UVic Dept. of Physics & Astronomy

Phys 313, Atomic Physics

A01 Winter 2025 (CRN 22577) 1.5 Units

Territory Acknowledgement

We acknowledge and respect the lawanan peoples on whose traditional territory the university stands, and the Songhees, Esquimalt and WSÁNEĆ peoples whose historical relationships with the land continue to this day.

Course Information

Contact Hours

Lectures: Mondays and Thursdays from 11:30-12:50 in Cornett B111 Office hours: Thursdays 130-230 in Elliott 113 or upon request

Course Prerequisites & Corequisites

Students must have completed MATH 204 (Calculus IV) and PHYS 323 (Quantum Mechanics I) Completed/enrolled in one of (PHYS 301, MATH 342, and MATH 346)

Course Instructor & TA

Instructor: Andrew MacRae (Office: Ell 113, email: <u>macrae@uvic.ca</u>) Course Grader: Matt Forbes (<u>mattforbes@uvic.ca</u>)

Learning Objectives

The overall goal for learning the material in this course can be split into two paths:

- 1. Understanding the structure of atoms, and the behaviour of matter
- 2. Using the knowledge of atomic behaviour to explore new technologies.

Course Textbook

Primary:

- "A Student's Guide to Atomic Physics" by Mark Fox (Available in the bookstore)

Secondary:

- "Atomic Physics" by Christopher Foot
- "The Feynman Lectures on Physics" (Available online)
- Any book you used for Phys 216!

Structure

The course will be split into three parts

Part I: Hydrogenic Atoms and the Central Field Approx Part II: Angular Momentum, Lasers, and Spectroscopy. External Fields Part III: Laser Cooling and Trapping, EIT, Computing, Fundamental tests

Evaluation

There will be 3 midterms, each worth 15%, 5 assignments, totalling 50% of your final grade. The lowest assignment grade will be dropped so if you are unable to hand one in for whatever reason, you can drop it without penalty. There will be weekly quizzes on Brightspace totalling 5% of your final mark. There will be no final exam for this course.

Tentative Syllabus

Part 1:

- Lecture 1-2: Intro & Quantum speedrun. Hydrogen review Part 1
- Lecture 3-4: Hydrogen Part II. The shell model and the periodic table.
- Lecture 5-6: Overview of Modern Optics. Interaction of atoms with light
- Lecture 7: Dipole Coupling

Part 2:

- Lecture 8: Angular Momentum review. Intro to Helium
- Lecture 9: Helium
- Lecture 10-11: Fine Structure
- Lecture 12: Lasers
- Lecture 13: Interaction with external fields: Zeeman and Stark
- Lecture 14: Atomic Spectroscopy

Part 3:

- Lecture 15: Radiation Pressure, Optical Tweezers
- Lecture 16: Laser Cooling: Magneto optical traps, evaporative cooling, BECs
- Lecture 17: Ultracold atoms. Semiclassical quantum optics
- Lecture 18: The 2-Level Atom: Rabi frequency, dissipation, dressed states
- Lecture 19: The 3-level Atom. EIT and slow/stopped light
- Lecture 20: Quantum Memory, Optical Lattices (Rydberg States?)
- Lecture 21: fundamental tests: Atomic Fountains, g-2