Course syllabus

Atom- och molekylspektroskopi Atomic and Molecular Spectroscopy

FAFN25, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED F/Pi
Date of Decision: 2023-04-18

General Information

Main field: Photonics.
Main field: Nanoscience.
Elective Compulsory for: MFOT1
Elective for: BME5-bf, F4, F4-f, F4-mt, F4-es, MNAV2, N4-m
Language of instruction: The course will be given in English

Aim

The aim of the course is to provide theoretical and practical knowledge on the many powerful methods provided by modern atomic- and molecular spectroscopy regarding basic studies as well as practical applications.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to account for spectroscopic methods in different energy intervals
- be able to describe the most common components in spectroscopic equipment for different energy intervals with special emphasis on optical methods and in particular laser spectroscopic methods
- be able to describe what can be measured using spectroscopic techniques
- be able to describe a consolidated image of quantum mechanics and atomic physics and its relation to classical physics.

Competences and skills
For a passing grade the student must

- be abe to carry out some practical work with optical components and lasers
- be abe to find and extract information from scientific literature and the internet and carry out smaller investigations
- be abe to make concise written and oral presentations of smaller projects which they have carried out.

Judgement and approach
For a passing grade the student must

- be able to assess magnitudes for many physical phenomena
- be able to assess which spectroscopic method that would be applicable in a given situation
- be able to describe how spectroscopy can be used as a powerful tool within science and technology.

Contents

The aim of the course is to provide knowledge in modern atom and molecular spectroscopy with special emphasis on practical applications. Overview of atomic and molecular structure implying a specialisation especially regarding molecules.

Radiation and scattering processes: resonant radiation, Rayleigh-, Raman- and Mie-scattering.

Optical spectroscopy: sources of light, optical and spectrally dispersive devices and components and detectors and optical analytical methods.

Lasers: different types of lasers, single mode operation, high power lasers and peripheral equipment.

Laser spectroscopy: time-resolved spectroscopy and high-resolution Doppler-free techniques, orientation in ultrafast spectroscopy and cooling and interception of atoms and ions.

Laser spectroscopic applications: remote sensing of air and water pollutions, combustion and reactions diagnostics and medical applications.

Demonstrations: laser diagnostics including remote sensing and combustion diagnostics.

Laboratory work: fourier transform spectroscopy and flame emission, applied laser spectroscopy on atmospheric gases and doppler-free saturation spectroscopy.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: The assessment is based on a written exam at the end of the course and through compulsory components (laboratory work, lab reports and written and oral project presentations).

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Parts
Code: 0117. **Name:** Laboratory Practice.
Credits: 1,5. **Grading scale:** UG. **Assessment:** Approved written laboratory report after each laboratory exercise. **Contents:** Experimental work as laboratory exercises in small groups. Preparation before and reporting after each exercise is mandatory.
Code: 0217. **Name:** Written Examination.
Credits: 6. **Grading scale:** TH. **Assessment:** Written examination.

Admission

Assumed prior knowledge: FAFA10 Quantum Phenomena and Nanotechnology or FAFF10 Atomic and Nuclear Physics with Applications or (FAFA50 Waves, Optics and Atomic Physics and FAFF45 Physics for Biomedicine).
The number of participants is limited to: No
The course overlaps following course/s: FAF080

Reading list

- Wolfgang Demtröder: Atoms, molecules and photons, An introduction to Atomic-, molecular and quantum physics. Springer, 2010, ISBN: 978-3-64210297-4. Complementary literature. Avaliable as eBook.
- Manuals for the laboratory exercises.
- Sune Svanberg: Atomic and Molecular spectroscopy, Basic aspects and practical applications. Springer, 2004, ISBN: 3-540-20382-6. Main textbook for this course.

Contact and other information

Teacher: Lars Rippe, Lars.Rippe@fysik.lth.se
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Teacher: Stefan Kröll, stefan.kroll@fysik.lth.se
Course homepage: http://www.atomic.physics.lu.se/education/elective-courses/fafn25-fyst14-atomic-and-molecular-spectroscopy/
Further information: It is mandatory to attend the first lecture in order to be admitted to the course.