# Atomic and Optical Physics (Physics 721)

Time: Monday/Wednesdays 2:30-3:50 Room: Physics 1219

**Instructors**:
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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 29 total lectures.

**Grades**: Grades will be derived from homework, two exams and a report in the following proportion: 60% Homework, 15% Midterm, 15% Final, 10% Report.

**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]
Atomic Physics [Budker, Kimball, and DeMille]
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
- Rydberg atoms

## Atoms + Light

- 2-level atoms, Einstein A&B, Rabi spectrum
- Optical bloch equations, master equations.
- Dipole approximation, dipole radiation pattern.
- Selection rules.
- Line shapes, Hanle effect,
- 3-level systems: EIT/Raman/Cascade Dark states
- Lamb-Dicke effect.
- Dressed states
- Non-linear optics, SHG and 4-wave mixing

## Atomic Motion in Light Fields

-Light shifts and Doppler cooling
-Saturated absorption Spectroscopy
-Diffusion constant
- Subdoppler cooling