USC Dornsife
Dana and David Dornsife
College of Letters, Arts and Sciences

ASTR-740 "Selected Topics in Astrophysics"

Units: 3

Instructor: Elena Pierpaoli, pierpaol@usc.edu , SHS 371, tel: (213)740-1117
Office hours: Tue 11:30 am -12:30 pm or by arrangement
Times and location: Tue-Thu from 10 to 11:15 am in VKC 103
Updated information about the course: see the blackboard site: https://blackboard.usc.edu/

Course description (topics): linear perturbation theory, dark matter, dark energy, the cosmic microwave background, inflation, galaxy and galaxy cluster surveys, non-linear perturbations, high-order statistics, gravitational lensing, concepts of data analysis.

Expanded Course description:
This course is for graduate students who want to have a thorough understanding of the main issues currently at the forefront of research in cosmology.
We will discuss important topics such as the origin of perturbations, models of dark matter and dark energy, secondary perturbations and their implication for cosmology. In addition, we will also discuss theory—data comparison and the statistical aspects of data analysis relevant in cosmological parameter estimation.

Learning objectives: On completion of the course, students should:

- Be informed of the current status of research and open questions on topics areas covered during the course.
- Connect facts and theory, and quickly evaluate if a research idea in the area of cosmology is valuable or cannot be pursued.
- Be able to assess which observables should be used to constrain a particular theoretical scenario (e.g. cosmological model, a specific dark matter candidate, a model for inflation)
- Communicate effectively their scientific ideas and arguments to peers
- Read with competence and fluidity, and understand well, research papers in cosmology

Pre-requisites: Formally, Astr540 is a requirement for this course. However, any equivalent experience may be sufficient. Please contact the instructor if you are interested in attending the course and never took Astr540.

Textbooks: We will use various chapters from the following books:

1) "Cosmological physics" J. Peacock [P]
2) "Modern Cosmology" by S. Dodelson [D]
3) "The primordial density Perturbation: Cosmology, Inflation and the origin of Structure " D. Lyth & A.Liddle [LL]
4) "Particle dark matter: Observations, models and searches " by G.Bertone [B]
5) "Extragalactic Astronomy and Cosmology:An introduction" P. Schneider [S]

We will supplement it with various readings linked to the blackboard webpage.

Some exercises will be assigned using the following book:
1) "Cosmology and Astrophysics through problems" by T. Padmanabhan

Grading:
Homework 0%
Classroom work and interaction: 15%
2 Midterm Exams @ 25% each : 50%
Final presentation of special topic: 35%

Grading type will be letter grade.
In class participation (asking of and answering questions, taking part in discussions, etc.) is strongly encouraged in general, and is in fact expected. Your final grade will take this into account.

General USC grading policies, Incompletes: Please see the "Grading and Correction of Grades" handbook:
http://www.usc.edu/dept/ARR/private/forms/Handbooks/Grade_Handbook_rev082010.pdf

Course Notes: Lectures will mainly be standard blackboard lectures with exercises, but slides, images and videos will be used when appropriate. In such case, they will be posted on the course site. Students are expected to take their own hand-written notes.
Students will need computer access and standard software to access the slides and images/videos in order to study.

Homework policy: There will be homework assignments during the course (approximately once a week). Assignments may consist in standard exercises on what explained in class, but they may consist in critical reading and answering questions.
The answer may require some calculations (either analytical or simple numerical ones). The assignments will not be graded, but selected problems will be solved

by the students in class after the assignment due date. This will contribute to the grade of classroom work and interaction.

Exam policy: No late exams will be accepted. For -very- serious (and proved) health related reasons, special arrangement may be done to make the exam on a different date. Exam dates are provided at this time. Please make sure you schedule your flights home, vacations, etc. accordingly.
The final presentation schedule will be decided at the beginning of the course.

You may use a simple (non-programmable) calculator during the exams.
The exam will be closed books. There will be a text available on the instructor's desk for consultation of necessary formulas and constants' numerical values.

Collaboration policy: NO collaboration is allowed for the final and midterm exams. As for the homework, you are encouraged to discuss the problems with other students. While scientific advancement is based on communication, and therefore you should learn how to communicate your scientific ideas, you should also make sure you do so by following the guidelines for Academic Integrity given below.

Attendance: Attendance is not mandatory, but a grade is also given for in class participation. Students are strongly encouraged to attend classes on a regular basis and participate in class work.
The course will offer various opportunities of class participation. These are designed to facilitate students' learning and optimize the use of your time in learning the material presented.

Communication policy: Students are welcome to contact the instructor by email or in person for any issue. Please allow for up to a full working day in order to receive the reply. Students are encouraged to look on the course website or ask other colleagues information relative to material covered during missed classes and relative assignments.

Classroom policy: Electronic communication devices (phones, blackberries, and similar) must be turned off or placed away during lectures and laboratories. You can check them at the break. Likewise, you should not use instant messenger or similar chat programs during lectures or labs. It is appreciated if you avoid having your lunch during class.

Statement for Students with Disabilities: Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.-5:00 p.m., Monday through Friday. Website and contact information for DSP:
http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html,

(213) 740-0776 (Phone), (213) 740-6948 (TDD only), (213) 740-8216 (FAX) ability@usc.edu.

Statement on Academic Integrity: USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. SCampus, the Student Guidebook, (www.usc.edu/scampus or http://scampus.usc.edu) contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A.

Emergency Preparedness/Course Continuity in a Crisis: In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies.

Course Schedule: A Weekly Breakdown

	Topics/Daily Activities	Readings and Homework	Deliverable/ Due Dates
Week 1 8/25-28	Boltzmann equations	D4	
Week 2 9/2-4	Einstein's equations	D5	
Week 3 9/ 9-11	Initial conditions	D6	
Week 4 9/16-18	Inhomogeneities, matter power spectrum, CMB primary anisotropies	D7-8	
Week 5 9/23-25	Dark Matter: particle physics models, astrophysical evidences, indirect detection and constraints	Selected readings from part II and V of B	TUE: FIRST MIDTERM EXAM
Week 6 9/30-10/2	Inflation: slow roll and multi-field dynamics, Reheating, phase transitions, generation of field perturbation	LL18.1-18.7 LL 20.1-20.2, LL21.1-21.7 LL24.1-24.8	
Week 7 10/7-10/9	Dark energy: evidences and theoretical modeling .Modified gravity models	LL7.6.3, LL19.1-19.5 B6	
Week 8 10/14-16	What we have learned from CMB observations in Cosmology	WMAP and Planck papers – posted on blackboard	
Week 9 10/21-23	Structure formation: spherical collapse model , Press-Schechter theory, number counts	S7.5, D9.5	
Week 10 10/28-30	Galaxy clusters : physical properties and cosmological use	S6, papers posted in blackboard	
Week 11 11/4-6	Matter inhomogeneities: galaxy surveys, bispectrum and three point function	Reading from papers posted on blackboard.	TUE: SECOND MIDTERM EXAM
Week 12 11/11-13	Other probes of inhomogeneities: peculiar velocities	D9.2, P16.10	
Week 13 11/18-20	Non gaussianities: primordial ones and non-linear evolution of the fluctuations The Cosmic Microwave Background: secondary aniosotropies, matter-CMB cross correlation	LL10.9, LL24.4 Plus papers posted on blackboard	
Week 14 11/25	Students' presentations		
Week 15 12/2-4	Students' presentations		
			Date: For the date and time of the final for this class, consult the USC *Schedule of Classes* at www.usc.edu/soc.