

# Astrophysical Sciences 203: The Universe

Spring 2009

Lectures: T & Th 3:00-4:20, McDonnell A02

This course comes in three parts – planets and life, stars and galaxies, and the universe – with a syllabus targeting the frontiers of modern astrophysics. Subjects include the intellectual history of astronomy, the solar system; the search for life in the universe; the birth, life, and death of stars; the structure of the Milky Way; the properties of galaxies; the expanding universe; Einstein’s special and general theories of relativity; black holes; time travel; and big bang cosmology and the future fate of the universe.

This course has three faculty lecturers, Christopher Chyba, J. Richard Gott and Anatoly Spitkovsky. Each will give roughly eight lectures. Prof. Spitkovsky is the administrative head of the course, and will be the easiest to reach throughout the semester. Prof. Michael Strauss, who has taught this course for 10 years, will kindly help with the organization and lecturing this semester. E-mail is always the easiest way to get ahold of us (put “AST 203” in the subject line, please!).

## **Professors:**

Christopher F. Chyba (x8-5633, 122 Peyton Hall, cchyba@princeton.edu)

J. Richard Gott (x8-3813, 118 Peyton Hall, jrg@astro.princeton.edu)

Anatoly Spitkovsky (x8-2307, 123 Peyton Hall, anatoly@astro.princeton.edu)

Michael A. Strauss (x8-3808, 110 Peyton Hall, strauss@astro.princeton.edu)

## **Course Assistants:**

Xin Liu (x8-5243, 19A Peyton Hall, xinliu@astro.princeton.edu)

Clay Hambrick (x8-7936, 19F Peyton Hall, dclayh@astro.princeton.edu)

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Katie Mack (x8-8060, 19C Peyton Hall, mack@astro.princeton.edu)

Office hours are listed on the course web site.

There will be regularly scheduled informal precepts throughout the semester, which will allow discussion of the material presented in lecture, discussion of the homework assignments with the course and teaching assistants and an opportunity to work with other students on the homework. They will be held in the Peyton Hall auditorium.

In addition, we will hold observing sessions throughout the semester, to explore the night sky, the planets, double stars, and nebulae. They are usually scheduled for Tuesday nights, but may move to other nights depending on the weather. Watch

your e-mail!

**Texts:**

- The Cosmic Perspective, 5th Edition (2007) (*Recommended*) Jeffrey Bennett, Megan Donahue, Nicholas Schneider, and Mark Voit (Addison Wesley)  
There is not much difference between 3rd, 4th and 5th editions; it will not hurt you much to have the 3rd or 4th editions, which you can probably buy used. However, do *not* get the abbreviated version: ‘Stars, Galaxies, and Cosmology’; this does not include some important chapters we will need.
- Time Travel in Einstein’s Universe: The Physical Possibilities of Travel through Time (2001) (*Required*) J. Richard Gott (Houghton Mifflin)

**Grading:**

Homework: 35% (six assignments; mixture of essay and quantitative questions)

Mid-Term: 25% Combination of Essay and Quantitative Questions

Final Exam: 40% Combination of Essay and Quantitative Questions

Homework is due in class on the date indicated in the syllabus below. Late homework will not be accepted, as homework solutions will be made available at the time that the homework is due. You are welcome to work together on the homeworks, but each person’s writeup should be their own, *using their own words*.

Each student will have a folder with their name on it, in one of a series of four boxes which will be placed in the hallway outside the lecture room (the Brush Gallery). Homework and exams will be handed in, and returned to you, via these folders.

The course Home Page is:

<http://www.astro.princeton.edu/~anatoly/AST203/>

Lecture notes, homework assignments (and solutions), and other relevant information will be posted on the page; check it out often. Notices will also be sent out by e-mail.

The following course outline is approximate, and may change as the course progresses. The syllabus can also be found on the course web site; it will be kept up-to-date. For each lecture, the corresponding chapters in our texts are indicated. You are responsible only for the material in the lectures and in the problem sets, not for all the material in the texts. There will be many occasions when the lectures cover material not discussed in the texts. Some supplementary reading material will be supplied.

Detailed outlines of each lecture will be made available on the course home page, as will a guide to what you should read in the textbooks. The dates and times of special events are listed in italics below. The schedule of observing sessions may change due to the vagaries of weather.

