

# ASTRON 3580: Galactic and Extra-galactic Astronomy

Term: 2224 (Spring 2022)

Meeting Time: Mondays and Wednesdays, 1:00-2:15 PM (eastern time), 210 Thaw Hall

Until Pitt decides to allow in-person courses: <https://pitt.zoom.us/j/94338887542>, password on Canvas

## Instructor: Prof. Rachel Bezanson (she/her)

[rachel.bezanson@pitt.edu](mailto:rachel.bezanson@pitt.edu) (email/slack is the best way to get in touch with me!)

Office: 308 Allen Hall

**Logistics:** I will hold regular office hours on Mondays and Thursdays between 3:30-4:30 PM in 308 Allen Hall (these times may change during the semester, but will always be up to date on Canvas and in this syllabus and any changes would be announced in class). If you cannot make these times, please contact me and we can arrange to meet at another time. I 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.

## Course Description:

Galaxies are the fundamental building blocks of the present universe. This class will give an overview of galaxies, their properties, and their formation and evolution with an emphasis on current research areas. Topics will include observational properties (morphology, masses, colors, concentrations), scaling relations, evolution with redshift, stellar populations, gas and dust, dynamics and dark matter, evolution and mergers, and active galaxies.

## Course Objectives:

My goal for this class is to provide a strong understanding of extragalactic astronomy. In one semester this survey course will not cover all topics in detail, but I hope for this to be a launching point from which you will be able to dive into research talks and or papers and fill in the details.

## Textbook:

I will point you towards material from a number of sources in this class, ranging from textbooks to review articles (mostly from the Annual Reviews of Astronomy and Astrophysics). I will post most of these materials on Canvas, however the book that I recommend that you rely upon most is *Galaxy Formation and Evolution* by Mo, van den Bosch, and White (henceforth MvdBW). Although we will not follow that book completely (it has a very theoretical bent), it is an excellent reference. Another promising book just came out: *Introduction to Galaxy Formation and Evolution: From Primordial Gas to Present-Day Galaxies* by Cimatti, Fraternali, and Nipoti - I have a copy in my office if you are interested.

## Grading Policy:

I expect to assign five problem sets over the course of the semester, in addition to one 15 minute in-class presentation and an oral exam at the end of the semester. You are encouraged to collaborate on problem sets, but individual write-ups are expected. Please hand in all problem sets on paper and *on time*, unexcused late problem sets will go down by 10% each day.

Finally, I expect students to regularly attend astro coffee on Monday/Thursday at 2:30. This does not mean that you have to be present every single meeting (I don't make it!), but I expect to see your smiling faces on most days when you don't have a conflict. I expect that over the course of the semester each student will *present at least three papers*. I have set up a google form (see link on Canvas) that you can fill out quickly each time you present so that I have a record. These papers don't have to be explicitly related to galaxies (but of course, basically all stars live in a galaxy and much of modern cosmology utilizes extragalactic sources). Two in-astrocoffee presentations may be replaced by one astrobites-style article. All instructions can be found on Canvas.

Your overall grade in the class will be computed as:

- **50%** Problem Sets (5)
- **15%** Presentation
- **10%** Astro Coffee (Graduate Students: zero papers - F, 1 papers - C, 2 papers - B, 3 papers - A, Undergraduate students: zero papers - F, 1 papers - B, 2 papers - A)
- **20%** Oral Final Exam
- **5%** Class Participation

## Course Topics in Detail:

Here is a rough outline of topics covered in ASTRON 3580, which will likely be modified according to student interests and pacing as the semester progresses.

|                       |  |  |
|-----------------------|--|--|
| <b>Lectures 1-5</b>   | Course overview, fundamental galaxy global properties, statistical trends and correlations | MvdBW §2.3 & 2.4   |
| <b>Lectures 6-7</b>   | Stellar Populations  | ARAA review (Conroy, 2013)   |
| <b>Lectures 8-9</b>   | Gas and star formation   | ARAA review (Kennicutt & Evans, 2012), theory: MvdBW §9-9.6            |
| <b>Lectures 10-11</b> | Chemical Evolution   | MvdBW §10.4, CGM ARAA review (Tumlinson, 2017)                         |
| <b>Lecture 12</b>     | Dark Matter  | MvdBW Chapter 7  |
| <b>Lectures 13-14</b> | Disk galaxies: scaling relations, structures, formation and evolution                      | MvdBW Chapter 11   |
| <b>Lectures 15-17</b> | Elliptical galaxies: scaling relations, structures, formation and evolution                | MvdBW §2.3.2, Chapter 13   |
| <b>Lecture 18</b>     | Groups and Clusters  | MvdBW §2.5   |
| <b>Lecture 19</b>     | Interactions and Mergers   | MvdBW §7.3, Chapter 12   |
| <b>Lecture 20</b>     | Large Scale Structure and Clustering   | MvdBW §1.4,2.7-2.7.1,15.6, ARAA review (Wechsler & Tinker, 2018)       |
| <b>Lecture 21</b>     | Galaxies over cosmic time  | ARAA reviews (Madau & Dickinson, 2014, Förster Schreiber & Wuyts 2020) |
| <b>Lecture 22</b>     | Models of galaxy formation   | ARAA review (Somerville & Davé 2015, Naab & Ostriker 2017)             |
| <b>Lectures 23-28</b> | AGN: Presentation tips (and class time for presentations!)                                 | MvdBW Chapter 15   |

## Canvas:

The University of Pittsburgh provides a web-based resource called Canvas, which is a portal to web sites for individual courses. A Canvas site for this course has been created and there you can view announcements, send email to the instructor and download course material such as the syllabus and lecture slides. Reading and homework assignments will all be announced on Canvas. To access Canvas go to <http://canvas.pitt.edu>. Use your Pitt email username and password to login to Canvas. 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, especially because we will not be following a textbook, I strongly encourage you to attend all lectures. If you must miss a lecture, please review the lecture slides on Canvas and get notes from a classmate. If you have remaining questions please come to office hours. I will try to remember to record in-person lectures on zoom, but please do not count on this – virtual lectures will be recorded automatically.

## 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](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. The University of Pittsburgh does not tolerate any form of discrimination, harassment, or retaliation based on disability, race, color, religion, national origin, ancestry, genetic information, marital status, familial status, sex, age, sexual orientation, veteran status or gender identity or other factors as stated in the University's Title IX policy. The University is committed to taking prompt action to end a hostile environment that interferes with the University's mission. For more information about policies, procedures, and practices, see: <https://www.diversity.pitt.edu/civil-rights-title-ix-compliance/policies-procedures-and-practices>. I ask that everyone in the class strive to help ensure that other members of this class can learn in a supportive and respectful environment. If there are instances of the aforementioned issues, please contact the Title IX Coordinator, by calling 412-648-7860, or e-mailing [titleixcoordinator@pitt.edu](mailto:titleixcoordinator@pitt.edu). Reports can also be filed online: <https://www.diversity.pitt.edu/civil-rights-title-ix-compliance/make-report/report-form>. You may also choose to report this to a faculty/staff member; they are required to communicate this to the University's Office of Diversity and Inclusion. If you wish to maintain complete confidentiality, you may also contact the University Counseling Center (412-648-7930).

### **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](mailto: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.