Order of magnitude astronomy

Ast734

Wednesdays 2:30 - 3:20pm

Jonathan Williams

Ast 734 Order of Magnitude Astronomy

Spring 2015 *Wednesdays 2:30pm-3:30pm*

Jonathan Williams, Institute for Astronomy

Estimation is an essential skill for astronomy and life in general. This course will introduce students to the utility of order of magnitude calculations and practicing the ability to "think on your feet". I will give short overviews of basic physical concepts but the majority of the class time will be spent interactively, with students tackling problems at the whiteboard. Problem sets will be pre-assigned with questions similar (and sometimes identical) to some in the Ohio State course. If time permits, I will challenge the class by extending the problem or asking a new, unseen question.

Grading is based mainly on participation. Showing up and being ready to answer the pre-assigned questions will account for 80% of the grade. If you cannot attend class because of a *good* reason (i.e., **not** because of a pressing deadline for something else), please let me know in advance. Students will submit their own order-of-magnitude astrophysics question and answer for the remaining 20% of the grade.

Introduction to the course -- the one and only lecture to be posted.
Cheatsheet of useful numbers (constants, conversion factors) from Tielen's ISM book. Students should create their own version as the course progresses.

Related courses and reading:

- Eugene Chiang's Order of Magnitude Physics course (Berkeley)
- Sterl Phinney's Order of Magnitude Physics course (Caltech)
- Dave Jewitt's Order of Magnitude Earth and Planetary Sciences course (UCLA)
- Order-of-Magnitude Physics: Understanding the World with Dimensional Analysis, Educated Guesswork, and White Lies (Goldreich, Mahajan, & Phinney)
- The Astronomical Reach of Fundamental Physics (Burrows & Ostriker 2014)

(If any reader of this knows of other good resources, please email me the links.)

www.ifa.hawaii.edu/users/jpw/classes/order_of_magnitude/

Why do OOM?

- Because its quick and gets you close to the right answer, especially in astronomy
- Because its broadly applicable — use across sub-fields, different disciplines, and life in general
- Because its useful for the qual!

How the course will work

- ~2 questions assigned each week. I will collect solutions at start of each class. Additional (unseen) questions may be given during class
- A randomly drawn student goes to whiteboard to show their solution
- Each student creates their own OOM astrophysical question and solution (due April 1st)

Grading

- 80 % for solutions & participation
- 20% for student question
- Actual grade depends on the distribution; if you are >1σ below the mean by Spring Break, I will talk to you.

Guidelines

- Work *independently* on the homework; ask me or other faculty/postdocs for advice but **not** your fellow classmates
- Get away from the computer. See how far you can get without looking stuff up!
- Show up to class *every* week. Absences only allowed with very good excuses (e.g. observing run or conference), and written solutions still to be delivered prior to class
- *Attend the colloquium after class…*

Resources

- not really necessary: mostly you just need a good understanding of physical principles and clear thinking — best done through application — but if you have time and inclination, follow the course web page for links to:
  - similar courses at Berkeley, Caltech, Ohio State
  - Mahajan book

AN INTRODUCTION TO

Modern Astrophysics

Bradley W. Carroll
Dale A. Ostlie

Astrophysics in a Nutshell

Dan Maoz

Strategies (from Mahajan)

- divide and conquer, use symbols
- guerrilla warfare
- lower your standards
- talking to your gut
- cross-check
- scaling
- dimensional analysis

Example

- How overdense is this classroom, relative to the average density in the Universe?

For next week

- create your own cheatsheet of useful numbers (e.g., see webpage)
- Two questions from the Ohio State list:
  - can we see other galaxies rotate?
  - what happens if the Sun is cooled to 0.01K?