ASTRON 1121: Galaxies and Cosmology
Course Syllabus

Revised January 6, 2016

Basic Course Information

Term: 2164 (Spring 2016)
Credits: 3
Prerequisites: Physics 0175, Astronomy 0113 and Math 0250 or 0290
Meeting Time: Monday & Wednesday, 3:00 to 4:15 PM, 210 Thaw Hall
(Note: The second floor of Thaw corresponds to the 5th floor of SRCC or the 3rd floor of OEH.)

Instructor Information

Prof. Carles Badenes
Office: 309 Allen Hall
Office Hours: Monday 2:00 to 3:00 PM & Wednesday 11:00 AM to 12:00 PM (or by appointment)
Email: badenes@pitt.edu (email is generally the best way to contact me)
Phone: (412) 624-9039

I am a faculty member in the Department of Physics & Astronomy at the University of Pittsburgh. My specialty is astrophysics, and I lead an active research group that works on many aspects of observational and theoretical stellar astrophysics, mostly related to supernova progenitors. Do not hesitate to contact me with any questions or concerns about ASTRON 1121. My goal is to work with students to ensure that the course is interesting and fun. Please do not wait until the end of the semester to express concerns – by that time there is very little I can do to address any problems. There is no question too insignificant and there is no need to wait until it is too late to express a concern. Of course, I have to abide by University and Department rules and I have to work within the Physics & Astronomy curriculum, so I cannot accommodate all requests, but my intention is to make this course as fun and productive as possible.

Textbook

The textbook for the course will be *Extragalactic Astronomy and Cosmology: An Introduction*, by Peter Schneider (Springer). This book is available in electronic editions (PDF and Kindle) editions as well as softcover.

Course Description

This course is an **introduction to the study of galaxies and cosmology at the advanced undergraduate level**. These fields have advanced greatly in recent years; we will use state-of-the-art astronomical datasets to explore the properties of galaxies and the nature of the expanding Universe. We will begin by studying our own galaxy, the Milky Way; then move on to the study of galaxies in general, their formation and evolution; and conclude by studying the Universe as a whole. The course is designed as a complement to ASTRON 1120 (Stars, Stellar Structure and Stellar Evolution), ASTRON 1122 (Solar System and Exoplanets), and ASTRON 1263 (Techniques of Astronomy). Together, these advanced courses are meant to provide a solid background in undergraduate astrophysics.

Course Objectives

The primary goals of this course are twofold:

1. To provide a basic knowledge of galaxies and cosmology, with sufficient grounding to engage in undergraduate research in these fields.
2. To develop skills in exploring astronomical data and solving problems.

At the end of the course, you should be able to explain, among other things:

- How the Milky Way Galaxy we live in is similar to (or different from) other galaxies
- Where galaxies come from and how they may transform amongst types
- Why we believe many galaxies have large black holes at their center
- What the main constituents of the Universe are
- How the Universe began and what its ultimate fate will be
- How the Universe has grown and changed over time
- How to perform basic calculations, file input/output, and plotting in the Python programming language

Course Structure

Physics and Astronomy education research has found in recent years that the most lasting learning comes not from lectures, but from active engagement with material. This course will employ techniques that have proved effective in the past, in particular group problem-solving. I expect that a significant fraction of class time will be devoted to working together in groups of 3 or so students to solve problems or explore astronomical data sets. **Students are expected to have read the relevant sections of the textbook or online readings (listed on Courseweb) before class**. The course lectures and activities are a supplement to the textbook, not a replacement for it. The goal is not for you to understand everything after reading, but you should come to class ready to ask questions about the parts that are unclear!

Course Grades

I expect that course grades will be weighted as:

- 30-40% Homework/Projects
- 25% Midterm
- 25% Final exam
- 10-20% Group work

Homework: There will be 5-10 homework assignments during the semester, consisting of a variety of astrophysical problems or, in some cases, exploration of astronomical data sets.

Exams: Exams will consist of a variety of problems broadly similar in nature to those on homework assignments or done in class.

Students are allowed (and encouraged) to collaborate in finding solutions to homework assignments, but each student should present their own reasoning and write up their own solution. Collaboration on exams is strictly forbidden. In both homework assignments and exams, the focus will be on having the correct reasoning. **No credit will be given for a correct answer without the reasoning being clearly explained**. A great deal of the credit for a problem may be given if the reasoning is correct, but the numerical answer is incorrect for one reason or another. Occasionally, you may find an answer that is obviously incorrect. For example, say you derived the distance to the sun to be three miles. In such a situation, you can still get partial credit for the problem simply by recognizing that the answer obviously does not make sense and explaining why the answer is manifestly incorrect.

Group work: There will be a group project for credit. Some portion of this grade may be credit for participating in groups during class.

Expectations

It will be vital for you to study the material at home, doing reading beforehand so that class time can be used productively for group work and mini-lectures. I expect you to attend all classes and to come prepared for active participation; failing to do so will not only impair your performance in the class, but also harm the other members of your group.

Following the School of Arts and Sciences' guidelines, I expect that you will study for class and work on class assignments for about 90 hours over the course of the term outside of class meetings (about 6 hours a week). I expect you to work in groups to discuss readings and solve problems and to be an active participant in your group. The classroom will be a safe environment for discussing and challenging ideas and concepts. The students and the instructor are expected to treat each other with respect at all times.

I will post new homework assignments on our CourseWeb site (at http://courseweb.pitt.edu/); I will not hand them out in class. It is your responsibility to check the site and obtain these materials. You may discuss homework problems with other students in the course, but you must hand in a unique solution that is your own. I will accept at most 2 late homework assignments from any letter-grade-option student, except in extreme (e.g. medical) circumstances or via prior arrangement more than two days before the deadline. The first late homework will have no penalty, the second one will have a grade penalized by 10%. Late HWs must be turned in within 24 hours of the nominal due date unless otherwise arranged in advance.

