SYLLABUS
Astronomy 540: Structure & Dynamics of Galaxies
The University of Arizona, Fall, 2018

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Office hours:	Wednesdays 4:30-6 PM		Wednesdays 3-4:30 PM

LECTURES: MW from 10:00-10:50 am in Steward Observatory, Room 208

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructors.

COURSE DESCRIPTION:

This is a core graduate level class that reviews how galaxies form and evolve, from the first stars at redshifts $z > 10$ to massive disks such as the Milky Way today. We will study how the physical properties and physical conditions of galaxies change over time. Broadly speaking, the objects and related phenomena include: stellar birth and death as ensemble populations, supernovae, formation of supermassive black holes, star formation feedback mechanisms, emergence of the Hubble sequence of galaxies, environmental factors that influence galaxy evolution, and reionization of the intergalactic medium. We will also study specifics of the Milky Way galaxy and the dwarf satellites that surround it. As part of the class, students will implement their own semi-analytic model, which will include the physical processes necessary to go from dark matter halos to galaxies. The final course project will be to incorporate an extra physics module of your choice into your semi-analytic model and give a class presentation of the results. Classes will be structured around Python notebooks instead of the traditional lecture format.

LEARNING OUTCOMES:

Upon successful completion of the course, a student will be able:

- to understand the physics relating to galaxy formation
- to understand papers and presentations on galaxy formation
- to learn how galaxies evolve, and how this depends on galaxy environment
- to learn the impact of galaxy feedback, from central AGN to supernovae
- to learn the epoch and process of the reionization of the IGM
- to learn about the formation and evolution of disk, elliptical and starburst galaxies
- to study the Milky Way and its surrounding satellites

- to become more proficient at programming in Python required to work through the probem sets
- to construct a model to explore galaxy evolution in dark matter halos
- to discuss in-class topics relevant to each week's Python notebook assignment
- to present an independent project at the end of the term in front of the class

These learning outcomes will be met through the attendance of lectures, writing assignments, problem sets, an independent galaxy modeling project, and in-class discussions.

OFFICE HOURS and EMAIL

Peter Behroozi's and Brenda Frye's office hours are in Steward Observatory, and by appointment.

GRADES

Your final course grade will come through assessments of the regular Workbook assignments (70%) and the final project plus presentation to the class (30%).

The Workbook assignments can be done independently, or with a partner. If working with a partner, then it is expected that each student show the work independently. If you have a true emergency and cannot attend the final presentation of your project, please contact us immediately with documentation.

Workbook grades will be based in part on demonstrated effort, completion & correctness of the results, **and** on clarity/accessibility of presentation, including documentation of any code, aesthetics and clarity of figures, etc. We will discuss especially clear (and reserve the right to discuss especially unclear) submissions in class anonymously, so that everyone can learn by example.

REQUIRED TEXT AND READINGS

Mo, van Den Bosch & White (2010)

COURSE WEBSITE:

http://behroozi.users.hpc.arizona.edu/Classes/ASTR540/

LECTURES

The lectures will chiefly involve working through provided Python notebooks, as well as some in-class discussion and brief lectures at the beginning of each class. Note that the **lectures will move at a pace intended to build and expand upon the assigned reading material, rather than to introduce material for the first time**. Attending the lectures is strongly encouraged, and it will be mandatory to bring your laptop with you to each class. If you know that you will be away at some point in the semester, please let us know in advance so we can accommodate you.

WORKBOOKS

The Python notebooks will include problem sets at the end, which will be posted in advance of each week on our course website. You are allowed to work in groups to share ideas, but all **code, figures, and write-ups must be your own**. Problem sets will be due on the Monday following the scheduled end of completion. If there is a true emergency, then please let us know as soon as possible so we can help you.

