ASTR 13300 Introduction to Astrophysics

Spring 2020, University of Chicago

Class Hours: T/Th 2.00-3.20 pm

Instructor: Prof. Chihway Chang
Office Hours: W 8.00-9.00 am
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TAs: Zhuowen (Ben) Zhang, Melissa Merz
Office Hours: F 11.00 am-12.00 pm
M 4.30-5.30 pm
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Syllabus last updated 04/07/2020. Subject to change. Please read the entire document, which outlines the requirements and expectations of the course.

Prerequisite(s):

PHYS 131, 132

Course Description

The course is intended for first-year students intending to major in Astrophysics as an introduction to the range of important physical processes that operate in astrophysical environments, and how these govern structures across a wide range of scales, from planets to superclusters to the Universe. Throughout the course, we will see that similar physical principles (gravity, radiation, particle physics) come in at different stages and systems (planets, stars, galaxies, the Universe). We will also incorporate into each class relevant current active research areas in Astrophysics, especially focusing on connection with research in the department. We anticipate a highly interactive class with a large number of group activities, demos and discussions.

Required Materials

Course Website

https://canvas.uchicago.edu/courses/20924

Course Zoom

https://uchicago.zoom.us/j/741399552 (meeting ID: 741-399-552)

Lecture Notes, Slides and Lecture Recording

Lecture notes, slides and lecture recordings will all be posted on Canvas.

Textbooks

1. *Astronomy: A Physical Perspective*, 2nd Edition (Kutner): We will be primarily using this book as a basis, though the course does not cover all chapters in the book. You are expected to know the content in the chapters listed in the Course Schedule. You can buy the book online, and the library will provide scanned versions of the chapters that are covered.
2. *An Introduction to Modern Astrophysics*, 2nd Edition (Carroll & Ostlie): This is the ultimate reference if you want to learn about certain topics in more depth. You can buy the book online, and the library has an online version https://catalog.hathitrust.org/Record/005631376.

Course Slack

uchicagoastr133.slack.com

Github Repo for Course Activities

https://github.com/chihway/astr133 [We will be using the University's Research Computing Center (RCC) cluster *Midway* https://rcc.uchicago.edu/]

Course Learning Goals

For each lecture:

1. **Week 1:** dimensions and units; order-of-magnitude problems; scales in the Universe; time and seasons; astronomical coordinates; Kepler's Law.
2. **Week 2:** photometry and spectroscopy; the EM spectra; blackbody radiation; telescopes; CCDs and spectrometers; observing in different wavelengths.
3. **Week 3:** energy source for stars; stellar structure; stellar evolution on main sequence; Cephieds; planetary nebulae; white dwarfs; supernovae; pulsars.
4. **Week 4:** extinction; interstellar medium; star formation; determining the structure and rotation curve for the Milky Way; the galactic center.
5. **Week 6:** galaxy classification (properties of ellipticals, spirals and irregulars); star formation; dark matter in galaxies; active galaxies.
6. **Week 7:** distribution of galaxies; expansion of the Universe; Friedmann equation; the ΛCDM model.
7. **Week 8:** the CMB; the Universe's thermal history; modern cosmological probes.
8. **Week 9:** exoplanets and observational techniques for exoplanet detection.

Overall: Have a broad view of what topics are covered in astronomy. Apply the laws of physics in a wide range of astrophysical processes. Can name some ongoing research topics and experiments in astronomy. Learn how to read papers and extract information, think critically. Learn how to present your own or others' work.

Course Structure

Each class is 80 minutes and we will usually have a short break after a 45-50 min **Lecture**. Each week there will be one 30 min **Activity** at the end of the second lecture. We also have **Reading** and **Homework** every week. There will be one **Midterm Exam** in the format of group presentations and one **Final Exam** with format TBD. Details for each of the items listed above is explained below.

Lecture: This will be a pretty standard lecture with (mainly) whiteboard and some slides at the end. We will try to be interactive and encourage questions in class.