Problem solving skills are of utmost importance and you must show all of your work, including all logical and algebraic steps used in deriving your answers in order to earn full credit. You may not refer to algebraic steps performed by a calculator or by a computer software package (Mathematica, Maple, etc.) for derivations. You must perform and show each step yourself. If a numerical answer is required, you may use a calculator to obtain the relevant number, but you must still show all of the logical and algebraic steps you took to arrive at the answer and the answer must have the correct units in order to receive credit. Throughout the course, I will give problems where you may need to know a piece of information (for example, the radius of the Sun) that it is not included in the problem statement. I will assume you can look this up in some reputable source (such as our textbook, or a reputable web site), but I will require that you to properly reference your source.

You can expect me to come prepared to give lectures, to explain difficult concepts, to assist your group, to assign relevant readings and homework problems, and to try to answer any questions you have. I will be a willing listener and advisor in helping you succeed in this class, and with other career questions you might have. You may expect me to be available outside of class to give additional support. I want this class to be interesting, informative, useful, and fun. I am always open to suggestions and willing to try to modify the topics, etc. to accommodate the interests of the class.

Tentative Calendar

Week 1 (Jan 6)	Introduction to the Course
Week 2 (Jan 11, 13)	Basics of Galaxies and Cosmology (Ch. 1); The Milky Way (Ch. 2)
Week 3 (Jan 20)	Introduction to Python; The Milky Way **Monday, Jan 18 MLK Day**
Week 4 (Jan 25, 27)	Other Galaxies (Ch. 3)
Week 5 (Feb 1, 3)	Active Galactic Nuclei (Ch.5)
Week 6 (Feb 8, 10)	Exploring galaxy properties
Week 7 (Feb 15, 17)	Exploring galaxy properties; Clusters of Galaxies (Ch. 6)
Week 8 (Feb 22, 24)	Galaxy Evolution
Week 9 (Feb 29, Mar 2)	Galaxy Evolution; **Midterm Exam: March 2nd**
(Mar 7, 9)	**Spring Recess**
Week 10 (Mar 14, 16)	Basic Cosmology (Ch. 4)
Week 11 (Mar 21, 23)	Large-scale structure of the Universe (Ch. 7)
Week 12 (Mar 28, 30)	Large-scale structure of the Universe
Week 13 (Apr 4, 6)	Cosmological Parameters (Ch. 8)
Week 14 (Apr 11, 13)	Cosmological Parameters; The high-redshift Universe (Ch. 9)
Week 15 (Apr 18, 20)	The high-redshift Universe and Course Summary
(Apr 25-29)	**Finals Week. Final exam date is Saturday, April 30 at 4:00 PM** (may arrange alternate date)

Students are expected to have read the relevant sections of the textbook before class. The schedule and procedures in this course are subject to changes by the instructor which will be posted on the ASTRON 1121 Courseweb site (and announced in class in the case of major changes). Exam dates are not expected to change, but the exact material covered will be adjusted according to the actual pace of the course.

The Department of Physics and Astronomy

As students at the University of Pittsburgh, you have access to a Physics and Astronomy Department that is highly recognized and is performing world-class research. The Department wants you to feel welcome. If you are interested in further study of or research in physics or astronomy please talk to me. You may make use of the undergraduate lounge off of the mail room on the second floor of the Old Engineering Hall. This is a good place to meet with classmates to discuss problem sets and course material. You might also meet physics majors here that can help you, discuss other classes with you, or inform you about the major program. The Department also hosts a doughnut and coffee hour every Wednesday at 4 PM in 321 Allen Hall which is designed to encourage discussion. The University of Pittsburgh's Astronomy research group hosts seminars on topics of current interest in astronomy and astrophysics every other Friday at Noon in 319 Allen Hall. The talks are typically at an advanced level, but eager students can learn a great deal about contemporary astronomy and astrophysics by attending.

CourseWeb

The University of Pittsburgh provides a web based resource called Courseweb, which is a portal to web sites for individual courses. A Courseweb site for this course has been created and there you can view announcements and download course materials. To access Courseweb go to http://courseweb.pitt.edu. Use your Pitt email username and password to login to Courseweb. If you have forgotten your username and password or need to set up an account, contact the help desk at 412-624-4357, or 4-HELP. Once you have logged into the system simply click on the link for this course to access the available material.

Academic Integrity

Students in this course will be expected to comply with the University of Pittsburgh's Policy on Academic Integrity. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity. This may include, but is not limited to, the confiscation of the examination of any individual suspected of violating University Policy. Furthermore, no student may bring any unauthorized materials to an exam, including dictionaries and programmable calculators.

Disability Services

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services (DRS), 140 William Pitt Union, (412) 648-7890, drsrecep@pitt.edu, (412) 228-5347 for P3 ASL users, as early as possible in the term. DRS will verify your disability and determine reasonable accommodations for this course.

Accessibility

CourseWeb/Blackboard is ADA Compliant and has fully implemented the final accessibility standards for electronic and information technology covered by Section 508 of the Rehabilitation Act Amendments of 1998. Please note that, due to the flexibility provided in this product, it is possible for some material to inadvertently fall outside of these guidelines.

Copyright Notice

Course materials may be protected by copyright. United States copyright law, 17 USC section 101, et seq., in addition to University policy and procedures, prohibit unauthorized duplication or retransmission of course materials. See Library of Congress Copyright Office and the University Copyright Policy.

Statement on Classroom Recording

To ensure the free and open discussion of ideas, students may not record classroom lectures, discussion and/or activities without the advance written permission of the instructor, and any such recording properly approved in advance can be used solely for the student's own private use.