Faculty of Science

FYST20, Physics:Spectroscopy and the Quantum Description of Matter, 7.5 credits

Fysik: Spektroskopi och materiens kvantmekaniska struktur, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2007-06-14 and was last revised on 2007-06-14. The revised syllabus applies from 2007-07-01, autumn semester 2007.

General Information

The course is an elective course for second-cycle studies for a Bachelor's or Master's degree in the Natural Sciences.

Language of instruction: Swedish and English
The course will be given in English on demand.

Main field of studies	*Depth of study relative to the degree requirements*
Physics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Learning outcomes

After completion of the course the student shall have acquired the following skills and abilities:

The student shall

- be able to describe the basics of the quantum mechanical description of molecules and solid materials,
- be able to explain the physical concepts of such spectroscopies which probe the electronic structure of matter, in particular electron spectroscopy and scanning probe spectroscopy,
- be able to relate the quantum mechanical description of matter to the results of spectroscopy experiments,

- be able to explain the physical background of such microscopies which are based on the measurement of the electronic structure of matter, in particular scanning tunnelling microscopy,
- have treated a course subject in a written report, which fulfils the requirements for scientific reporting,
- have prepared and given an oral presentation, which fulfils the requirements for scientific reporting.

Purpose of the course

The course treats how one can employ spectroscopy to develop a quantum mechanical understanding of the properties of matter. Such an understanding is of fundamental importance in many areas of application in basic and applied research within atomic, molecular, and solid state physics as well as in materials science and chemistry.

The purpose of the course is to achieve a deeper understanding of the quantum mechanical description of matter and the connection to spectroscopy methods. The course is primarily problem based, and the students work with different projects during the course. The course finishes off with a larger project which is presented both in a written report and in an oral presentation.

Course content

Atoms, molecules, and the solid state of matter can be described using the same principles. The electronic structure of matter (i.e. the distribution and dynamics of the electron density) plays a decisive role for its structural and chemical properties, and it is the electronic structure of matter which is mirrored by the results of the spectroscopy techniques used in atomic, molecular, and solid state physics. Therefore, focus is on the description of the electronic structure of molecules and solid materials and its relationship to the spectra obtained in some of the most important spectroscopy methods. Particular emphasis is put on electron spectroscopy. Moreover, the connection between spectroscopy and microscopy is treated for such microscopy methods which primarily image the electronic structure. The course treats the following aspects:

- chemical bonds in molecules and the quantum mechanical description of molecules,
- chemical bonds in solid materials and the quantum mechanical description of solid materials,
- spectroscopies for the probing of the electronic structure of matter, in particular electron spectroscopy and scanning tunnelling spectroscopy,
- microscopy techniques which probe the electronic structure of matter.

Course design

The teaching consists of lectures, seminars, group sessions, hand-in problem solving, and project works. Participation in all parts of the course is mandatory.

Assessment

Written and oral examination in the form of a written project report and an oral presentation at the end of the course. Students who do not pass the regular exam are offered a new possibility shortly after the regular exam.

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 course an approved project report, approved oral presentation, and participation in all mandatory parts of the course are required. The final grade is decided by assessment of the written report and oral presentation in equal parts.

Entry requirements

For admission to the course FYSC01, Physics 3, Quantum Physics, 30 credits, or the equivalent and English B is required.

Subcourses in FYST20, Physics:Spectroscopy and the Quantum Description of Matter

Applies from V08

0701 Spectroscopy and the Quantum Description of Matter, 7,5 hp
Grading scale: Fail, Pass, Pass with distinction