Activity: This will be a 30-min time each week where the class engages in an activity. Some weeks this activity will be led by a guest speaker (faculty/postdocs/students who are experts in that field).

Reading: There will be reading material that corresponds to each class. It is **not** required that the students read all of the material, just the particular material that is also covered in class. However, the full reading material will help the student understand the class a lot better.

Homework: There will be homework every week. Homework will be posted on Canvas Thursdays and should be submitted on Canvas by the following Thursday in class. Students are encouraged to discuss them but should complete them on their own.

Midterm Presentation: We plan to have the midterm in the form of a presentation – you will work in groups to present a topic of your choice. Your task is to find a good way to present the topic (slides, videos, body language etc.) and answer any questions people may have. Half the groups will present on Tuesday and half on Thursday. You are encouraged to come up with your own topics (consult with the instructor or the TAs is you are not sure), but we will have a list of good topics for you to choose from too. Please sign up from this Google Doc: https://docs.google.com/document/d/1QhpYHrHttv9KFdrzo8TQKHAH4oaV6V3a0G16rCpu4og/edit.

Final Exam: Format of final exam is TBD, but either a longer problem set or a Quiz on Canvas.

Assessments

Grading

Homework (40%), Midterm (40%), Final (20%).

Policies on Late Assignments

Late assignments will be accepted for no penalty as long as a reasonable excuse is communicated to the instructor or TA before the finals. Otherwise assignments will be accepted for a 50% deduction to the score up to 2 days after the deadline and 0 after that.

Course Schedule

	Lecture 1	Lecture 2
Week 1 4/7 4/9	**Units, scales, OOM problems** *Reading:* Ch 1, extra material *Activity:* Intro to remote learning tools	**Basic concepts** *Reading:* parts of Ch 22 *Activity:* The Universe in chalk
Week 2 4/14 4/16	**Observables** *Reading:* Ch 2,3	**Telescopes** *Reading:* Ch 4 *Activity:* Working at the South Pole [Anne Gambrel]
Week 3 4/21 4/23	**Stars I** *Reading:* Ch 9	**Stars II** *Reading:* Ch 10,11 *Activity:* Jupyter notebook basics, Stellar evolution
Week 4 4/28 4/30	**The Milky Way I** *Reading:* Ch 14,15	**The Milky Way II** *Reading:* Ch 16 *Activity:* Globular clusters [Nora Shipp]
Week 5 5/5 5/7	**Midterm presentations I** Group 1-5	**Midterm presentations II** Group 6-10
Week 6 5/12 5/14	**Galaxies I** *Reading:* Ch 17	**Galaxies II** *Reading:* Ch 19 *Activity:* Strong Lensing [Brian Nord]
Week 7 5/19 5/21	**Galaxies III** *Reading:* Ch 18	**Cosmology I** *Reading:* Ch 20 *Activity:* Estimating H_0
Week 8 5/26 5/28	**Cosmology II** *Reading:* Ch 21	**Cosmology III** *Reading:* extra material *Activity:* the CMB and inflation [Kimmy Wu]
Week 9 6/2 6/4	**Extra-solar planets** *Reading:* extra material *Activity:* Exoplanet formation [Gijs Mulders]	College reading period (no class)

* The schedule is tentative and subject to change.
* Textbook chapters refer to Kutner chapters.
* Aside from the first week, homework problem sets are due on Thursday 3.20 pm. The last problem set is due Tuesday, June 2th 3.20 pm. There are total 7 problem sets.

