AS109: Cosmology – Syllabus

Fall Semester 2016
Professor Alan Marscher, Department of Astronomy

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Prof. Marscher's Office: Room CAS 418 [Note: this is an office suite. Open the metal hallway door, next to which you'll see my nameplate. My office is inside the wooden door straight ahead. Once past the wooden door, you'll see me either right in front of you or in the room to the left.]

Prof. Marscher's Office Hours: M 2-3:20, R 11-12:30

Teaching Fellows:

Mr. Deep Anand; e-mail: gaanand@bu.edu; office: room CAS 524; phone: (617)353-5611; **office hours:** W 3:30-4:30, F 11-1

Mr. Zhexing Li; e-mail: zhexingl@bu.edu; office: room CAS 524; phone: (617)353-6554; **office hours:** T 3:30-5, W 4-5:30

Course Description:

Cosmology is the study of the universe as a whole. Our topic will therefore be expansive by definition. A surprise of the last century was that understanding the universe requires knowledge of the physical world on the smallest scales as well as the largest. Furthermore, our current picture of the universe is very exotic, even difficult to believe without the historical context within which the ideas were developed and tested. Our quest to describe our cosmos will therefore include (1) an overview of the historical development of our view of nature and the universe, (2) a discussion of how waves, particles, and force fields form the building blocks of the natural world, (3) an explanation of how light is created and what we learn by observing the radiation from cosmic objects, (4) Einstein's relativity that applies to motions near the speed of light and to the gravity of massive compact objects as well as the universe as a whole, (5) how astronomers determine distances to remote galaxies, (6) why scientists have concluded that the universe is expanding and cooling, (7) what the universe was like when it was young, extremely dense, and ultra-hot, and (8) how the universe developed to the state we currently observe. Along the way, we will look at the philosophical and theological implications of the astronomer's view of the universe.

The power of mathematics, logic, and the scientific methods in describing nature has led to an explosion of knowledge of the universe. We will therefore use math and logic in the course. However, we will limit the math to basic algebra and trigonometry. The book has a mathematical appendix that you should consult if you are rusty with your high-school math, and the discussion sections or office hours are a good place to ask questions about math or anything else that you find difficult.

Components of the Course

There are two main components to the course: the lecture section and the discussion section. You must attend both components throughout the semester. Prof. Marscher will conduct the lecture sections. Many of the lecture classes will include time for discussions and other activities. The teaching fellows will lead

the discussion sections. This is an opportunity for you to go over material that you find difficult or to discuss matters that are particularly interesting and not covered in the lecture sessions. Both the lecture and discussion sections will have exercises that will count toward your grade; some of these will **not** be announced in advance.

The lectures will be held twice per week, TR 2:00-3:20 in **Room CAS 313 (725 Commonwealth Ave.)**. Discussion sections will meet for 50 minutes each week in room **CAS B04** (in the basement near the western end of the building next to Marsh Plaza).

Course Website

All course materials will be posted on the website for AS109. To access the website, type the URL http://learn.bu.edu, and log in with your BU user id and Kerberos password. You should find the link to the AS109 website on the right.

Textbook

Prof. Marscher has written a textbook for the course, *From Nothing to Everything: The Story of Our Universe*, provided to you electronically at no cost. The textbook is available in the "**Course Documents**" section of the course website. The files are in PDF format. Please notify Prof. Marscher if you encounter any difficulties in downloading, reading, or printing the textbook files. Also, if you find any errors or passages that are unclear, please bring these to Prof. Marscher's attention, preferably via e-mail.

You should pay light attention to names and dates as you read the textbook and take notes during the lectures and discussions. ***It is the concepts – including observations as well as theories and the evidence supporting them – and their applications that are most important.*** All concepts and facts presented in the book can be included in quizzes and exams even if they are not specifically covered in the lectures and discussions. However, nearly all of the material on the tests will be covered in both the book and class.

Exams, Homework, and Grading

There will be two midterm exams plus a cumulative final exam. The **date of the final exam is Saturday December 17, 3:00-5:00 P.M. in the lecture room**. This date is set by the university and cannot be changed for individual students. See the attached course schedule for the dates of the midterm exams.

There will homework assignments out of the textbook most weeks. These will be announced in class and posted on the course website under "**Assignments**." (We do **not** expect you to complete unassigned homework questions in the textbook.) There also will be activities at many discussion and lecture classes that will count 100 points if completed and 0 if not, so attendance is necessary to maintain a high grade.

Your final numerical grade will give the following weight to each of these components of the course: Midterm exams: 40% (2 exams, 20% each) Final Exam: 30% Homework assignments: 20% Lecture and discussion activities: 10%. Class participation: If noteworthy (meaning frequent insightful questions or discussion points), 1 point will be added to the final course numerical average.

Late Assignments

While we'd like to be lenient with late assignments, giving full credit to late work (without a valid excuse or prior arrangement with the relevant instructor) is unfair to the students who hand their work in on time.

