ASTRON 329/429: Cosmology and Extragalactic Astrophysics (Fall 2017)

This course will provide a broad introduction to modern cosmology, the branch of physics that studies how the Universe began, what it is made of, how it has expanded with time, and how structures likes stars and galaxies formed out of the Big Bang. An understanding of cosmology provides important background for students who plan to pursue research in astronomy or high-energy physics. The course will cover the standard hot Big Bang cosmological model, including the evidence for dark matter and dark energy. Cosmology is an exciting and active area of research, and the course will prepare students to understand some of the recent developments.

Instructor: Prof. Claude-André Faucher-Giguère
Email: cgiguere@northwestern.edu
Office: Tech F243
Office hour: Thursday 11 AM (or by appointment)
Course website: http://galaxies.northwestern.edu/teaching (follow links).

To save trees, problem sets will be posted on the course web site. If you miss a lecture, be sure to monitor the course web page and ask your classmates about possible assignments.

Alex Gurvich (Tech F222; agurvich@u.northwestern.edu) will be the grader for the course.

Time and location: Tuesday and Thursday, 9:30-10:50, in Searle 3220.

Textbook (required): Introduction to Cosmology (2nd edition) by Barbara Ryden. Cambridge University Press (ISBN: 1107154839). Make sure to get the 2nd edition!

Other useful references: An Introduction to Modern Cosmology (3rd Ed.) by Andrew Liddle. Wiley (ISBN: 1118502140). Similar to Ryden but more concise.

Extragalactic Astronomy and Cosmology: An Introduction (2nd Ed.) by Peter Schneider. Springer (ISBN: 3642540821). More advanced textbook – a useful reference for topics not covered by Ryden.

Modern Cosmology by Scott Dodelson. Academic Press (ISBN: 0122191412). Much more technical – a useful reference for students planning to pursue research in cosmology.

We will cover most of Ryden's book. The textbook is written at the level of advanced undergraduates so it is easy read. Some more advanced topics that connect to current research will be covered in the lectures.

Course pre-requisites: The course is targeted at advanced undergraduates and graduate students in physics or astronomy. Students should have a good understanding of special relativity but general relativity is not required. This course does not have a specific astronomy requirement, but students should be familiar with basic astronomical concepts at the level of ASTRON 220.

Course evaluation: Grades for the course will be determined as follows:
40% homework assignments
20% mid-term exam
40% final exam

For the homework assignments, you are welcome to discuss problems with other students, but you must write up your own solutions independently. There will be approximately 5 regular homework assignments. Assignments will be due in class. Grades for late assignments will be automatically reduced by 20% and a further 10% will be deducted for each day late. Assignments turned in more than five days late will not be graded except under extraordinary circumstances.

The midterm and final exams will be closed-books but you will be allowed one hand-written "cheat sheet" of notes (8.5"×11", both sides) that you can use, e.g., for equations. The exams will consist of problems similar to the homework problems.

The midterm will be in class on Tuesday, Oct. 24. Following the registrar's schedule, the final examination will be on Monday Dec. 4, 3-5, in the regular classroom. The final examination will cover material from the entire quarter.

All graduate students should register for ASTRON 429. Undergraduates should register for ASTRON 329 instead. The lectures and regular homework problems will be identical.

On the exams, ASTRON 429 students will be required to solve additional problems. ASTRON 429 students will also be expected to complete an "independent study" of chapters 11 and 12 in Ryden, on structure formation. Most the material in these chapters will be not covered in class during the quarter. Rather, ASTRON 429 students will be expected to read the chapters on their own and solve problems 11.1, 11.3, 11.4, 11.5, 12.1, 12.2, and 12.3. Solutions to these problems will be due at the end of the quarter as an extra problem set. Of the 40% of the final grade for homework assignments, 10% will be determined by performance on the independent study problems for ASTRON 429 students, and the remaining 30% will be for the rest of the problem sets.

Important: ASTRON 429 students can and should get started on the independent study chapter well before we reach the end of the quarter, since most of the chapter does not depend on knowledge of other material that we will cover toward the end of the term. Part of the exercise is to test your ability to learn new topics on your own, so I will not provide guidance on the pace at which you should be progressing through the chapter. You do not want to wait until the end of the quarter and have to simultaneously complete the final regular problem set, the independent study problem set, and prepare for the final exam!

Topics to be covered: fundamental observations and cosmological principles; the Friedman-Robertson-Walker metric and different cosmological models; dark matter and dark energy; measuring cosmological parameters; the cosmic microwave background; Big Bang nucleosynthesis; and cosmic inflation. ASTRON 429 will learn extra topics in structure formation.