

Atomic and Optical Physics (Physics 721)

Time: Monday/Wednesdays 2:30-3:50

Room: Physics 1219

Instructors:

Gretchen Campbell, gcampbe1@umd.edu , CSS 2229

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TA: To be announced

Office Hours: Will be by arrangement on Monday/Wednesday/Friday.

Course Goals: The course will provide a graduate-level introduction to atomic and optical physics with 28 total lectures.

Grades: Grades will be derived from homework. There will typically be one problem set per week.

Text: The course will not use a textbook, however the following books are recommended as reference:

The Quantum Theory of Light [Loudon]

Quantum Optics [Scully&Zubairy]

Physics of Atoms and Molecules [Bransden and Joachain]

Atom-Photon Interactions [Cohen-Tannoudji, Dupont-Roc, Grynberg]

Laser Cooling and Trapping [van der Straten and Metcalf]

Course Outline

Light

- Quick review of E&M, modes, momentum, pointing vector
- Quantize EM fields
- Classical theory of coherence, correlation functions $g^{(1)}$ $g^{(2)}$
- HB Twiss , quantum theory of coherence
- Coherent states, squeezing, HO Mandel, quantum erasure.

Atoms

- Spectroscopic notation
- Fine Structure and Lamb Shift
- Helium and multi-electron
- Wigner Eckhart review,
- Hyperfine Structure
- Atoms in external fields: Zeeman and Stark effect

Atoms + Light

- 2-level atoms, Einstein A&B, Rabi spectrum

- Optical Bloch equations, master equations.
- Dipole approximation, dipole radiation pattern.
- Selection rules.
- Line shapes
- Lamb-Dicke effect.
- 3-level systems: EIT/Raman/Cascade Dark states
- Dressed states
- Non-linear optics, SHG and 4-wave mixing

Atomic Motion in Light Fields

- Light shifts and Doppler cooling
- Subdoppler cooling