

ASTRON 3101: Special Topics-Introduction to Astrophysics

Term: 2211 (Fall 2020)

Meeting Time: Tuesdays and Thursdays, 11:05 AM -12:20 PM

on the interwebs (<https://pitt.zoom.us/j/91927746857>, password on Canvas)

Instructor: Prof. Rachel Bezanson (she/her)

<http://rachelbezanson.github.io>

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

Office: 308 Allen Hall (HA!) . . . the third floor of my house in Lawrenceville

Phone: 412-624-9013 (that is my office phone. I will provide my cell phone number in class.)

Logistics: I will hold regular office hours on times TBD (these times may change during the semester, but will always be up to date on courseweb 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.

Remote Instruction:

In order to mitigate the spread of the novel coronavirus and to provide a continued and sustainable mode of instruction, I will not be teaching face-to-face this semester.

Course Description:

Astronomy is the oldest science, but modern field of astrophysics is primarily comprised of applications of (mostly classical) physics. Most modern astrophysicists use the terms astronomy and astrophysics interchangeably. This class will provide a broad survey of the field of astrophysics.

Course Objectives:

I hope that this course will prepare students with the background knowledge to read scientific literature, attend and understand research talks in the Astrophysics group at Pitt, excel in upper level and focused advanced graduate courses and independent research projects in the astrophysics group. Subjects will include: stars, extrasolar planets, interstellar medium and star formation, galaxies, and cosmology.

Textbook:

This class will rely heavily on "Astrophysics in a Nutshell, 2nd Edition" by Dan Maoz. The book is readily available online - given the amount of time that we currently spend staring at a screen I strongly recommend that you purchase a physical copy of the book - it is also a great reference. However, there are also rental and electronic copies available.

Course Organization:

Because this class is completely web-based, I will structure daily lessons in a primarily flipped, interactive manner. Prior to each class, I expect students to read the appropriate sections of the Maoz textbook (see schedule below), take notes, and come with any questions. Class activities will focus on conceptual and/or quantitative problem solving intended to solidify your understanding of the material. Therefore, regular synchronous attendance in the class is expected. Although I encourage video and audio participation, if you feel uncomfortable turning on your camera for any reason (technological or personal) audio-only participation is acceptable. I understand that there are some days when technological challenges might limit students to participation via the chat box, but I prefer that be limited as synchronous interaction works best through a single medium. I hope that all students participate in full-group discussions, but I expect that all students actively engage in small group work.

Grading Policy:

I expect to assign ~5-6 problem sets throughout the term and an oral exam at the end of the semester (to be conducted via Zoom). You are encouraged to collaborate on problem sets, but individual write-ups are expected. Please try to hand in all problem sets *on time*, unexcused late problem sets will go down by 10% each day. Given the current pandemic crisis requested extensions (especially when requested in advance) will be granted liberally.

Finally, I expect students to regularly attend astro coffee on Monday/Thursday at 2:30 (times to be confirmed). 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 (say once a week or so). I expect that over the course of the semester each student will *present at least four papers*. I have set up a google form (<https://forms.gle/E4iLeAwc7FVjET8B8>) that you can fill out quickly each time you present so that I have a record.

Your overall grade in the class will be computed as:

- **10%** Astro Coffee (zero papers - F, 1 paper - D, 2 papers - C, 3 papers - B, 4 papers - A)
- **40%** Problem Sets (~5-6)
- **20%** Class Participation (partially based on self-evaluation)
- **30%** Oral Final Exam (to be scheduled during finals week)

A note on Flexibility and Understanding:

To say that the current climate is full of uncertainty and challenges beyond the usual is an understatement. To whatever extent possible I commit to providing as much flexibility and support as I can throughout the semester. If you think any of these expectations seem insurmountable, please speak up and I will try to be as accommodating as possible.

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 in-class slides or recordings. Reading and homework assignments will all be announced on Canvas. To access Courseweb go to <https://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 class?

I will not take attendance during class but I strongly encourage you to attend all classes. If you must miss a lecture, please review any handouts from Canvas and get notes from a classmate. As long as all students consent, all classes will be recorded. However, given that the class will be largely flipped and very interactive regular attendance is important.

Course Topics in Detail:

Here is a rough outline of topics covered in ASTRON 3101, which will likely be modified according to student interests and pacing as the semester progresses.

| | | Topics discussed | Reading <i>(before class)</i> |
|-----------------|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| Week 1: | (1) Aug 20 | \$h*t astronomers say (jargon, terminology, positions, and observations) | |
| Week 2: | (2) Aug 25 (3) Aug 27 | Stars: as blackbodies, spectra and spectral types Stars: physical properties (mass, luminosity), H-R Diagram | Maoz §1, 2.1 Maoz §2.2-2.3 |
| Week 3: | (4) Sept 1 (5) Sept 3 | Stars: hydrostatic equilibrium, mass continuity, radiative transfer Stars: radiative transfer, equation of state, opacity | Maoz §3.1-3.4 Maoz §3.5-3.7 |
| Week 4: | (6) Sept 8 (7) Sept 10 | Stars: scaling relations, energy production Stars: Nuclear reaction rates, energy transport (radiative/convective) | Maoz §3.8-3.9 Maoz §3.10-3.12 |
| Week 5: | (8) Sept 15 (9) Sept 17 | Stars: Stellar Evolution - beyond the main sequence, white dwarfs Stars: Supernovae, Neutron Stars, Pulsars | Maoz §4.1-4.2 Maoz §4.3-4.4 |
| Week 6: | (10) Sept 22 (11) Sept 24 | Stars: Black Holes, Binary systems ISM: Cloud collapse and star formation | Maoz §4.5-4.6 Maoz §5.1 |
| Week 7: | (12) Sept 29 (13) Oct 1 | ISM: HII regions, components of the ISM Shocks, supernova remnants, cosmic rays | Maoz §5.2-5.3 Maoz §5.4 |
| Week 8: | (14) Oct 6 (15) Oct 8 | Extrasolar planets: detection methods Extrasolar planets: occurrence and architecture, formation, search for life | Maoz §6.1 Maoz §6.2-6.4 |
| Week 9: | (16) Oct 13 (17) Oct 15 | Galaxies: The Milky Way Galaxies: Demographics | Maoz §7.1 Maoz §7.2 |
| Week 10: | (18) Oct 20 (19) Oct 22 | Galaxies: Active galactic nuclei (AGN) Galaxies: Environment and Large Scale Structure | Maoz §7.3 Maoz §7.4 |
| Week 11: | (20) Oct 27 (21) Oct 29 | Cosmology: Olbers Paradox and the distance ladder Cosmology: Hubble Law, age | Maoz §8.1-8.2 Maoz §8.3-8.5 |
| Week 12: | Nov 3 (22) Nov 5 | Election Day – NO CLASS <i>Please vote, volunteer, etc.!</i> Cosmology: FLRW, Friedmann equations | Maoz §9.1-9.2 |
| Week 13: | (23) Nov 10 (24) Nov 12 | Cosmology: special cases of FLRW - cosmic history Cosmology: Newtonian Friedmann equations, Dark Energy | Maoz §9.3 Maoz §9.4-9.5 |
| Week 14: | (25) Nov 17 (26) Nov 19 | Cosmology: Observational tests (1) - Hubble Law, CMB Cosmology: Observational tests (2) - BAO, big bang nucleosynthesis, distant objects | Maoz §10.1-10.3 Maoz §10.4-10.6 |

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. 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 titleix-coordinator@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, (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.