PHYS-407

Frontiers in nanosciences

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Cursus	Sem.	Type
Ing.-phys	MA1, MA3	Opt.
Physicien	MA1, MA3	Opt.

Language of teaching	English
Credits	3
Session	Winter
Semester	Fall
Exam	Oral
Workload	90h
Weeks	14
Hours	**3 weekly**
Courses	2 weekly
Exercises	1 weekly
Number of positions	

Summary

The students understand the relevant experimental and theoretical concepts of the nanoscale science. The course move from basic concepts like quantum size effects to ##hot fields## such as spin transport for data storage applications (spintronics), carbon electronics, or nanocatalysis.

Content

1. Introduction to the concepts of nanoscale science
2. The art of making nanostructures:
a. Bottom-up assembly
b. Top-down fabrication
3. Quantum structures and devices:
a. Current at the nanoscale
b. Quantum technology
4. Carbon nanotechnology:
a. From fullerenes to graphene
b. Molecular electronics and machines
5. Microscopy and manipulation tools:
a. Electron microscopy
b. Scanning probe microscopy: STM, AFM, MFM
6. Spectroscopy tools:
a. Electron and photon spectroscopy: XPS, XAS, Auger
b. Electron and photon diffraction: LEED, TEM, SXRD
c. Synchrotron radiation
7. Magnetism at the nanoscale:
a. Orbital and spin magnetic moment
b. Superparamagnetic limit in magnetic data storage
8. From electronics to spintronics:
a. 2D electron gas at heterogeneous semiconductor interfaces
b. Single electron transistor
c. Spin transport: spin valve, GMR and TMR effects

Learning Prerequisites

Recommended courses

Solid state physics

Learning Outcomes

By the end of the course, the student must be able to:

- Explain the differences between nanoscopic and macroscopic scale
- Analyze the results of a scientific experiment
- Design a scientific experiment

Transversal skills

- Summarize an article or a technical report.
- Access and evaluate appropriate sources of information.
- Use a work methodology appropriate to the task.

Teaching methods

Ex cathedra with visiting of laboratories at EPFL and the Max-Planck-Institute for Solid State Research in Stuttgart, Germany

Assessment methods

oral exam (100%)

Resources

Ressources en bibliothèque

- Quantum Transport, Atom to Transistor / Datta
- Physics of surfaces and interfaces / Ibach
- Surfaces and interfaces of solids / Lüth
- Introduction to Nanoscience / Lindsay
- Physics at surfaces / Zangwill

Websites

- http://moodle.epfl.ch/course/view.php?id=7781