Order of Magnitude Physics

Astron 9 Summer 2018
May 21 - Jun 29

Instructors:	Richard Anantua, Jing Luan & Jeffrey Fung	**Time:**	M,W,F 13:30 – 16:00
Email:	astron9a@gmail.com	**Place:**	Campbell Hall: Rm 121

Course Pages:

1. http://classes.berkeley.edu/content/2018-summer-astron-9-001-lec-001

Materials:

- Caltech Order of Magnitude Notes: http://www.inference.org.uk/sanjoy/oom/book-a4.pdf
- Sanjoy Mahajan, *The Art of Insight in Science and Engineering: Mastering Complexity* : https://tinyurl.com/z8cj6gc

Objectives:

This course is an introduction to order-of-magnitude physics - the art of computing practical answers to physical problems in a fast and efficient manner by sacrificing some precision. We will tackle problems using a wide range of physical concepts taken from atomic physics, quantum mechanics, material physics, fluid mechanics, and celestial mechanics. At the same time, it also serves as a survey of astronomical topics. Students will learn about the properties and evolution of astronomical objects, such as moons, planets, neutron stars, black holes, and even the entire universe as a whole, by utilizing order-of-magnitude calculations to obtain a quantitative picture. After this course, order-of-magnitude calculations will become a powerful tool for students to not only answer physical problems, but also to deepen their understanding of the underlying physics.

Prerequisites:

Basic knowledge of calculus such as the concepts of differentiation and integration is required. We assume competence in high-school level physics on topics including Newtonian motion, thermodynamics, wave mechanics, and nuclear and atomic physics. An open mind is highly recommended.

Tentative Course Outline:

Week 1: May 21-25 Basics
Order-of-Magnitude Jeopardy; units and dimensional analysis; error propagation; Buckingham π Theorem; **Brainstorm for Midterm Experiment** (group assignment; rubric given in class)

Week 2: May 28-Jun 1 Atomic and Nuclear Physics
PSet 1 prepared on back of an envelope, delivered by email as scanned or photographed copy by 13:30 Mon.; Standard Model of fundamental particles and interactions; nuclear reactions; Pauli exclusion principle

Week 3: Jun 4-Jun 8 Fluid Dynamics
PSet 2 due before class on Mon.; a touch of fluid dynamics by understanding water waves: deep water, shallow water, surface wave

Week 4: Jun 11-15 Material Physics
A touch of material properties by understanding elasticity and thermal diffusivity; **Midterm Project** (12-Min PowerPoint Presentation and Poster) due on Fri.

Week 5: Jun 18-Jun 22 Celestial Mechanics
PSet 3 due before class Mon.; Orbits (different types of orbits, orbital elements, energy and angular momentum); gravitating bodies in a medium (dynamical friction, gravitational scattering and focusing); secular interaction (excitation of eccentricity, orbit and spin precession)

Week 6: Jun 25-Jun 29 Cosmology: The Universe at Large
PSet 4 due before class Mon.; Universe at large (Big Bang, structure formation, fate of the Universe); **In-Class Final Exam** Wed.; Final Exams returned

Grading Policy: Homework (35%) (PSet1 5%+ PSet2 10%+ PSet3 10%+ PSet4 10%), Midterm (30%) (15% Presentation, 15% Poster), Final Exam (30%), Class Participation (5%).

Important Dates:

Midterm Experiment Announced .. F 17:00 May 25
PSet#1 ..... M 13:30 May 28
PSet#2 ..... M 13:30 Jun 4
Midterm Presentation ..... F 13:30 Jun 15
Midterm Poster ..... F 16:00 Jun 15
PSet#3 ..... M 13:30 Jun 18
PSet#4 ..... M 13:30 Jun 25
Final Exam ..... W Jun 27

Class Policy:

- Regular attendance is essential and expected.
- Late homework will be penalized 50% pts/wk without instructor permission in advance of the deadline.

Academic Honesty: https://teaching.berkeley.edu/berkeley-honor-code