

ASTRONOMY 376, Cosmology

Unique No. 48765, Spring 2014

CLASS MEETS: TTh 2-3:30pm in RLM 15.216B

INSTRUCTOR: Prof. Volker Bromm

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Office Hours: W 4-5pm, or by appointment

COURSE WEBSITE:

<http://www.as.utexas.edu/astrometry/education/spring14/bromm/376.html>

TEACHING ASSISTANT: Aaron Smith

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Office Hours: TBA

COURSE OBJECTIVES: Cosmology is a fantastic subject! We will apply the laws of physics to address some of the most fundamental questions of humanity: What are our origins? What is our place in the overall cosmic scene? What is time? What is dark energy, and what the dark matter? Cosmology has recently made great strides, primarily driven by novel telescopes and other observational probes. We will trace this great story of discovery, leading us to the current frontier of knowledge. You will learn to look at the physics behind these exciting phenomena, and make things as simple as possible, but still capture the important effects.

TEXTS:

There is one required text, available at the Co-op. In addition, we here suggest some optional books that you may find useful. To cover the course material, we will provide you with detailed lecture notes, available for downloading from the course website. Beyond that, there is a huge universe of cosmology-related online tutorials, many of them are quite good. We will make specific suggestions while we go ahead.

The required text is (available at the Co-op):

- Barbara Ryden: "Introduction to Cosmology", Addison Wesley

The optional texts are (available at the PMA Library):

- Andrew Liddle: "An Introduction to Modern Cosmology" (2nd edition), Wiley

- Peter Schneider: "Extragalactic Astronomy and Cosmology" (Springer)

- Oyvind Gron/Arne Naess: "Einstein's Theory" (Springer)

- Edward Harrison: "Cosmology: The Science of the Universe", Cambridge University Press
- Alan H. Guth: "The Inflationary Universe" (Basic Books)

GRADING: Your final grade will be based on a point system:

In-class Quizzes 10
2 In-class Exams 2x15
Homework 40
1 Group Project 20

We won't have a Final Exam.

The following grading scheme will be used:

A = 89 - 100
A- = 85 - 88
B+ = 82 - 84
B = 72 - 81
B- = 70 - 71
C+ = 68 - 69
C = 62 - 67
C- = 60 - 61
D = 50 - 59

Any score below 50 is failing (F).

HOMEWORK AND GROUP PROJECT:

The smaller problem sets and the more extended group project will contain analytical and numerical parts. I assume that you know one high-level language (C, Fortran, IDL, Mathematica, ...), enabling you to solve problems numerically. Please ask if you feel you need to catch up on your computer literacy. We will be glad to suggest ways to quickly get up to speed if necessary.

QUIZZES: We will have frequent in-class, unannounced quizzes, where you will work with 1 or 2 of your colleagues to solve small problems (with a duration of about 10 mins each). The quizzes will not test your memory by asking you to remember some fact or another. Instead, the quizzes will often ask you to devise an "order-of-magnitude" (back-of-the-envelope) solution to a problem based on the material that we have introduced in class.

COURSE AND UNIVERSITY POLICIES:

- CLASS ATTENDANCE:

It is important that you come to class. You will not be successful otherwise in following the course material. In addition, we will have unannounced quizzes. If you miss one, there will be no make-up

quiz. But you are allowed to miss up to 2 quizzes without penalty; make sure to talk to me if you have to be absent from class more than 2 times, so that we can discuss your situation.

- EXAMS: There will be no final exam. Instead, we will have two in-class exams, covering roughly 1/2 of the course material each.

There will be make-up exams ONLY for students with valid excuses.

- PLAGIARISM: Scholastic dishonesty, in particular any plagiarism, will be prosecuted in accordance with the university guidelines. In simplest terms, plagiarism occurs if you represent as your own work any material that was obtained from another source, regardless how or where you acquired it.

Please have a look at:

http://deanofstudents.utexas.edu/sjs/scholdis_plagiarism.php

There, you find a more detailed description of what constitutes plagiarism in its various forms. In particular, have a careful look at "paraphrasing".

- RELIGIOUS HOLIDAYS: University policy is to respect religious holidays. If you have to miss a lecture or exam because of a religious holiday, you will not be penalized. But you need to tell me ahead of time.
- NOTICE: Students with disabilities may request appropriate academic accommodations from the Division of Diversity and Community Engagement, Services for Students with Disabilities, 471-6259.

COURSE CONTENT:

- Introduction
- Expansion of the Universe
 - > Survey of basic facts
 - > General relativity: brief intro
 - > Spacetime (Robertson-Walker) geometry
 - > Cosmic dynamics: Friedmann models
 - > Cosmological parameters
 - > Problems with the 'Standard Model'
- Dark Matter
 - > Evidence
 - > Candidates: WIMPs, axions,...
- Dark Energy
 - > Evidence: supernova cosmology
 - > Basic physics: how come 'negative pressure'?
 - > Candidates: cosmological constant, quintessence,...
- Very Early Universe
 - > Quantum gravity and the Big Bang

- > Baryogenesis
- > Inflation

- Early Universe
 - > Primordial nucleosynthesis
 - > Recombination
 - > Cosmic microwave background

- Structure Formation
 - > Basic principles
 - > CMB anisotropies
 - > galaxy formation

- High-Redshift Frontier
 - > First stars and galaxies
 - > Reionization

- Epilogue: The Cosmic Frontier