Astronomy 622 - Fall 2023
"Cosmology"

Instructor: Prof. Massimo Ricotti
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Phone: (301) 405 5097
Office hours: by appointment
Textbook: "Cosmology" by Peter Cole and Francesco Lucchin (not mandatory, other notes available)
Class web page: `http://www.astro.umd.edu/~ricotti/NEWWEB/teaching/ASTR622-23.html`

Schedule

Lectures on Tuesday and Thursday from 12:30pm to 1:45pm
Room ATL 0201

Course Description

The evolution of the Universe from the Big-Bang to the era of stars and galaxies. The course is divided in two main parts. Part I: the linear evolution of the Universe. Part II: the non-linear growth of perturbations and galaxy formation. Part I covers (i) Inflation, (ii) baryogenesis, (iii) thermal history and neutrino decoupling, (iv) nucleosysnthesis, (v) recombination and radiation decoupling, (vi) CMB radiation, (vii) growth of cosmological perturbation, (viii) CMB anisotropies. Part II covers: (i) measuring cosmological parameters, (ii) Large scale structure and galaxy formation.

Textbooks

NOTE: all these books are not mandatory and you can study on resources I will make available on ELMS. But if you want to own a book with topics similar to the ones covered in class, here you will find a few recommendations.

Recommended book:
Cosmology
Authors: Peter Coles and Francesco Lucchin
ISBN: 13-978-0471489092

Another book I suggested last year:
Galaxy Formation and Evolution
Authors: Houjun Mo, Fan van den Bosch, Simon White
ISBN: 13-978-0521857932

I have developed my own lecture notes, but many topics can be found on the recommended books. I will also post on ELMS pdf files of lecture notes from other published Cosmology course

Course Grading

Weekly Quiz (ELMS)	20%
Homework (4 HW: roughly one every 2 weeks)	25%
Midterm Exam	20%
Final Exam	20%
Term Project	15%

Weekly Quiz: These are multiple choice quizes on ELMS (automatically graded). Typically 5 short questions on either concepts covered in class or short calculations. There will be a quiz per week due on Tue before the beginning of each class. The quiz should become available for you to work on it on Wed the week before it is due.

Homework: There will be one in-class Midterm exam and an in-class Final (the dates of the exams are shown below in the "Tentative course outline" section). Class participation is strongly encouraged. Class attendance is instead required. During the semester I will hand out 4 homework; their due dates will be announced at the time they are assigned. On the due date the students will be expected to turn in their homework in class.

The homework turned in will be graded and returned to the students with solutions and the solution may be discussed in class. In case of well motivated circumstances a late homework will be accepted, but a penalty (that will be gradually more severe depending on number of days the homework is late) will be applied to the grade. After the solution is published I will not accept a late homework. A missed homework will receive a "zero" grade and there will not be extra credit or dropping of the lowest grade.

I will post the homework assignments, solutions and grades on ELMS.

Term Project: Each of you will write a term paper on a cosmology topic of your choice. At the end of the semester you will give a short presentation. More information on the format and possible topics of the term project will be revealed during the semester.

Exams: The exams will be closed book, but calculators will be allowed. University regulations will apply regarding academic honesty and excused absences.

The midterm and final exams are a "major scheduled grading event" and is covered by the relevant rules for excused absence (see the following link: `https://www.ugst.umd.edu/V-1.00(G).html`). See also the addendum on ELMS under Syllabus.

If you are not able to take an exam due to illness or other legitimate reasons, you must make every reasonable attempt to contact me on or before the day of the exam either by email or voice mail. In addition, you must provide documentation detailing the reason for your absence. A self-signed note is insufficient. A make up exam must be taken promptly. I will give at most one make-up exam. If, for whatever reason, the University is officially closed on the day of the exam, the exam will be re-scheduled for the next lecture date.

The final exam will cover all material discussed in this course after the midterm exam.

Letter Grades

97%-100%	A+
94%-97%	A
90%-94%	A-
87%-90%	B+
84%-87%	B
80%-84%	B-
77%-80%	C+
74%-77%	C
70%-74%	C-
60%-70%	D
<60	F

I may rescale the grades depending on the average class performance. The rescaling can only increase your final grade.

Code of Academic Integrity

"The University of Maryland, College Park has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit `https://studentconduct.umd.edu/`."

Course expectations

Attendance: Attendance in class is crucial. A major part of this course will center around in-class discussions. Simply getting hold of the lecture notes will not allow you to be successful in this course. In the event of an emergency where you have to miss class, you must make sure that you complete all of the assigned reading, get hold of any lecture notes, and see me in my office hours.

