Physics 285A, Modern Atomic, Molecular, and Optical Physics I

Fall 2023 Syllabus

Instructor: Susanne Yelin

Monday, Wednesday, 3:00 – 4:15pm

- **Instructor information**

  Email: syelin@g.harvard.edu
  Online: https://canvas.harvard.edu/courses/123329
  Office hours: TBA

- **TF and section information**

  Name: Abigail McClain Gomez
  Email: amcclain@g.harvard.edu
  Discussion section: TBA

- **Homework**

  There will be about 10 homeworks, every week or every other week.

  Collaboration on homeworks is encouraged, but please note on the homework with whom you worked. Everybody must turn in their own homeworks. Late submission is permissible only with prior instructor consent.

  One homework will consist of scripting or updating the script on one lecture.

- **Grading**

  There will be no exams. Grading will be broken down as follows: 60% homework, 30% research presentations, 10% class participation. The research presentation will be either a 10–20 minute presentation in class or a movie on a topic agreed upon with the instructor.

- **Primary text**

  Lecture notes will be posted on Canvas. These will consist of the handwritten class notes and a typeset version made by the class on overleaf (https://www.overleaf.com/9367543389zwsdvqfbjtyk

  In addition, there are optional textbooks.

- **Optional textbooks**

  1. Cohen-Tannoudji, Dupont-Roc, and Grynberg, *Atom-Photon Interactions*, Wiley Interscience 1992.
  2. C. Foot, *Atomic physics*, Oxford 2005.
  3. Budker, Kimball, DeMille, *Atomic physics: An exploration through problems and solutions,* Oxford University Press 2004.
  4. Haken, Wolf, *The physics of atoms and quanta*, Springer. (Many editions available, latest is 7th, but doesn't matter.)
  5. C. Cohen-Tannoudji, *Atoms in Electromagnetic Fields.* World Scientific, 2005.
  6. Bransden, Joachain, *Physics of atoms and molecules*, Prentice Hall 2003.
  7. Friedrich, *Theoretical atomic physics,* Springer 2006.
  8. Berth, *Sprectra of atoms and molecules*, Oxford 2005.

9. Metcalf, van der Straten, *Laser cooling and trapping,* Springer 1999.
10. Tinkham, *Group theory and quantum mechanics*, Dover 1964.

There might be more books. Let me know if you like some in particular!

- **Contents** (subject to change, in order and contents)

1. Units and fundamental constants
2. Resonance: Physics of two-state systems
   - Theory/Language of two-state systems
   - Weak and strong driving fields: adiabatic passage and Rabi oscillations
   - Density matrix and Bloch Equations
3. Atoms
   - Hydrogen and Alkali
   - Quantum defects/Relativistic corrections
   - Fine structure
   - Lamb shift
   - Hyperfine interaction, isotope effects
   - Atoms in fields
4. Symmetry — a short introduction to group theory
5. Artificial atoms
6. Molecules
7. If there is extra time or a particular demand, the following topics will be included:
   - Line shapes, decay, laser cooling
   - Two-photon processes

- **General University Policies**

  Regarding academic integrity, please refer to the pages on https://gsas.harvard.edu/codes-conduct/academic-integrity

- **Generative AI policies (Text from Harvard College OUE AI guidance website)**

  Certain assignments in this course will permit or even encourage the use of generative artificial intelligence (GAI) tools such as ChatGPT. The default is that such use is disallowed unless otherwise stated. Any such use must be appropriately acknowledged and cited. It is each student's responsibility to assess the validity and applicability of any GAI output that is submitted; you bear the final responsibility. Violations of this policy will be considered academic misconduct. We draw your attention to the fact that different classes at Harvard could implement different AI policies, and it is the student's responsibility to conform to expectations for each course.