EPFL

PHYS-745

Spin Dynamics

Ansermet Jean-Philippe, Various lecturers

Cursus	Sem.	Type
Physics		Opt.

Language of teaching	English
Credits	4
Session	
Exam	Oral presentation
Workload	120h
Hours	**56**
Courses	28
Exercises	28
Number of positions	**28**

Frequency

Every year

Remark

Postponed to Fall 2021

Summary

To acquire knowledge about the conceptual building blocks of spintronics, such as the fundament notions of magnetism, spin relaxation and diffusive transport, so as to be able to understand current research and the basic principles that led to breakthroughs in information technology.

Content

This course is intended to develop an understanding of the fundamental notions pertaining to spintronics: magnetism, transport and spin relaxation. The course contents will be as follows:
1. Magnetoresistance, phenomenology, spin-dependent transport
2. Thermodynamics of spin dependent transport, spin diffusion length, GMR
3. Boltzmann theory : introduction, collisions with spin, two-current model, spin accumulation
4. Perpendicular transport and Berry phase : Boltzmann description of Hall and Nernst effect, Mott relations
5. Rashba effect
6. Topological Insulators
7. Principles of spin relaxation : two-level system, relaxation by fluctuating fields, fluctuation-dissipation theorem, spin temperature
8. Mechanisms of spin-flip: spin-orbit scattering, magnetic scattering, Elliott-Yafet and Dyakonov-Perel mechanisms
9. Magnetic resonance : Bloch equations, ferromagnetic resonance, Landau-Lifshitz equation, Stoner-Wohlfarth relaxation
10. Spin waves, magnons, Holstein-Primakov transformation
11. Antiferromagnetic resonance, Pincus model, magnetic polaritons
12. Coherent spin dynamics : resonant pulses, quantum mechanics of spin precession, spin echoes
13. Quadrupolar echoes, double quantum coherence, coherence transfer
14. Dynamic nuclear polarization : Overhauser effect, Thermal mixing

The format of the course is ex cathedra classes followed by a presentation by one of the participant. Participants will be challenged to understand and present to the class one recent paper that would connect to some extent with their PhD research. As much as possible, the presentation will match with topic of the lecture of the same week.
Occasionally, a member of the Institute of Physics, expert in one of the topics, may give the lecture.

Keywords

exchange, RKKY, DM, Rashba splitting, magnetic anisotropies
spin relaxation, spin-dependent transport, magnetic resonance, spin waves

Learning Prerequisites

Recommended courses

Quantum mechanics
Prof. D. Grundler's course on magnetism

Expected student activities

to be able to understand recent research on spintronics or magnetic resonance

Resources

Ressources en bibliothèque

- Fulde / Electron Correlations in Metals and Solids
- Gurevich / Magnetic Osc. and Waves
- Mattis / Theory of Magnetism Made Simple
- R.M. White / Quantum Theory of Magnetism

Moodle Link

- https://moodle.epfl.ch/enrol/index.php?id=15722