ASTRON 1121: Galaxies and Cosmology

Term: 2204 (Spring 2020)
Credits: 3
Prerequisites: Astronomy 113 (Introduction to Astronomy); Math 240 (Calculus 3)
Suggested Co-requisites: Physics 479 (Modern Physics I); Math 290 (Differential Equations)
Meeting Time: Tuesdays and Thursdays, 11:00 AM -12:15 PM, 210 Thaw Hall

Instructor: Prof. Rachel Bezanson

`rachel.bezanson@pitt.edu` (email is the best way to get in touch with me!)
Office: 308 Allen Hall
Phone: 412-624-9013

Background: I joined the Department of Physics and Astronomy at the University of Pittsburgh in Fall 2017. I am an observational astronomer and my research focuses on the formation and evolution of galaxies through cosmic time.

What should you call me? Dr. Bezanson, Prof. Bezanson, Dr. B, Prof. B, Rachel - honestly with an upper-level class I will respond to most things.

Goals: My main goal is to work with students to make this course engaging, interesting, and fun. Do not hesitate to contact me with **any** questions or concerns, either by email or by coming to office hours. I need your feedback in order to improve your learning experience! Please let me know if you have issues with the course material, or you would like me to cover some topic that you are particularly interested in. Of course, I have to abide by University and Department rules and I have to work within the Physics and Astronomy curriculum, so I cannot accommodate all requests, but I will do my best.

Logistics: I will hold regular office hours on Mondays and Thursdays 3:30-4:30 in 308 Allen Hall (my office). If you cannot make these times, please contact me and we can arrange to meet at another time. I would encourage you to use me as a resource - the problem sets in this course can be challenging and I want to help you work through them. If you need further help or would prefer to seek help from a tutor, the Department of Physics and Astronomy maintains a Physics Resource Room in 312 Thaw Hall that is staffed by tutors between 9 AM and 5 PM on weekdays throughout the semester. Please take advantage of this service.

Textbook:

Extragalactic Astronomy and Cosmology: An Introduction, by Peter Schneider (second edition)
This book is available in electronic ($\sim$ \$40) editions as well as hardcover/paperback ($\sim$ \$80/\$70).

Course Description:

This course will be an introduction to the study of galaxies and cosmology at an advanced undergraduate level. These fields have advanced greatly in recent years; we will use state-of-the-art 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.

Course Objectives:

This course has two primary objectives:

→ to provide a basic knowledge of galaxies and cosmology, providing sufficient grounding to engage in undergraduate research in these fields; and

→ to develop skills in exploring astronomical data and solving problems using the Python programming language.

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 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:

In recent years, Physics and Astronomy education research has found in a variety of contexts that the most lasting learning comes not from lectures, but from active engagement with material. The course will employ techniques that have proven 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 data sets.

Students are expected to have read the relevant sections of the textbook or online readings (listed on Courseweb) before class. Lectures and these activities are a supplement to the textbook, not a replacement. 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!

Grading Policy:

There will be approximately 5-10 problem sets and group projects due throughout the course of the semester as well as one midterm exam that will be given during class either before or after spring break and a cumulative final exam that will take place during finals week on **Wednesday, April 22, at 8 AM**.

Grade Components

30-40%	Homeworks/Projects
25%	Midterm Exam
25%	Final Exam
10-20%	Group work/Presentations

Arrangements for make-up exams must be made well in advance of the exam. Acceptable excuses for missing an exam include being out of town for a verified University-related activity or illness. If you miss an exam for any reason, be prepared to provide a signed letter from your doctor, from the university health service, or from your coach or person responsible for the University-related activity.

In both homework assignments and exams, the focus will be on showing 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. To get full credit for a problem, you must give a detailed statement of the problem and a brief but complete explanation of your reasoning. 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. **NO CREDIT** will be given for an answer that has incorrect units unless you comment on the fact that your answer is wrong and take a guess where you may have gone wrong. For example, if you expect an answer that should have units of length (inches, meters, miles, etc.) but give an answer of 25 seconds you will get no credit unless you comment on this. Finally, your work must be legible. You are not saving the environment by cramming all of your work onto

one sheet of paper. **NO CREDIT** will be given for work that either the course grader or Dr. Bezanson find illegible. **NO CREDIT** will be given if either Dr. Bezanson or the course grader find it difficult to follow the sequence of steps. Your work must flow sequentially from left to right across the page and from the top to the bottom of the page. It is your responsibility, and yours alone, to make sure that your work is legible and orderly. You may discuss problems with others on your homework sets, but the solutions you hand in must be your original work. Homework must be turned in *at the beginning of class* (first 5 minutes) on the day that they are due. I will accept *emailed* assignments, but the due dates will be the same regardless of technical difficulties. I will accept **one** free late assignment during the semester, after which late homework will be accepted with the grade reduced by 10% per 24 hours. I will post all solutions to problem sets, usually within a couple of days after the due date and without prior warning. Once I have posted a solution set on CourseWeb, no late credit may be obtained for that assignment.

