Faculty of Science

FYSC11, Physics: Atomic and Molecular Physics, 7.5 credits

Fysik: Atom- och molekylfysik, 7,5 högskolepoäng

First Cycle / Grundnivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2010-12-15 and was last revised on 2016-12-05. The revised syllabus applies from 2016-12-05, spring semester 2017.

General Information

Language of instruction: Swedish and English
The course is given in English unless all students speak Swedish.

Main field of studies	*Depth of study relative to the degree requirements*
Physics	G2F, First cycle, has at least 60 credits in first-cycle course/s as entry requirements

Learning outcomes

Knowledge and understanding

On completion of the course, the student should be able to:

- explain the quantum mechanical concepts needed to describe modern atomic and molecular physics
- describe the detailed energy structure of atoms with one or two valence electrons and qualitatively for many-electron systems
- describe some basic experiment from the atom and molecular physics history
- describe how atoms and molecules interact with electromagnetic radiation

Competence and skills

On completion of the course, the student should be able to:

- use basic quantum mechanical concepts and apply them to the physics of atoms and molecules

- plan, carry out and present experiments
- analyze simple atomic and molecular spectra
- at a general level illustrate and describe current research within atomic physics and synchrotron light physics

Judgement and approach

On completion of the course, the student should:

- be able to evaluate experimental results
- show an ability to assess the applicability and limitations of physical models
- independently be able to acquire new knowledge and present these in oral or written form
- demonstrate an understanding of the role of atomic physics in society

Course content

The thematic content of the course:

- The history of atomic physics.
- Basic experiment in atomic physics history e.g. the Stern-Gerlach experiment and Lamb's and Rutherford's experiment.
- Recapitulation of basic quantum mechanical concepts.
- Angular momentum: the electron spin and orbital angular momentum.
- Addition of angular momenta. Clebsch-Gordan coefficients.
- Quantum mechanical treatment of the hydrogen atom, fine structure, the helium atom, spin wave functions, the Pauli principle, LS- and other types of coupling, the central field approximation. Experimental observations of effects connected to these phenomena.
- Electric dipole approximation: Selection rules and relative intensities in radiative transitions.
- X-ray radiation, X-ray spectra, X-ray spectroscopy, Moseley's law.
- Photoelectron spectroscopy.
- Interaction with external magnetic fields, Zeeman and Paschen-Back effect. Hyperfine - and isotope structure.
- Diatomic molecules. The LCAO-method. Molecular orbitals. Quantum mechanical treatment of the energy contributions from rotation and vibration.
- Einstein coefficients: Boltzman distribution, line profiles.
- Laser and applications within laser physics.
- Synchrotron light and applications within synchrotron light physics.
- Applications within astrophysics.
- Laboratory exercises: Zeeman effect, Two-electron spectroscopy and Diode-laser spectroscopy

Course design

The teaching consists of plenary lectures, group tuition and supervision in connection with laboratory sessions. The lectures are mainly devoted to an overview of the theoretical content, problem-solving and presentation of current research results.

The laboratory work, consisting of the actual experiment and a written report, is compulsory and is graded separately from the theoretical part of the course

Assessment

The examination routines contain both written hand-ins and a written final test. Three examinations are given per academic year and module.

Subcourses that are part of this course can be found in an appendix at the end of this document.

Grades

Marking scale: Fail, Pass, Pass with distinction.
To pass the entire course requires approved examination, passed laboratory reports and participation in all compulsory parts.

The final grade of the course is decided through a weighted average of the grades for the written examination and the laboratory sessions according to their individual credits.

Entry requirements

Admission to the course requires the knowledge equivalent to 60 credit points of physics, including the course FYSA21 Tools in Science, 30 credits, or the equivalent.

Further information

The course may not be included in a higher education degree together with FYSA31 Modern physics, 30 credits, or FYSB04 Atomic and Molecular Physics, 7.5 credits.

Subcourses in FYSC11, Physics: Atomic and Molecular Physics

Applies from H14

1003 Exam, 5,0 hp
Grading scale: Fail, Pass, Pass with distinction
1004 Laboratory Exercises, 2,5 hp
Grading scale: Fail, Pass, Pass with distinction

Applies from V11

1001 Oral Exam, 5,0 hp
Grading scale: Fail, Pass, Pass with distinction
1002 Laboratory Exercises and Projects, 2,5 hp
Grading scale: Fail, Pass, Pass with distinction