—————**Christopher Chyba: Science, Planets and Life**—————

Tuesday February 3	Introduction: Our Solar System and Life (Chapters 1, 7; Appendix C of CP)
Thursday February 5	Motions on the Sky and Ancient Astronomy (Chapters 2 and 3 of CP)
Tuesday February 10	The Copernican Revolution: Science and Skepticism (Chapter 3 of CP)
<i>Wednesday February 11 7:30-9:30 PM</i>	Discussion/Problem Session Peyton Hall Auditorium
Thursday February 12	Kepler, Newton, and The Law of Universal Gravitation (Chapter 4 of CP) <b>Homework #1 due.</b>
<i>Thursday February 12 8 PM</i>	Observing session (for those whose last names start with A-F) Peyton Hall
Tuesday February 17	Philosophy of Science; Radioactive Dating: how old is the Solar System (Chapters 5, 8 and 9 of CP)
<i>Tuesday February 17 8 PM</i>	Observing session (for those whose last names start with G-M) Peyton Hall
Thursday February 19	Light, Black-Body Radiation, and Spectroscopy (Chapter 5 of CP)
<i>Monday February 23 7:30-9:30 PM</i>	Discussion/Problem Session Peyton Hall Auditorium
Tuesday February 24	Planetary Habitability and the Greenhouse Effect. (Chapter 10 of CP) <b>Homework #2 due.</b>
<i>Tuesday February 24 8 PM</i>	Observing session (for those whose last names start with N-Z) Peyton Hall
Thursday February 26	Life in the Solar System and Beyond (Chapter 24 of CP)

—————**Anatoly Spitkovsky: Stars and Galaxies**—————

Tuesday March 3	The Properties of Stars (Chapter 15 of CP)
<i>Wednesday March 4 7:30-9:30 PM</i>	Discussion/Problem Session Peyton Hall Auditorium
Thursday March 5	How do stars shine? (Chapter 14 of CP) <b>Homework #3 due</b>
Tuesday March 10	Star Life and Star Death (Chapters 15, 16, 17 of CP)
<i>Wednesday March 11 7:30-9:30 PM</i>	Discussion/Review for midterm Peyton Hall Auditorium
Thursday March 12	<b>Midterm exam</b> in class
SPRING BREAK	
Tuesday March 24	Stellar Explosions and the Interstellar Medium (Chapters 16, 17, 19 of CP)
Thursday March 26	The Structure of the Milky Way (Chapter 19 of CP)
Tuesday March 31	The Expansion of the Universe (Chapter 20, 22 of CP)
<i>Wednesday, April 1 7:30-9:30 PM</i>	Discussion/Problem Session Peyton Hall Auditorium
Thursday April 2	The Big Bang (Chapter 22, 23 of CP) <b>Homework #4 due</b>

—————**J. Richard Gott: Einstein and the Universe**—————

Tuesday April 7	Einstein's Special Theory of Relativity, Part I (Chapter S2 of CP; Chapters 1 and 2 of TTEU)
Thursday April 9	Einstein's Special Theory of Relativity, Part II (Chapter S2 of CP; Chapters 1 and 2 of TTEU)
<i>Thursday April 9 9 PM</i>	Observing session Peyton Hall
Tuesday April 14	Einstein's General Theory of Relativity (Chapter S3 of CP; Chapters 1 and 2 of TTEU)
<i>Wednesday April 15 7:30-9:30 PM</i>	Discussion/Problem Session Peyton Hall Auditorium
Thursday April 16	Black Holes (Chapter 18 of CP; Chapter 3 of TTEU) <b>Homework #5 due</b>
Tuesday April 21	Cosmic Strings, Wormholes, and Time Travel (Chapter S3 of CP; Chapter 3 of TTEU)
<i>Tuesday April 21 9 PM</i>	Observing session Peyton Hall
Thursday April 23	The Big Bang and the Shape of the Universe (Chapters 22, 23 of CP; Chapter 4 of TTEU)
Tuesday April 28	Inflation, and Recent Developments in Cosmology (Chapters 22 and 23 of CP; Chapter 4 of TTEU)
<i>Wednesday April 29 7:30-9:30 PM</i>	Discussion/Problem Session Peyton Hall Auditorium
Thursday Apr 30	Our Future in the Universe (Chapter 5 of TTEU) <b>Homework #6 due</b>