Faculty of Science

FYSN36, Physics: Molecular Physics, 7.5 credits

Fysik: Molekylfysik, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by The Education Board of Faculty of Science on 2024-12-09. The syllabus comes into effect 2024-12-09 and is valid from the autumn semester 2025.

General information

The course is an elective course for second-cycle studies for a scientific candidate or Master's degree (120 credits) in physics.

Language of instruction: English

Main field of study	*Specialisation*
Physics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Learning outcomes

Upon completion of the course, students will have acquired knowledge of both the theoretical and practical aspects of basic molecular theory and molecular spectroscopy.

Knowledge and understanding

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

- describe how a molecule interacts with electromagnetic radiation via electric dipole transitions and Raman scattering processes
- describe how temperature and molecular symmetry can affect this interaction
- explain the principles of interaction with rotational, vibrational, and electronic states for some of the simple molecules

- describe and compare advantages and disadvantages with different spectroscopic technologies for different wavelength regions from microwaves to X-rays.

Competence and skills

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

- analyse molecular spectra for diatomic and polyatomic molecules
- calculate different parameters such as temperature and moment of inertia from a spectrum of a diatomic molecule
- decide the symmetry characteristics of diatomic and some simple polyatomic molecules based on analysis of different spectra for IR and Raman scattering
- write laboratory reports with a thorough analysis of measurement data
- solve assignments that require use of information from other sources than the course material e.g. via Internet and databases.

Judgement and approach

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

- critically discuss the essential information in an advanced English textbook and literature
- orally and in writing summarise a written project assignment of investigating nature with examples on how molecular spectroscopy can be applied within science, industry or society.

Course content

The course addresses:

- Repetition of atomic structure
- Basic molecular orbital theory (linear combination of atomic orbitals, binding and anti-bonding orbitals, hybridisation of orbitals, covalent bindings, basic molecular properties that can be explained with these theories),
- Born-Oppenheimer approximation
- Spectral transitions
- Selection rules and procedures
- Franck-Condon principle and transition strengths
- Term notations
- Microwave spectroscopy Molecular rotation of simple and polyatomic molecules, technologies for rotational spectroscopy
- Infrared spectroscopy: Vibrations of simple and polyatomic molecules, infrared techniques
- Theory of Raman spectroscopy
- Electron spectroscopy Theory and technologies.

Laboratory session: Computer simulation of simple molecular spectra and adaptation to experimental measurement data
Demonstrations: Emission spectroscopy, Laser-induced fluorescence.

Course design

The teaching consists of lectures, laboratory session and written assignments. Participation in laboratory session, demonstrations and written assignments are compulsory.

Assessment

Examination takes place in the form of written laboratory report and written assignments during the course and a written exam at the end of the course.

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.

Grades

Grading scale includes the grades: Fail, Pass, Pass with distinction
To pass the course requires a passed exam, approved laboratory report, and approved assignments.

The grade scale for laboratory reports is Fail, Pass, while assignments and exam are graded according to the grade scale Fail, Pass, Pass with distinction.

The final grade is determined by a weighting of the results of the exam and the assignments.

Entry requirements

For admission to the course, knowledge is required equivalent 90 credits in natural sciences, including knowledge equivalent to FYSB24, Physics: Atomic and Molecular Physics, 7.5 credits. General entry requirments, English 6/B.

Further information

The course replaces FYST36, Physics: Molecular Physics, 7.5 credits, and credits from that course cannot count towards a degree together with this course

The course is offered at the department of Physics, Lund University.