Information for Remote Learning

Zoom

- When you first log in, check that you are muted, and that your video is turned on/off depending on your preference and internet capability. [upper left Fig.1]
- Browse through the participants, find the picture of the instructor, go to the upper-right corner and click on "...", choose "pin video". [upper right Fig.1]
- Once the instructor starts sharing screen (either write board or slides), go to the top of the screen and click on "View Options", choose "side-by-side view" and click the upper right corner so you are on "speaker view". This would be the setup that you will use most of the time listening to the lecture. You can adjust the relative size of the two screens. [lower left Fig.1]
- I will try to pause regularly during lecture and ask if you have questions. You can press "participants" and then "raise your hand" so I can check during these pauses. Or feel free to unmute and ask questions when I pause too. [lower right Fig.1]
- The instructor and the TAs' office hours will be hosted on each of our individual zoom lines:
  - Chihway: https://uchicago.zoom.us/j/7429296035
  - Ben: https://uchicagostudents.zoom.us/j/4092972090
  - Melissa: https://uchicagostudents.zoom.us/j/8165387691

NB: It appears that the zoom window each of you are seeing could be slightly different, so not all the instructions above will be applicable to you, so you might need to play around a little. Bottomline is you want to make sure you set up the windows so it is comfortable for you to learn.

Lecture Videos

These will be stored on the cloud and we will post the link on Canvas when they are ready. If you have difficulties attending the class during class hours (due to internet problems), you can watch the videos instead. Please also see guidelines on the class recordings in the document "Spring 2020 Recording Policy" on Canvas.

Submit Homework on Canvas

Go to "Assignments" on Canvas and click on the week's assignment, then upload your homework in PDF form. The TAs will grade the homework on Canvas and return it from Canvas too.

Slack

We encourage the use of slack for group discussions (you can form private chats between your group of 3-4 people) for midterm project and pretty much anything related to the class.

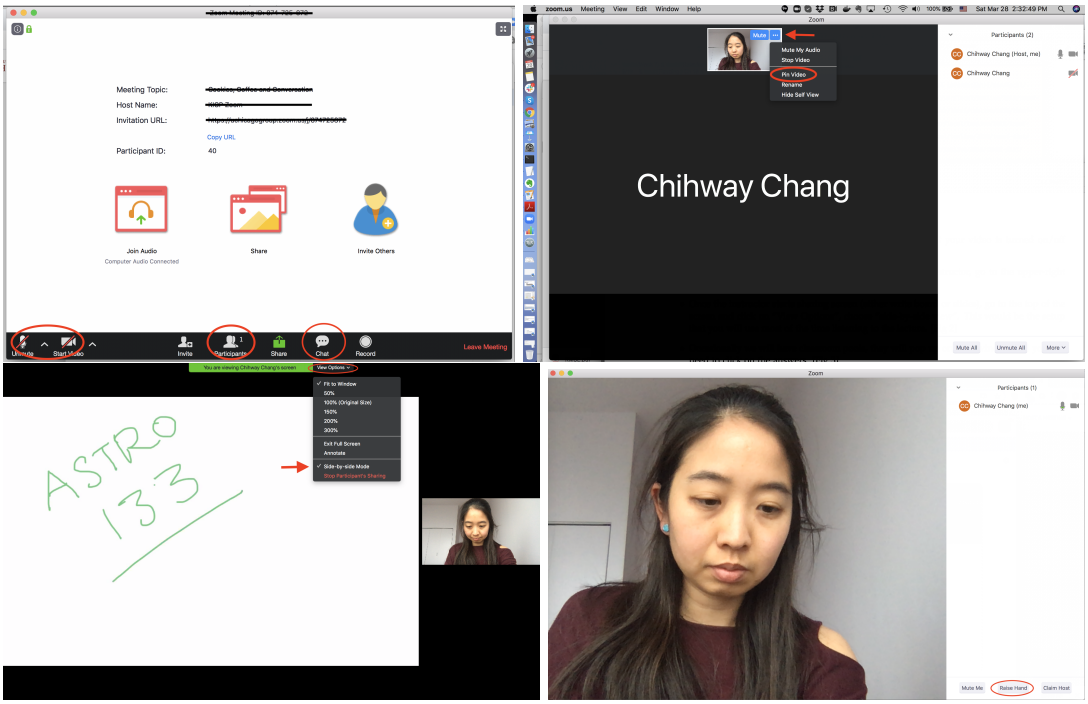

Figure 1: Illustration of various functionalities in Zoom.

Course Feedback

At the end of each homework set, we will provide a link to a Google Form where you can provide feedback to the course.