The policy is: Less than 24 hours late – forgiven the first time, –10% for subsequent infractions; from 24 hours late up to Monday 5:00 P.M. after the due date, –25%; later than this, no credit.

If you know that you will hand in an assignment late, arrange the delayed submission in advance with your TF, who may grant a no-penalty extension. Also notify your TF in advance if you know that you will miss a discussion class; it may be possible to arrange for you to attend another discussion class that week. If you know that you will miss a midterm exam, notify Prof. Marscher as far in advance as possible so that he can work out an alternate time with you. Sudden illnesses and emergencies will be handled on an *ad hoc* basis; contact the relevant instructor in a timely fashion after the urgent problem is over.

Absences

Although you are expected to attend every class in AS109, there may be times when something comes up (illness, for example) and you need to miss a class. In addition, sometimes you might have a bad day and perform poorly on a quiz or mess up your homework assignment. In order to take this into account, we will **drop**:

- 5 zeros on lecture or discussion activities when you are absent for legitimate or non-legitimate reasons
- the lowest 2 homework scores

Academic Conduct

Please read the University's Academic Conduct Code. Misconduct involves not only direct cheating on tests, but also direct copying on homework assignments. The quizzes and exams will be proctored by the instructors to discourage cheating. In addition, there will generally be multiple versions of the quizzes and exams, so copying is ill-advised. Any evidence of cheating on quizzes or exams will be reported to the appropriate dean for disciplinary action.

Homework assignments: Since students often learn well from each other, you are allowed to work together toward understanding how to do the homework assignments. However, you cannot copy part or all of another student's work. That is, after you figure out how to do the assignment, you should write it up on your own. **If we find evidence of copying, the numerical grade for the assignment will be divided by the number of students that handed in essentially identical assignments. The 3rd such infraction by a given student will be reported to the appropriate dean.**

Help on Homework Assignments

During some weeks, parts of the discussion sections will be devoted to homework problem-solving sessions. In addition, solutions to sample problems that are quite similar to the homework problems are given in most chapters of the textbook. Help is also available at the office hours of Prof. Marscher and the TFs. (You can attend the office hours of a TF other than the one that leads your discussion class.) Help is more difficult to supply via e-mail, but you are welcome to send e-mail to Prof. Marscher if you get stuck. Response times will vary, depending on when you send the message and other factors.

Special Evening Class Meeting: Hayden Planetarium at the Museum of Science Sept. 28 or 29
In order to become acquainted with the sky, there will be a planetarium show at the Boston Museum of Science, offered on 2 separate evenings: Wednesday September 28 & Thursday September 29 at 6:30-8:15 P.M. Logistics will be announced. You should attend **one** of these shows, which will include a very brief assignment to hand in that will be counted as a lecture activity.

AS109 Lecture and Exam Schedule, Fall 2016

Date	Topic	Reading from textbook
T Sep. 6	Methods of Science	Chapter 1, Appendix A
R Sep. 8	Ancient Cosmology	Chapter 2
T Sep. 13	The Copernican Revolution	Chapter 3
R Sep. 15	Newton's Laws of Motion	Chapter 4
T Sep. 20	Implications of Newton's Formulation	Chapter 4
R Sep. 22	Waves	Chapter 5
T Sep. 27	Light and the Electromagnetic Spectrum	Chapter 5
W Sep. 28 & R Sep. 29	**Planetarium show (6:30-8:15 P.M. at Museum of Science)**	Chapter 2
R Sep. 29	Dark Night Sky & Distances to Remote Cosmic Objects	Chapter 6
T Oct. 4	Quantum Description of Atoms & Light	Chapter 7
R Oct. 6	**Midterm Exam #1 on Chapters 1-6**	Chapters 1-6
T Oct. 11	***No lecture class: Monday schedule followed	
R Oct. 13	Particle Waves & other Peculiarities of the Nanoworld	Chapter 7
T Oct. 18	Particles and Force Fields	Chapter 8
R Oct. 20	Nuclear Reactions	Chapter 8
T Oct. 25	Special Relativity: Motion Near the Speed of Light	Chapter 9
R Oct. 27	General Relativity: Einstein's Theory of Gravity	Chapter 9
T Nov. 1	Expanding Universe	Chapter 10
R Nov. 3	Big Bang Cosmology	Chapter 11
T Nov. 8	Pondering the Universe	Chapter 11
R Nov. 10	**Midterm Exam #2 on Chapters 7-11**	Chapters 7-11
T Nov. 15	Formation of Galaxies	Chapter 12
R Nov 17	Black Holes and Quasars	Chapter 12
T Nov. 22	Formation of Stars	Chapter 12
T Nov. 29	Evolution of Stars	Chapter 13
R Dec. 1	Deaths of the Most Massive Stars	Chapter 13
T Dec. 6	Formation of Star Systems with Planets	Chapter 14
R Dec. 8	Humanity & the Cosmos in Perspective	Chapter 15

Saturday Dec. 17 3:00-5:00 P.M. Final Exam (in lecture room) Chs. 1-15