ASTR 25000/35000 Order of Magnitude Astrophysics

Basic Information

Instructor: Prof. Leslie Rogers (larogers@uchicago.edu, pronouns: she/her/hers)

Classes: T/Th 14:40 – 16:00 Remotely on Zoom

Website: canvas

Office Hours: Mondays 4:15pm-5:15pm, or by appointment

Course Description:

In physics and astrophysics, an approximate answer is often just as (if not more) useful than an exact answer. Making order-of-magnitude estimates is helpful to develop physical intuition, to verify numerical solutions, and to evaluate whether a research problem is worth pursuing. In this course, students will receive coaching and practice in physics-based reasoning, back-of-the envelope estimation, and thinking on their feet. Students will be encouraged to take a broad perspective, to think critically, and to have fun using physics to understand the universe around them.

Learning Goals:

- Hone "Street Fighting" Problem Solving Skills
- Develop physical intuition and gain practice applying physics and math to understand the universe around us.
- Instill confidence in the application of physics-based reasoning and back-of-the envelope estimation
- Heighten critical thinking skills and the ability to evaluate the strengths and weaknesses of arguments based on the use of data, technical claims, and scientific theories.

Expectations of Student Behavior:

- **Be respectful** by actively listening, seeking to understand comments, and critiquing ideas (not people).
- **Be engaged** by sharing your knowledge, coming prepared, and cooperatively working with your colleagues.
- **Exercise intellectual curiosity and humility** by asking questions, taking risks, and acknowledging times when you do not know an answer.

Textbook:

The art of insight in science and engineering: mastering complexity, Sanjoy Mahajan
Freely available online through the UChicago library:
http://pi.lib.uchicago.edu/1001/cat/bib/11238275

Grading:

Blogging Assignments	70%
Constructive comments on blog posts	15%
Pre-class Reading Quizzes	15%

Class Format:

Before class:

- Complete assigned reading
- Complete pre-call reading quiz on canvas

In Class:

- Class will start with a brief mini-Lecture overview of topic of the day and assigned reading.
- Collaboratively, the class will then assemble a list of "tips and tricks" to remember from the assigned reading
- The majority of the class sessions will be devoted to collaborative problem solving in small group break-out rooms

After Class:

- Complete the anonymous post-lecture feedback survey

Homework Assignments:

- Homework assignments center around a class blog
- There are 8 assignments total (one per week)
- Assignments will alternate between smaller homeworklets and larger homeworks
- The homeworklets count half as much as the homeworks toward your final grade
    - each homeworklet is worth 70%*1/3*1/4 = 5.83% of the final grade
    - each homework is work 70%*2/3*1/4 = 11.67% of the final grade
- Assignments are submitted by publishing your post to the class blog.
- Assignments are due by Tuesday at noon, the week after they are assigned.
- Reading and commenting on your classmates' blog posts also contributes 15% to your final grade.
- To get full marks for commenting, students must comment on at least 2 posts submitted in response to each homework/homeworklet within 1 week of the homework's due-date -- i.e., at least 16 comments total, with at least 2 comments per homework(let).
- Comments that are rude or insulting will not be tolerated and will count negatively toward the commenters' grade.

Classroom Norms:

- This class aims to nurture a supportive, collaborative learning environment (where mistakes are encouraged and expected). Please behave in a supportive, collaborative, and respectful way toward your classmates. Respect individual differences in values, personalities, work styles, and theoretical perspectives.
- Engage in constructive group behaviors (cooperating, clarifying, inspiring, harmonizing, risk taking, process checking) and try to avoid destructive group behaviors (dominating, rushing, withdrawing, discounting, digressing, blocking).
- Please keep yourself muted in Zoom when you're not speaking.
- Please use the "raise hand" feature in zoom or type a question in the chat to ask a question/make a comment during class presentations and full-group discussions.
- At the start of each class, I may ask for a volunteer to help monitor the chat and to keep track of the stack of raised hands.
- Small group discussions in break-out rooms may not require use of the "raise hand" feature to indicate that you want to speak. Regardless, please be aware of how much/how little space you are occupying in the discussion. Each individual in a breakout room shares the responsibility to tend to the wellbeing of the discussion.
- There is an expectation that students in this course will be actively engaged and on camera (when possible) while on Zoom, especially during breakout discussions. I am mindful that it is not always possible or convenient to turn on one's camera/microphone, so students are also welcome to participate through the chat feature and/or without video, when necessary.
- Class sessions will be recorded, for students who cannot participate synchronously.

Recording and Deletion Policies for Academic Year 2020-2021

The Recording and Deletion Policies for the current academic year can be found in the Student Manual under Petitions, Audio & Video Recording on Campus.

