Physics 208B
Spring, 2005
Instructor: Y. R. SHEN

Course content

This course will focus on laser spectroscopy. The following topics may be discussed.

1. Brief review on lasers.
2. Brief review of nonlinear optics.
3. Wave mixing spectroscopy.
   - Degenerate wave mixing
   - Coherent antiStokes Raman Scattering
   - Multi-dimensional spectroscopy
4. High-resolution spectroscopy.
5. Frequency comb and precision spectroscopy.
6. Coherent transient spectroscopy
7. THz spectroscopy
8. Surface spectroscopy.
9. Detection of single atoms and molecules.
10. Cavity electrodynamics.
11. Strong interaction of light with matter.
    - Dark states
    - Electromagnetically induced transparency
    - Coherent control of optical processes
12. Ultrahigh intensity laser interaction with matter.
13. Laser manipulation of particles.
14. Nanophotonics.

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This course will focus on laser spectroscopy. The following topics could be discussed.

1. Review on lasers.
   Types of lasers; laser characteristics.
2. Review of nonlinear optics.
   Wave mixing; phase matching; parametric process; stimulated light scattering; induced change of medium properties (AC Stark effect, inverse Faraday effect, dress atoms, induced refractive index change, etc.); self-action of light.
3. Wave mixing spectroscopy.
   Degenerate wave mixing: spectroscopy, phase conjugation.
   Coherent antiStokes Raman Scattering: Variations of CARS.
   Multi-dimensional spectroscopy: Double and triple resonances.
4. High-resolution spectroscopy.
   Doppler-free spectroscopy; labeling spectroscopy; hole burning; Ramsey fringes.
5. Frequency comb and precision spectroscopy.
6. Coherent transient spectroscopy.
   Coherent excitation; T_1 and T_2 relaxations; photon echoes; ultrafast spectroscopy; multi-dimensional spectroscopy.
7. THz spectroscopy
8. Surface spectroscopy.
9. Detection of single atoms and molecules.
   Fluorescence and ionization.
10. Cavity electrodynamics.
11. Strong interaction of light with matter.
    Near-resonant approximation; coherent interaction; dressed atoms; electromagnetically induced states
    Dark states
    Electromagnetically induced transparency
    Coherent control of optical processes
12. Ultrahigh intensity laser interaction with matter.
13. Laser manipulation of particles.
    Optical tweezer; optical control of particle motion and rotation.
14. Nanophotonics.
    Spectroscopy of nanoparticles, nonlinear optics of nanoparticles; synthetic optical materials; negative refractive index materials.