Instructor: Hailin Wang  
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Office hour: 11 am – noon Tuesday

TA: Lucia Schwarz

Text: *Principles of laser spectroscopy and quantum optics*, Berman & Malinovsky  
(Princeton University Press, 2011)

References:

*Quantum Optics*, Scully & Zubairy (Cambridge University Press, 1997)  
*Optical resonance and two-level atoms*, L. Allen and J.H. Eberly (Dover)  
*Elements of Quantum Optics*, Meystre & Sargent (Springer)  

*Quantum and atom optics*, D.A. Steck  

Grading:

- Home work: 30%  
- Mid-term: 30%  
- Final: 40%
Course topics:

1) Atom-field interactions for a two level system
   - Interaction Hamiltonian
   - Fermi’s golden rule
   - Rotating wave approximation
   - Rabi oscillation
   - Dressed states and optical Stark effect
   - Adiabatic passage
   - Rotating frame and unitary transformation

2) Density matrix for a two-level system
   - Equation of motion
   - Damping
   - Bloch vectors
   - Adiabatic following
   - Optical Bloch equations

3) Maxwell-Bloch equations
   - Polarization and susceptibility
   - Slowly varying field approximation
   - Absorption and dispersion
   - Steady state solution
   - Rate equation approximation
   - Power broadening
   - Semi-classical picture of stimulated emission and absorption

4) Semi-classical laser theory
   - Population inversion and optical amplification
   - The laser self-consistency equations
   - Steady state amplitude and frequency

5) Coherent transient phenomena
   - Ramsey fringes
   - Spin echoes
   - Pulse propagation and area theorem
   - Self-induced transparency

6) Pump-probe spectroscopy
   - Lamp dip
   - Coherent wave mixing
   - Mollow spectrum

7) Atomic coherence in a three level system
   - Coherent population trapping and dark states
   - Stimulated Raman adiabatic passage
Electromagnetically-induced transparency
Slow and fast light

8) Mechanical effects of light
   Radiation pressure
   Laser cooling
   Doppler cooling limit
   Recoil cooling limit
   Sysyphus cooling