GALAXY MODELING PROJECT

A significant fraction of the course grade will be to add an independent module to the galaxy formation model that you develop during the course. This will be on an aspect of your choice, and can either represent improved physics compared to the class implementation or an entirely new calculation. We will mention opportunities for both during the class, but you are also welcome to choose an entirely different topic (e.g., galactic planet formation rates). This project will consist of:

- 40%: A 4-page science write-up, with $\sim$ 1 page each spent on introduction/motivation (i.e., why it's interesting to add the module and what you expected to learn from it), a description of the method/equations that you used, comparison with observations or theoretical expectations, and discussion of how the module could be improved in the future. This write-up should include embedded references.
- 50%: A 10-minute in-class presentation covering the same topics (intro, methods, comparison, future).
- 10%: Documented code for your implementation.

For each item, half of the grade will come from completeness/accuracy of content, and half will come from clarity/accessibility of that content. (Remember, no-one will care about how great a scientist you are if they can't understand you!)

SCHEDULE

Week	Topics
August 20, 22	Syllabus, Workbook #1
August 27, 29	Workbook #2
September 3, 5	Labor Day (no class); Workbook #3
September 10, 12	Workbook #3; Workbook #4
September 17, 19	Workbook #4 (Cont'd.); Workbook #4 (Cont'd.)
September 24, 26	Workbook #5; Workbook #5 (Cont'd.)
October 1, 3	Workbook #5 (Cont'd.); Workbook #6
October 8, 10	Workbook #6 (Cont'd); Workbook #7
October 15, 17	Workbook #7 (Cont'd); Workbook #8
October 22, 24	Workbook #8 (Cont'd); Workbook #9
October 29, 31	Workbook #9 (Cont'd); Review & Discussion
November 5, 7	Discussion, start of project; Workbook #10
November 12, 14	Veteran's Day (no class); Workbook #10
November 19, 21	Workbook #11; Workbook #11 (Cont'd.).
November 26, 28	Review and Discussion
December 3, 5	Final project presentations

ACADEMIC HONESTY

We follow the policies outlined in the Dean of Students code of academic integrity, including cases of plagiarism and cheating (see http://deanofstudents.arizona.edu). We encourage you to work with your peers on the Workbooks. Such collaborations can include a discussion of the qualitative concepts and on the quantitative aspects (i.e., whether you get the same conclusions), but in the end you must do your own work. Academic honesty also extends to printed texts, websites, and video content. If an assignment even only *appears* to be copied from someone else, or copied from a source without a reference, or copied from a referenced source and only a few words changed, then the assignment will be assumed to be plagiarized. We will give a grade of "F" for the assignment, and further to that the Dean may assign a grade of "F" for the course and/or pursue a more stringent repercussion.

ATTENDANCE AND CLASSROOM ETIQUETTE

Students are expected to attend all lectures. Please turn off cell phones in class, and refrain from extraneous talking, distracting/discourteous behavior, distracting use of laptops/cell phones, and coming late and/or leaving early.

The UAs policy concerning Class Attendance, Participation, and Administrative Drops is available at: http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop.

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, http://policy.arizona.edu/human-resources/religious-accommodation-policy.

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See: https://deanofstudents.arizona.edu/absences.

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

The University is committed to creating and maintaining an environment free of discrimination; see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy.

ASSISTANCE

We are here to help you, so please take advantage of office hours. Please contact us promptly if you have any questions or concerns regarding this class. If disability-related assistance is needed, please contact the Disability Resources Center (621-3268; http://drc.arizona.edu/) and also please let us know. We will work together with the DR office to ensure your full participation in this course.

The University of Arizona provides a wide variety of resources to help you feel more at home in the UA environment. Examples of student resource/cultural centers include:

- The African-American Student Affairs Center
- The Asian & Pacific American Student Affairs Center
- The Guerrero Student Center
- The Immigrant Student Resource Center
- The LGBTQ+ Student Affairs Center
- The Native American Student Affairs Center
- The Transfer Student Center
- The Veterans Education and Transition Services Center
- The Women & Gender Resource Center

We encourage you to take advantage of the community, support, and learning opportunities afforded by these centers, and to encourage your friends and colleagues to do the same.