

Cosmology

SPCS Summer Institutes 2019

Session 1: June 24–July 12

Course Website: ekitanidis.github.io/cosmo-spcs

Course Description and Goals:

This course aims to provide a solid foundation of the fundamental principles of modern cosmology, while also exposing students to cutting-edge developments in the field. Topics include the Big Bang, inflation, dark energy, dark matter, the growth of large-scale structure, the formation and evolution of galaxies, the cosmic microwave background, and current research topics.

Cosmology means “study of the universe” - its origin, history, and fate. That’s a lot of ground to cover in 3 weeks! Rather than attempt an exhaustive survey of all possible topics, we will focus on the core ideas that form the basis of the Standard Model of Cosmology. This model has been remarkably successful, yet has several major gaps; we will critically examine its evidence, explore extensions and alternative theories, and learn about active areas of research.

Prerequisites

This course assumes no prior knowledge of calculus. However, familiarity with algebra, trigonometry, and the basic concepts of vectors and matrices is expected.

Course Format and Expectations

Morning lectures will go over key ideas and derivations. Afternoon sessions will be interactive; students will work in small groups, supervised by TAs, on problems that deepen, expand, enrich, and solidify the concepts explored in the morning lectures. Afternoon sessions will sometimes take other formats as well, including field trips and guest lectures.

At the end of the course, students will receive a letter of evaluation. I expect to write a glowing letter for any student who makes a sincere and committed effort to engage with the material, contribute in class, and challenge themselves!

Final Presentation

Students will choose a special topic in cosmology to delve into more deeply and give a 10 minute slide presentation on the last two days of class. A list of suggested topics will be made available, though students are also free to pick something not on the list. Topics should be

self-contained in scope and technicality. Students will meet with the instructor to ensure their choice of topic is appropriate, and will be guided by the TAs throughout the process.

Schedule of Topics

	Topics
Week 1	The Structure and Contents of the Universe
Day 1 {6/24}	<i>Arrival Day</i>
Day 2 {6/25}	Introductions
Day 3 {6/26}	A few key ideas from special and general relativity
Day 4 {6/27}	Cosmic dynamics, dark energy and dark matter
Day 5 {6/28}	Measuring cosmic ages and distances
Week 2	The Cosmic Timeline, from the Big Bang to Today
Day 1 {7/1}	The early universe, from the Big Bang to the first stars and galaxies
Day 2 {7/2}	The Cosmic Microwave Background
Day 3 {7/3}	The growth of large-scale structure and galaxy formation
Day 4 {7/4}	The Standard Model
Day 5 {7/5}	Modern observational cosmology
Week 3	The Future of Cosmology
Day 1 {7/8}	The future of cosmology
Day 2 {7/9}	The future of cosmology
Day 3 {7/10}	<u>Final presentations</u>
Day 4 {7/11}	<u>Final presentations</u>
Day 5 {7/12}	<i>Departure day</i>