- Do not record, share, or disseminate any course sessions, videos, transcripts, audio, or chats.
- Do not share links for the course to those not currently enrolled.
- Any Zoom cloud recordings will be automatically deleted 90 days after the completion of the recording.

Appreciation for Diversity

The University of Chicago believes that a culture of rigorous inquiry demands an environment where diverse perspectives, experiences, individuals, and ideas inform intellectual exchange and engagement. I concur with this commitment and also believe that we have the highest quality interactions and can creatively solve more problems when we recognize and share our diversity. I thus expect to maintain a productive learning environment based on open communication, mutual respect, and non-discrimination. I view the diversity that students bring

to this class as a resource, strength, and benefit. It is my intent to present materials and activities that are respectful of diversity. Any suggestions for promoting a positive and open environment will be appreciated and given serious consideration.

Students with Disabilities

I recognize that students in this class include people with a wide range of visible and invisible disabilities—cognitive, learning, emotional, psychological, and physical, and I welcome all students of various backgrounds and abilities. If there are circumstances that make our learning environment and activities difficult, please contact Student Disability Services at 773.702.6000, or disabilities@uchicago.edu to explore reasonable accommodations.

Students in Need

Graduate students facing challenges securing food or housing who believe this may affect their performance in the course are urged to contact Student Support Services at 773.702.5710 for support. Students in the College may contact the Center for College Student Success at 773.702.1234.

ASTR 25000/35000 Order of Magnitude Astrophysics

Class Topic Schedule and Assigned Readings

Version: 11/07/20

(Note: Expect some adjustments as the quarter progresses)

Week 1:

Class 1 (Tues 9/29): Introductions, Getting your feet wet
Reading: None

Class 2 (Thurs 10/1): Divide and Conquer
Reading: Mahajan Chapter 1, pp. 3-25

Week 2:

Class 3 (Tues 10/6): Abstraction
Reading: Mahajan Chapter 2, pp.28-53

Class 4 (Thurs 10/8): Symmetry and Conservation
Reading: Mahajan Chapter 3, pp. 57-99

Week 3:

Class 5 (Tues 10/13): Proportional Reasoning
Reading: Mahajan Chapter 4, pp.103-135

Class 6 (Thurs 10/15): Dimensional Analysis I
Reading: Mahajan Chapter 5 (5.1-5.3), pp. 139-165

Week 4:

Class 7 (Tues 10/20): Dimensional Analysis II
Reading: Mahajan Chapter 5 (5.4-5.6), pp. 165-192

Class 8 (Thurs 10/22): 2020 Physics Nobel Prize
Reading: THEORETICAL FOUNDATION FOR BLACK HOLES AND THE SUPERMASSIVE COMPACT OBJECT AT THE GALACTIC CENTRE – Nobel Committee for Physics
Note: This class will end early (at 3:30pm Central) to allow everyone to attend the MGM lecture by 2020 Physics Nobel Laureate Andrea Ghez.

Week 5:

Class 9 (Tues 10/27): Lumping
Reading: Mahajan Chapter 6, pp. 199-234

Class 10 (Thurs 10/29): Stars and Planets
Reading: 1) Burrows & Ostriker (2014) first 6 pages (up until "Characteristic Mass of a Galaxy")
2) Crossfield Notes: Chapter 10

Week 6:

Class 11 (Tues 11/3): Probabilistic Reasoning
Reading: Mahajan Chapter 7, pp. 235-276

Class 12 (Thurs 11/5): Easy Cases
Reading: Mahajan Chapter 8, pp. 279-312

Week 7:

Class 13 (Tues 11/10): Spring Models
Reading: Mahajan Chapter 9 (9.0-9.2), pp. 317-330

Class 14 (Thurs 11/12): Radiation
Reading: Mahajan Chapter 9 (9.3-9.5), pp. 331-353

Week 8:

Class 15 (Tues 11/17): Galaxies
Reading: 1) Choudhuri Chapter 6, 6.1-6.5 pp. 153-177
2) Burrows & Ostriker (2014) last 3 pages (from "Characteristic Mass of a Galaxy" until the end)

Class 16 (Thurs 11/19): Tides, the Roche Limit, and Accretion
Reading: Crossfield Notes Chapter 23

****** Thanksgiving Break ******

Week 9:

Class 17 (Tues 12/1): In-Class Problem Solving of Student-Designed Questions (HW8)
Reading: None

Class 18 (Thurs 12/3): In-Class Problem Solving of Student-Designed Questions (HW8)
Reading: None