CH-360

Atoms and radiation

Polishchuk Serhii, Versteeg Rolf Baldwin

Cursus	Sem.	Type
Ing.-phys	MA2, MA4	Opt.
Physicien	MA2, MA4	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	Oral
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

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

- Atoms, Molecules and Optical Physics / Hertel
- Laser spectroscopy / Demtröder

Notes/Handbook

Lecture slides
Reading material