**Atomic and Optical Physics (Physics 721) Fall 2012**

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

**Instructors**:

 Gretchen Campbell, gcampbe1@umd.edu , CSS 2229

 Trey Porto, Trey.Porto@nist.gov, CSS 2247

**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, including introductions to classical and quantum theories of coherence, atomic structure, quantized light field interactions with atoms and an introduction to laser cooling. The goal is to expose students to a range of topics relevant for atomic physics research.

**Grades**: Grades will be derived from homework, one exams and a report in the following proportion: 65% Homework, 20% Midterm, 15% Paper.

**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

- Brief review of E&M, modes, momentum, pointing vector

- Quantization of EM fields

- Classical theory of coherence, correlation functions g(1) g(2)

- Quantum theory of coherence

- Coherent states, squeezing, HO Mandel, quantum erasure.

# Atoms

- Spectroscopic notation

- Fine Structure and Lamb Shift

- Helium and multi-electron, Hartree Fock

 - Wigner Eckhart review,

- Hyperfine Structure

- Atoms in external fields: Zeeman and Stark effect

# Atoms + Light

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

 - Dressed states, Adiabatic Rapid passage, Landau Zener

 - Wigner-Weisskopf treatment of spontaneous emission.

 - Master equations, Optical Bloch equations

- Non-linear optics, SHG and 4-wave mixing

 - Line shapes, Hanle effect, dispersion, sat. absorption spectroscopy

- Multi-level atoms, selection rules, 6-J symbols and radiation patterns.

 - Selection rules.

- Quantum regression theorem, Mollow triplet.

# Atomic Motion in Light Fields

-Light shifts and Doppler cooling

-Diffusion constant

-Subdoppler cooling