

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
Lecture	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, SXR
 - 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

- 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>

Moodle Link

- <https://go.epfl.ch/PHYS-407>