will be sent out to be submitted on Canvas before the start of each class. Some will test basic concepts from previous lectures and readings. Others will be ungraded (I.e. full credit will be given for any attempt) and will be used to assess background knowledge before beginning a new topic. Quiz solutions will be discussed at the beginning of each class, and therefore late quiz submissions will not be accepted. The lowest 2 quiz scores will be dropped (including quizzes that are not submitted by the deadline).

Midterm Exam: There will be a take-home midterm exam to be submitted via Canvas by Friday March 10. Students may use their course notes, the Baumann lecture notes, and any textbook, but may not search for answers on the internet nor collaborate with others. Students must work alone and submittheir own solutions on the exam. Students enrolled in 6368 will be asked to complete more challenging problems than students in 4368.

Final Project: Each student will be required to give a presentation of a topic relevant to modern cosmology for the instructor and all other students in the course (4368: 15 minutes, 6368: 20

minutes). More details and a suggested topic list will be provided later in the semester. The project will take place in several phases:

- Select a topic to be approved by instructor
- Submit outline of presentation
- Submit draft slides
- Deliver presentation
- Respond to all student and instructor questions and post final revised video

Course Policies

Topics to be covered:

- Introduction to General Relativity
- The homogeneous Universe
- Dynamics of expansion
- Thermal history of the Universe
- Cosmological nucleosynthesis
- The cosmic microwave background
- Dark matter
- Dark energy
- Cosmic inflation
- Sketch of cosmological perturbation theory

Logistics: Canvas will be the main hub for the course. It is where quizzes, reading assignments, homework, exams, lecture notes, and videos will be posted. All graded work will be submitted electronically through Canvas. It is recommended that you enable Canvas alerts to ensure that you are aware when quizzes and assignments are posted.

Course Flow: Most class periods will begin with a discussion of the quiz that was assigned before class. Students will be asked to provide answers and to ask for clarification in class about the concepts covered on each quiz. This is an opportunity to solidify knowledge and review recently covered concepts and to introduce basic ideas about new topics that will cover next. After discussion of the quiz and a brief review of the previous class period, we will begin the lecture portion of the course. It is important that students complete reading assignments in advance, since the readings will contain more details than can be covered in class. Students are strongly encouraged to ask questions in class, where the answers can benefit everyone.

Title IX and Disability Accommodations

Disability Accommodations

Students who need academic accommodations for a disability must first register with Disability Accommodations & Success Strategies (DASS). Students can call 214-768-1470 or visit smu.edu/DASS to begin the process. Once they are registered and approved, students then submit a DASS Accommodation Letter through the electronic portal, *DASS Link*, and then communicate directly with each of their instructors to make appropriate arrangements. Please note that accommodations are not retroactive, but rather require advance notice in order to implement.

Sexual Harassment

All forms of sexual harassment, including sexual assault, dating violence, domestic violence and stalking, are violations of SMU's Title IX Sexual Harassment Policy and may also violate Texas law. Students who wish to file a complaint or to receive more information about the grievance process may contact Samantha Thomas, SMU's Title IX Coordinator, at accessequity@smu.edu or 214-768-3601. Please note that faculty and staff are mandatory reporters. If students notify faculty or staff of sexual harassment, they must report it to the Title IX Coordinator. For more information about sexual harassment, including resources available to assist students, please visit smu.edu/sexualmisconduct.

Pregnant and Parenting Students

Under Title IX, students who are pregnant or parenting may request academic adjustments by contacting the Office of Student Advocacy and Support by calling 214-768-4564. Students seeking assistance must schedule an appointment with their professors as early as possible, present a letter from the Office of the Dean of Students, and make appropriate arrangements. Please note that academic adjustments are not retroactive and, when feasible, require advance notice to implement.

Academic Policies

Religious Observance

Religiously observant students wishing to be absent on holidays that require missing class should notify their professors in writing at the beginning of the semester and should discuss with them, in advance, acceptable ways of making up any work missed because of the absence. Click here for a list of holidays.

Medical-Related Absences

To ensure academic continuity and avoid any course penalties, students should follow procedures described by their instructors in order to be provided with appropriate modifications to assignments, deadlines, and exams.

Excused Absences for University Extracurricular Activities

Students participating in an officially sanctioned, scheduled university extracurricular activity should be given the opportunity to make up class assignments or other graded assignments that were missed as a result of their participation. It is the responsibility of the student to make arrangements for make-up work with the instructor prior to any missed scheduled examinations or other missed assignments. (See current Catalog under heading of "Academic Records/Excused Absences.")

Final Exams

Final course examinations shall be given in all courses where appropriate, and some form of final assessment is essential. Final exams and assessments must be administered as specified in the official examination schedule. Exams cannot be administered or due during the last week of classes or during the Reading Period. Syllabi must state clearly the form of the final exam or assessment, and the due date and time must match the official SMU exam schedule. Final exams are not required to be provided online.

Academic Dishonesty

Students are expected to embrace and uphold the SMU Honor Code. Violations of the Honor Code will be acted upon in accordance with the policies and procedures outlined in the Mustang Student Handbook.

Student Support Services

Student Academic Success Programs

Students needing assistance with writing assignments for SMU courses may schedule an appointment with the Writing Center through Canvas. Students who would like support for subject-specific tutoring or success strategies should contact SASP, Loyd All Sports Center, Suite 202; 214-768-3648; smu.edu/sasp.

Caring Community Connections Program

CCC is a resource for anyone in the SMU community to refer students of concern to the Office of the Dean of Students. The online referral form can be found at smu.edu/deanofstudentsccc. After a referral form is submitted, students will be contacted to discuss the concern, strategize options, and be connected to appropriate resources. Anyone who is unclear about what steps to take if they have concerns about students should contact the Office of the Dean of Students at 214-768-4564.

Mental Health Resources: On-Call and Ongoing Counseling Services

Throughout the academic year, students may encounter different stressors or go through life experiences which impact their mental health and academic performance. Students who are in distress or have concerns about their mental health can schedule a same-day or next-day appointment to speak with a counselor by calling Counseling Services. Counselors are available at any time, day or night for students in crisis at this number: 214-768-2277 (then select option 2) They will be connected with a counselor immediately. Students seeking ongoing counseling should call the same number (214-768-2277, then select option 1) during normal business hours to schedule an initial appointment.

Campus Carry Law

In accordance with Texas Senate Bill 11, also known as the 'campus carry' law, and following consultation with entire University community, SMU chooses to remain a weapons-free campus. Specifically, SMU prohibits possession of weapons (either openly or in a concealed manner) on campus. For more information, please see: smu.edu/campuscarrylaw.

Course Schedule

Week	Topics	Textbook Sections
1	Overview and General Relativity	Preface, Appendix A
2	Homogeneous Isotropic Spacetime	1.1
3	Distance, Time, Redshift	1.2
4	Dynamics of Expansion	1.3
5	Thermal History	3.1
6	Equilibrium Thermodynamics	3.2
7	Departure from Equilibrium	3.3
8	DM Freezeout, BBN,	3.3

	Recombination	
9	Cosmic Inflation	2.1-2.2
10	Dynamics of Inflation	2.3
11	Cosmological Perturbations	4.1-4.2
12	Perturbation Dynamics	4.3-4.5
13	Structure Formation	5.1
14	Cosmic Sound and CMB Anisotropies	5.2-5.3