This course covers the evolution of the Universe from shortly after the Big Bang to the formation of galaxies like the one live in. This enormous span of time, 13.7 billion years, sounds like a lot to pack in one semester. However, we are aided by the fact that as you go back to early times in the Universe, things are simpler. With straightforward physics we can describe how spacetime expands, how the primordial fireball cools down and becomes transparent to photons, how the light nuclei (H, He, Li, Be) form, and how gravitational instability amplifies tiny density fluctuations so that they grow into the large structures we see today. The study of these things is called physical cosmology, and has led us to the startling conclusion that most of the matter in the Universe is not made of the stuff we are (we call it dark matter), and most of the energy density in the Universe is not even matter at all (we call it dark energy).

The study of physical cosmology raises many other fundamental questions, including:

- Why is the night sky dark?
- What is spacetime, and why does it expand?
- What is the precise mathematical description of this expansion, and what does it tell us about gravity?
- How can we derive cosmological parameters (age of the Universe, etc.) from the cosmic microwave background? How are such observations done?
- What is dark matter? How can we learn about its particle nature in the lab? In space?
- Where do the "primordial" elements (H, He, Li, Be) come from?
- What is inflation, and what problems does it solve?
- How does the large-scale structure (galaxy clusters, etc.) form? Why does it look like it does?

By exploring such questions, we will see how the Big Bang model unifies so many disparate observational facts into a coherent picture, while also raising profound new questions for both astrophysics and particle physics.

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Office Hours
Your TF and I are happy to make an appointment to meet you at the CfA any time to discuss the class. We will also arrange a problem session at the Science Center before the weekly homework sets are due.

Depending on interest, there may be opportunities for special lectures (outside class hours) to hear local/visiting scientists talk about their latest research, or to visit local labs.

Website:    http://www.courses.fas.harvard.edu/73826
We will utilize the course website for reading quizzes and for posting important materials, problem sets, solutions, etc.
Lectures, Readings, and Course Goals
This course meets for lecture Tuesdays and Thursdays from 11:30AM-1:00PM in Science Center Room 111. If there is significant conflict of this time with other classes, please come talk to me.

Your basic introduction to the material is through readings from the required textbook by Barbara Ryden, although the lectures will try to go to greater depths. Lectures will consist of blackboard lectures and sample problems. Readings from the textbook will be assigned once a week. I ask that you complete a brief online questionnaire by midnight on Sundays. This will verify that you have done the reading, and will allow us to identify areas of confusion before the class, so we can have a more focused discussion.

Required Course Text:
Introduction to Cosmology, Barbara S. Ryden. The Coop should have copies, as does Amazon.

Extra Reading:
Principles of Physical Cosmology, P. J. E. Peebles. This is a classic book used in some graduate cosmology classes. It contains too much detail for Ay130, but if you want a more thorough discussion, it is a good reference.

Grading
Grading will be on an absolute scale to mitigate worries that helping your fellow classmates will lower your own grade.
90-100%: A, A- 80-89% B+, B, B- 65-79% C+, C, C- 55-64%D <55% F

Collaboration
We encourage you to collaborate on homework with your fellow classmates, since you are valuable resources to each other. For collaborations, you must list the names of the relevant individuals, and the work you hand in must be your own. Copying is unacceptable.

Homework assignments 30%
Problem sets will be due every week, probably on Thursdays. If a majority of the class prefers Tuesday, we will discuss changing that. Points will be deducted from late assignments at a rate of 5%/day. We recommend turning assignments in at lecture, but they may be brought to the TF until 5pm on the day they are due. In other words, please don't skip class to finish your homework!

Midterm 20%
We will have one midterm, the week of March 8th.

Class Participation 5%
I expect you to attend and participate in the lectures. We will try to keep the discussion lively!

Reading Assignments 5%
Questionnaires on your reading assignments are due on Sunday at midnight. Your reading assignment answers will be graded on a simple 2-point scale, where 2 demonstrates that you have read the material, 1 indicates room for improvement, and 0 is unsatisfactory or incomplete. Late reading assignments will not be accepted.

Final Exam 40%
Exam content will focus on fundamental concepts relevant to course material covered throughout the semester.