PHYS-462

Quantum transport in mesoscopic systems

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Cursus	Sem.	Type
Ing.-phys	MA2, MA4	Opt.
Minor in Quantum Science and Engineering	E	Opt.
Physicien	MA2, MA4	Opt.
Quantum Science and Engineering	MA2, MA4	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	Oral
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

This course aims to introduce the transport behaviors of micron-size systems, emphasizing learning about recent path-breaking experiments on 2D systems such as Graphene and other vad der Waala materials. The course will also introduce the concept of topological protection and strong correlations.

Content

1. Introduction to mesoscoscopic systems and semi classical transport equation
2. One dimensional ballistic transport -Landauer-Buttiker formalism
3. Topological effects - Interger and Fractional quanum Hall effect
4. Fractionally charged particles and anyonic sttistics
5. Chern insulators: Berry's phase, Haldane model and TKNN model
6. Quantum dot: Clulomb blockade and charge transfer
7. Introduction to Graphene: Pseudospin, Hamiltonian, Quantum Hall effect
8. Superconductivity:BCS, BdG hamiltonian and Topological superconductivity
9. Magic angle twisted graphene: Superconductivity and Corrrelated states
10. Semiconducting van der Waals materials and strongly correlated phases of matter
11. Introduction to recent significant experimental works
12. Introduction to topological quantum computation

Keywords

Graphene, Topology, string correlation, superconductivity, quantum Hall effects

Learning Prerequisites

Required courses

Quantum mechanics I and II
Solid state I and II (not mandatory)

Learning Outcomes

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

- Describe current research in the field of mesoscopic systems and quantum devices
- Use theoretical concepts to describe real quantum systems
- Formulate the challenges in the field of device physics and connect to quantum science and technology

Teaching methods

Lectures with student's participation and hands-on activities.

Expected student activities

Actively participate to all lectures by asking questions. Deliver a final presentation on modern research topic.

Assessment methods

Each student will be presenting one of the proposed papers during a final symposium.

Resources

Bibliography

Mesoscopic Physics: An introduction by C Harmans
Electronic transport in mesoscopic system by Supriyo Datta
Semiconductor Nanostructures by Thomas Ihn

Ressources en bibliothèque

- Electronic transport in mesoscopic systems / Datta
- Semiconductor Nanostructures / Ihn

Références suggérées par la bibliothèque

- Mesoscopic Physics: An introduction / Harmans

Moodle Link

- https://go.epfl.ch/PHYS-462