Preparation: I expect you to be prepared to work. We will be covering some fascinating but challenging concepts - you will understand this material much more easily if you preview the recommended reading material ahead of time, as well as giving it a more careful read after the lecture. You also should review your class notes sometime before the next lecture to make sure everything is clear. I encourage you to ask questions in the lectures or during my office hours.

Study Habits: Study wisely and ask for help if you need it. It is better to keep up with the material on a daily basis than cram the night before the exam. I encourage you to chat about problems with your friends and classmates – you will learn a huge amount from trying to explain confusing issues to each other. However, please keep in mind that all graded materials, including class-assignments and home-works, must be your own thoughts in your own words.

Course Evaluation

Your participation in the evaluation of courses through CourseEvalUM is a responsibility you hold as a student member of our academic community. Your feedback is confidential and important to the improvement of teaching and learning at the University. Please go directly to the website `https://www.courseevalum.umd.edu` to complete your evaluations. By completing all of your evaluations each semester, you will have the privilege of accessing online, at Testudo, the evaluation reports for the thousands of courses for which 70% or more students submitted their evaluations.

Course Policies

You can find updated information on Course Related Policies at `https://www.ugst.umd.edu/courserelatedpolicies.html`.

Students With Disabilities

Students who would like to request academic accommodations for a disability should notify the professor at the beginning of the semester and should also register with Disability Support Services: `http://www.counseling.umd.edu` (phone: 301.314.7682).

Tentative Course Outline - *28 lectures & 2 exams*

Part I: Linear Universe - 19 lectures

A. Cosmological Principles, Geometry and Dynamics - *8 lectures*

1. **Tue Aug. 29**: Introduction, course overview
2. **Thu Aug. 31**: Cosmological principle, Hubble's law, redshift, ages, particle horizon
3. **Tue Sep. 5**: Robertson Walker metric and GR (Homework 1 assigned)
4. **Thu Sep. 7**: Proper and comoving distances, luminosity distance, angular diameter distance
5. **Tue Sep. 12**: Cosmological Field Equations, Newtonian approach
6. **Thu Sep. 14**: Cosmological Field Equations and their evolution
7. **Tue Sep. 19**: Cosmological Field Equations and their evolution, flat cosmologies (cont) (Homework 1 due)
8. **Thu Sep. 21**: Problems of the standard model, Hot Big Bang, singularity, Planck time

B. Thermal History and Linear Growth of Perturbations - *11 lectures*

1. **Tue Sep. 26**: Kinetic theory in expanding Universe and thermal history,neutrino decoupling (Homework 2 assinged)
2. **Tue Oct. 3**: Models of Inflation, Reheating and Baryogenesis

3. **Thu Sep. 28**: Phase transitions, Inflation and origin of structures problem
4. **Tue Oct. 3**: Models of Inflation, Reheating and Baryogenesis
5. **Thu Oct. 5**: Big Bang Nucleosynthesis (BBN)
6. **Tue Oct. 10**: Recombination, decoupling and reionization (Homework 2 due)
7. **Thu Oct. 12**: The Cosmic Microwave Background (CMB)
8. **Tue Oct. 17**: Theory of structure formation (Jean theory) (Homework 3 assigned)
9. **Thu Oct. 19**: Gravitational instability in expanding Universe
10. **Tue Oct. 24**: Multi-fluid equations

    Thu Oct. 26: *Midterm exam*
11. **Tue Oct. 31**: Transfer function and power spectrum of matter perturbation (Homework 3 due)
12. **Thu Nov. 2**: CMB anisotropies

Part II: Large Scale Structures and Galaxy Formation - 9 lectures

1. **Tue Nov. 7** Top-hat collapse, virialization (Homework 4 assigned)
2. **Thu Nov. 9**: Press-Schechter Theory
3. **Tue Nov. 14**: Cosmological simulations
4. **Thu Nov. 16**: Galaxy formation
5. **Tue Nov. 21**: Galaxy formation (cont.) (Homework 4 due)

   Thu Nov. 23: *Thanksgiving*
6. **Tue Nov. 28**: Dark matter and particle physics
7. **Thu Nov. 30**: Hot topics in cosmology
8. **Tue Dec. 5**: Projects presentations/review
9. **Thu Dec. 7**: Projects presentations/review

Monday, Dec 18th, 1:30pm-3:30pm: Final exam (CSS 0201)