Summary
This course discusses the interaction between atoms and visible electro-magnetic radiation and introduces the main instrumentation for light detection and spectroscopy. The principles of LASER light sources are described, providing notions of nonlinear and ultrafast optics.

Content

**Spectroscopies Fundamentals**
- Emission, absorption and dispersion of light
- Quantum mechanics modelling: Einstein coefficients and Planck law
- The spectral lineshape and broadening mechanisms
- Time-dependent quantum mechanics problems

**Radiation measurements:**
- Spectrometers
- Interferometers
- Detectors

**Fundamentals of Lasers:**
- Stimulated absorption and emission of radiation
- Rate equations
- Laser cavities
- Laser gain and mode competition
- Technology, basics and limitations
- Gas, dye, excimer and solid state lasers

**Non-Linear Optics**
- Non-linear optical effects
- Perturbative description of nonlinear optical interactions
- Second Harmonic Generation
- Sum Frequency Generation and Difference Frequency Generation

**Ultrafast Optics**
- Short light pulses generation
- Mode-locking
- Pulse propagation and chirp
- Chirped Pulse amplification

**Keywords**
Atoms, electromagnetic radiation, spectroscopy, laser, light measurement, non-linear optics, ultrafast physics

**Learning Prerequisites**
**Recommended courses**
Quantum mechanics, Electromagnetism

Learning Outcomes
By the end of the course, the student must be able to:
• Link classical and quantum mechanical pictures for the interaction of atoms with electromagnetic radiation
• Explain laser cavities
• Explain the relation between atomic properties and spectroscopic line shapes
• Explain the physics behind a laser
• Describe spectroscopic instrumentation
• Explain nonlinear optical interaction

Transversal skills
• Make an oral presentation.
• Write a scientific or technical report.
• Use a work methodology appropriate to the task.
• Demonstrate the capacity for critical thinking
• Access and evaluate appropriate sources of information.

Assessment methods
30% course project
20% mid-term
50% oral exam

Supervision
Office hours Yes
Others Office: CH H1 565, CH H1 545

Resources
Bibliography
W. Demtröder : Laser Spectroscopy (Springer Verlag, Berlin 1997)
Hertel : Atoms, Molecules and optical physics

Ressources en bibliothèque
• Laser spectroscopy / Demtröder
• Atoms, Molecules and Optical Physics / Hertel

Notes/Handbook
Lecture slides
Reading material