I hope to have a grader for this course, but one has yet to be assigned.

Course Topics in Detail:

Here is a rough outline of what will be covered in ASTRON 1121. This plan may be modified according to student interests, to accommodate questions that may arise during the course, and to adapt to the pace at which we proceed.

Week 1: 1/7,1/9	Introduction to the course, basics of galaxies and cosmology (Chapter 1)
Week 2: 1/14,1/16	The Milky Way (Chapter 2)
Week 3: 1/21, 1/23	The Milky Way, Introduction to Python
Week 4: 1/28, 1/30	Galaxies (Chapter 3)
Week 5: 2/4, 2/6	Galaxies and Active Galactic Nuclei (Chapter 5)
Week 6: 2/11, 2/13	Exploring galaxy properties
Week 7: 2/18, 2/20	Groups and Clusters of Galaxies (Chapter 6)
Week 8: 2/25, 2/27	Galaxy Evolution
Week 9: 3/3, 3/5	Galaxy Evolution
Spring Break: 3/8-3/14	(finish Galaxy Evolution), Basic Cosmology (Chapter 4)
Week 10: 3/17, 3/19	
Week 11: 3/24, 3/26	Large scale structure of the Universe (Chapter 7)
Week 12: 3/31, 4/2	Measuring Cosmological Parameters (Chapter 8)
Week 13: 4/7, 4/9	Measuring Cosmological Parameters
Week 14: 4/14, 4/16	The high-redshift Universe (Chapter 9)
Finals Week	**Final Exam: Wednesday, April 22, 8 AM**

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, send email to the instructor or the TAs, and download course material such as the syllabus and lecture slides. Reading and homework assignments will all be announced on Courseweb. 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.

What to do if you miss a lecture?

I will not take attendance during lectures but I strongly encourage you to attend all lectures. If you must miss a lecture, please review the lecture slides on courseweb and get notes from a classmate. If you have remaining questions please come to office hours.

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 of Physics and Astronomy wants you to feel welcome. If you are interested in further study of or research in physics or astronomy please talk to me or any other faculty member.

The Department of Physics and Astronomy provides free assistance for all students. The **Physics Exploration Center** allows students to operate some simple experiments and demonstrations. Within the Exploration Center is the **Physics Help Room**, staffed with TAs who can answer homework related questions, explain basic concepts and help you with the math. This is a free service and you are encouraged to use it. The Physics Exploration Center and the Physics Help Room are both located in Thaw 312, and a detailed schedule is posted here: `http://www.physicsandastronomy.pitt.edu/resource_room`. In addition, tutoring is available through the Academic Support Center (WPU 311). You may also 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 and astronomy majors here that can help you, discuss other classes with you, or inform you about the major program. The Department hosts a doughnut and coffee hour every Wednesday at 4PM, which is designed to encourage discussion. The Astrophysics group within the Department hosts seminars on topics of current interest in astronomy and astrophysics every other Friday at noon. The talks are typically at an advanced level, but eager students can learn a great deal about contemporary astronomy and astrophysics by attending. You can find the talk schedule in the Department web site: `http://www.physicsandastronomy.pitt.edu`. We also hold bi-weekly coffee discussions on several astronomy-related topics that are regularly attended by faculty, graduate students, and undergraduate students who are completing guided research projects in the astronomy group. Please ask me for updated information about these events if you want to attend.

Academic Integrity:

The integrity of the academic process requires fair and impartial evaluation on the part of faculty and honest academic conduct on the part of students. To this end, students are expected to conduct themselves at a high level of responsibility in the fulfillment of the course of their study. It is the corresponding responsibility of faculty to make clear to students those standards by which students will be evaluated and the resources permissible for use by students during the course of their study and evaluation. The educational process is perceived as a joint faculty-student enterprise which will perforce involve professional judgment by faculty and may involve - without penalty - reasoned exception by students to the data or views offered by faculty.

Cheating/plagiarism will not be tolerated. Students suspected of violating the University of Pittsburgh Policy on Academic Integrity, from the February 1974 Senate Committee on Tenure and Academic Freedom reported to the Senate Council, will be required to participate in the outlined procedural process as initiated by the instructor. A minimum sanction of a zero score for the quiz or exam will be imposed. For details, refer to the University Guidelines on Academic Integrity (`https://provost.pitt.edu/sites/default/files/academic_integrity_guidelines.pdf`).

Diversity and Inclusion:

I consider this class to be a place where you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability - and other visible and non-visible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.

Disabilities:

If you require special accommodations or classroom modifications, please notify both your instructor and Disability Resources and Services by the end of the first week of the term. The office of Disability Resources and services is located in 140 William Pitt Union, (412) 648-7890, drsrecep@pitt.edu, (412-228-5347 [voice or TDD]), and their website is at `http://www.drs.pitt.edu`. If you have a physical, learning, or emotional disability, please let me know as early as you can so that appropriate accommodations can be made.