Astronomy 1143: History of the Universe
Autumn 2012

Meetings: WF, 2:20-3:40, Journalism Building 300
Midterm exam: Friday, October 5, full class period
Final exam: Thursday, December 6, 2:00-3:45, in regular classroom
Web page: `http://www.astronomy.ohio-state.edu/~dhw/A1143`

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Office hours: Wednesday, 3:45 - 4:45, Friday, 9 - 10:15

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Office hours: Thursday, 1:45 - 3:00, Friday, 11:15 - 12:15

Course Material

Why is there something, rather than nothing? This is one of the oldest questions in human thought, and astronomers and physicists have made extraordinary progress towards answering it over the last century. We now know that the universe we see today has expanded from an extremely hot, extremely dense state — the "Big Bang" — that existed about 14 billion years ago. We know that the rich structure in today's universe — billions of galaxies that are arranged in enormous filaments and sheets and filled with stars and planets — emerged from the action of gravity on tiny primordial fluctuations. We know that the matter that makes up our everyday world, comprised of protons, neutrons, and electrons, accounts for only about 5% of the total matter and energy in the universe. We know something about the other dominant components, known as dark matter and dark energy, but their true nature remains mysterious, and a subject of intense research by astronomers and physicists.

This course will teach you about the history of the universe as we currently understand it and about the history of cosmology as a subject. We will see how astronomers have used observations from telescopes and satellites together with basic physical principles to piece together the picture summarized above. We will learn about some of the research that is being done today to gain deeper understanding of the matter and energy contents of the cosmos, the physics of the Big Bang, and the origin of galaxies. Along the way we will learn about light and its role as a messenger from the distant universe, about gravity and its impact on the motions of galaxies and the expansion of the cosmos, and about atoms and how they are forged in the hot early universe and the centers of stars.

Prerequisites

The only prerequisite is math at the level of Math 075 or 076 (actually, well below this level would be sufficient). The math in this course will not go beyond simple algebra, but there will be equations and geometrical or mathematical reasoning in the lectures and in the assignments. The math itself will not be difficult, but the concepts will be challenging, and *translating concepts into equations and back is one of the major things you will learn during the course.*

Textbook

The textbook is *Your Cosmic Context*, by Todd Duncan and Craig Tyler, which is available at the campus bookstore or via online vendors. It is a good book, clear in its explanations and broad in its view. I will proceed in a quite different order from the textbook, but I will assign readings from the book for each section, which should be a useful complement to what I cover in lecture. However, the book cannot possibly substitute for the lectures.

Assignments, exams, and grading:

Grades will be based on four take-home assignments (40% total), a midterm exam (25%), and a final exam (35%). The take-home assignments will consist of questions from the lectures and reading and problems for you to work out, and they should typically take 6-8 hours. The grading scale for the take-home assignments is "standard" – i.e., 95=A, 85=B, etc. The grading scales for the midterm and final will be mildly curved. My expectation, based on teaching similar courses in the past and on the general policy for introductory level GEC courses in Physical Sciences, is that the average course grade in the class will be somewhere between a C+ and a B-.

How To Do Well In This Course

The most important advice is: come to class, start early on the take-home assignments, and get help on those assignments if you need it.

After each section of the course is completed, I will post my lecture notes on the course web page, and they should be helpful for reference during the assignments and for reviewing. However, I do *not* expect that you can learn the course material from these notes (or from the book) unless you are attending lecture. If you do miss a class, check with me for any handouts you might have missed, and check the course web page for anything that has been posted there.

The take-home assignments are intended to be challenging. However, you are *welcome* to come to my office hours or Dan Stevens' office hours to get help on them. If you devote enough time to the assignments and get help on them as needed, you should be able to do well on this portion of course grade. The work you put into the assignments will also improve your performance on the exams, but that is *not* the primary purpose of the assignments. They are an integral part of the course in their own right.

For doing well on the exams, my first advice is to spend some time each week going over the lecture notes, identify any things you don't understand, and ask me about them. There will also be question & answer review sessions before the midterm and the final, and attending these will likely improve your performance. I will give other advice in advance of the exams themselves.

Students with Disabilities

Any student who feels that he or she may need an accommodation based on the impact of a disability should contact me to discuss specific needs. I will work with the Office for Disability Services to verify the need for accommodation and develop appropriate strategies. Students with disabilities who have not previously contacted ODS are encouraged to do so in advance by visiting the ODS website and requesting an appointment.

Academic Misconduct

All OSU instructors are required to report suspected cases of academic misconduct to the Committee on Academic Misconduct. See the University's Code of Student Conduct for details.

Learning objectives

The Curriculum Committee of the College of Arts & Sciences requests that syllabi of all GEC courses list the goals and learning objectives for the relevant category of the GEC.

As a Natural Science GEC course, the goals are: "Students understand the principles, theories, and methods of modern science, the relationship between science and technology, the implications of scientific discoveries and the potential of science and technology to address problems of the contemporary world."

More specifically, the "Expected Learning Outcomes" for GEC Physical Science courses are:

1. Students understand the basic facts, principles, theories and methods of modern science.

2. Students understand key events in the development of science and recognize that science is an evolving body of knowledge.

3. Students describe the inter-dependence of scientific and technological developments.

4. Students recognize social and philosophical implications of scientific discoveries and understand the potential of science and technology to address problems of the contemporary world.

Cosmology as a subject is an ideal vehicle for objectives 1-3, as we will closely examine one of the most exciting fields of modern science, one in which theory, observation, and technology all play crucial and interlocking roles. It's not clear that cosmology can do much to address problems of the contemporary world, other than providing a sense of perspective. However, cosmology is perhaps the field of science with the greatest philosophical implications, and I hope that learning about the history of the universe will inform your own philosophical world view.

Course Topics and Schedule

Because I have not taught this course previously, I cannot predict accurately how long it will take me to cover individual topics. The topics I aim to cover are:

- Measuring distances and velocities; properties of light; expansion of the universe
- Gravity; the influence of gravity on cosmic expansion; evidence for dark matter
- The Big Bang theory; the geometry of space
- The cosmic microwave background
- The origin of atoms: nucleosynthesis in stars and the early universe
- The large scale structure of the universe: observations
- Dark matter, again
- The formation of galaxies and large scale structure
- Inflation and other possible pre-histories of the Big Bang
- Dark energy and the fate of the universe

We will meet every Wednesday and Friday from 8/22 through 11/30, except for the week of Thanksgiving — no class on 11/21 or 11/23.

Homework assignments will be handed out in class on Friday and due at the beginning of class the following Friday. Specifically, the homework assignments will be handed out at the end of Week 3 (9/7, due 9/14), Week 5 (9/21, due 9/28), Week 10 (10/26, due 11/2), and Week 12 (11/9, due 11/16).

The midterm exam will be in class on Friday, 10/5 (Week 7).

The final exam will be on Thursday, 12/6, from 2:00-3:45, in the usual classroom.