

Astrophysical Sciences 203: The Universe

Spring 2012

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

This course comes in three parts – planets and life, stars and relativity, and galaxies and cosmology – 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; Einstein’s special and general theories of relativity; black holes; the structure of the Milky Way; the properties of galaxies; the expanding universe; and big bang cosmology and the future fate of the universe.

This course has three faculty lecturers: Christopher Chyba, Anatoly Spitkovsky, and Jenny Greene. Each will give roughly eight lectures. **Prof. Spitkovsky is the administrative head of the course and should be the contact for organizational questions throughout the 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)

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

Jenny Greene (x8-0764, 4 Peyton Hall, jgreene@astro.princeton.edu)

Course Assistants:

Jose Garmilla (32 Peyton Hall, garmilla@astro.princeton.edu)

Wendy Ju (21 Peyton Hall, wju@astro.princeton.edu)

Sudhir Raskutti (23 Peyton Hall, raskutti@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 teaching assistants and an opportunity to work with other students on the homework. They will be held in the Peyton Hall auditorium the night before the homework is due. These precepts are not mandatory.

In addition, we will hold observing sessions throughout the semester, to explore the night sky, the planets, double stars, nebulae and galaxies. Observing sessions are usually scheduled for Tuesday or Thursday nights, but may move to other nights or get canceled depending on the weather. Watch your e-mail! The attendance of the observing sessions is not mandatory, but is highly recommended. The observing sessions in the beginning of the semester are organized by last name to reduce crowding in the telescope room. If you cannot make your session, you can attend another

one without asking the instructors. Auditors are welcome to attend as well. The observing sessions at the end of the semester are not restricted by last name.

Text:

- The Cosmic Perspective, 6th Edition (2009) Jeffrey Bennett, Megan Donahue, Nicholas Schneider, and Mark Voit (Addison Wesley)
There is not much difference between 4th, 5th and 6th editions; it will not hurt you much to have the 4th or 5th edition, which you can probably buy used. Beware of page number changes between editions; we will only reference the 6th edition pages. **Also, do *not* get the abbreviated versions:** ‘The Cosmic Perspective: Stars, Galaxies, and Cosmology’; ‘The Cosmic Perspective Fundamentals,’ ‘The Cosmic Perspective: Solar System.’ These do not include some important chapters we will need.

Grading:

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

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

Final Exam: 40% Combination of Essay and Quantitative Questions

Homework is due at the end of 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**. Mindless copying of assignments will result in disciplinary action for plagiarism. ***When computing the final homework total, we will discard the lowest homework score, even if it is 0 for one missing homework.***

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

The course Home Page is:

<http://www.astro.princeton.edu/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 on the web. For each lecture, the corresponding chapters in our text are indicated. You are responsible only for the material in the lectures and in the problem sets, not for all the material in the text. There will be many occasions when the lectures cover material not discussed in the text. 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 textbook. 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. The date for the final exam will be set by the Registrar.

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

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| Tuesday February 7 | Introduction: Our Solar System and Life (Chapters 1, 7; Appendix C of CP) |
| Thursday February 9 | Motions on the Sky and Ancient Astronomy (Chapters 2 and 3 of CP) |
| Tuesday February 14 | The Copernican Revolution: Science and Skepticism (Chapter 3 of CP) |
| <i>Wednesday February 15 7:30-9:30 PM</i> | Discussion/Problem Session Peyton Hall Auditorium |
| Thursday February 16 | Kepler, Newton, and The Law of Universal Gravitation (Chapter 4 of CP) Homework #1 due. |
| <i>Thursday February 16 9 PM</i> | Observing session (for those whose last names start with A-E) Peyton Hall |
| Tuesday February 21 | Philosophy of Science; Radioactive Dating: how old is the Solar System (Chapters 5, 8 and 9 of CP) |
| <i>Tuesday February 21 9 PM</i> | Observing session (for those whose last names start with F-L) Peyton Hall |
| Thursday February 23 | Light, Black-Body Radiation, and Spectroscopy (Chapter 5 of CP) |
| <i>Monday February 27 7:30-9:30 PM</i> | Discussion/Problem Session Peyton Hall Auditorium |
| Tuesday February 28 | Planetary Habitability and the Greenhouse Effect. (Chapter 10 of CP) Homework #2 due. |
| <i>Tuesday February 28 9 PM</i> | Observing session (for those whose last names start with M-R) Peyton Hall |
| Thursday March 1 | Life in the Solar System and Beyond (Chapter 24 of CP) |

Anatoly Spitkovsky: Stars and Relativity

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| Tuesday March 6 | The Properties of Stars (Chapter 15 of CP) |
| <i>Tuesday March 6 9 PM</i> | Observing session (last names start with S-Z) Peyton Hall |
| <i>Wednesday March 7 7:30-9:30 PM</i> | Discussion/Problem Session Peyton Hall Auditorium |
| Thursday March 8 | How do stars shine? (Chapter 14 of CP) Homework #3 due |
| Tuesday March 13 | Star Life and Star Death (Chapters 15, 16, 17 of CP) |
| <i>Wednesday March 14 7:30-9:30 PM</i> | Discussion/Review for midterm A02 McDonnell (room TBC) |
| Thursday March 15 | Midterm exam in class |
| SPRING BREAK | |
| Tuesday March 27 | Stellar Explosions and the Interstellar Medium (Chapters 16, 17, 19 of CP) |
| Thursday March 29 | Stellar Remnants and Special Relativity (Chapter S2 of CP) |
| Tuesday April 3 | General Theory of Relativity (Chapter S3 of CP) |
| <i>Wednesday, April 4 7:30-9:30 PM</i> | Discussion/Problem Session Peyton Hall Auditorium |
| Thursday April 5 | Astrophysical Black Holes (Chapter 18, 21 of CP) Homework #4 due |

Jenny Greene: Galaxies and the Universe

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| Tuesday April 10 | The Nature of Galaxies (I); Classification Systems (Chapter 20 of CP) |
| Thursday April 12 | The Extragalactic Distance Scale (Chapter 20 of CP) |
| <i>Thursday April 12 9 PM</i> | Observing session Peyton Hall |
| Tuesday April 17 | Telescopes, Redshifts, and the Expanding Universe (Chapter 20 of CP) |
| <i>Wednesday April 18 7:30-9:30 PM</i> | Discussion/Problem Session Peyton Hall Auditorium |
| Thursday April 19 | The Nature of Galaxies (II); Black Holes and Dark Matter Homework #5 due (Chapter 21 of CP) |
| Tuesday April 24 | Galaxy Evolution and the Growth of Structure (Chapter 22 of CP) |
| <i>Tuesday April 24 9:00 PM</i> | Observing session Peyton Hall |
| Thursday April 26 | The Cosmic Microwave Background and The Fate of the Universe (Chapter 22 of CP) |
| Tuesday May 1 | The Accelerating Universe and Dark Energy (Chapter 22 of CP) |
| <i>Wednesday May 2 7:30-9:30 PM</i> | Discussion/Problem Session Peyton Hall Auditorium |
| Thursday May 3 | Early Universe and Inflation (Chapter 23 of CP) Homework #6 due. Date of Final exam will be set by Registrar. |