UE Quantum Condensed Matter

Niveau d'étude
Bac +5

ECTS
3 crédits

Composante
UFR Physique, Ingénierie, Terre, Environnement, Mécanique (PhITEM)

Période de l'année
Automne (sept. à dec./janv.)

Diplômes intégrant cet élément

- Master Nanosciences et nanotechnologies

Langue(s) d'enseignement: Anglais
Ouvert aux étudiants en échange: Oui
Code d'export Apogée: PAX9QIAB

Présentation

Description

Teacher : Hermann Sellier (UGA)

Ojectives :
The lecture "Quantum Condensed Matter" provides a theoretical understanding of important quantum effects in solid state systems, including the quantum transport properties of electrons in metals and semiconductors, the macroscopic quantum coherence of superconductivity, and the topological properties of specific band structures.

Program :

Chapter 1: *Mesoscopic physics* :
- scattering process (electrons, phonons, spin, temperature dependence)
- interference effects (Aharonov-Bohm oscillations, weak localization, spin-orbit interaction)
- ballistic transport (1D conductance, quantum point contacts, quantum Hall effect)

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- scattering theory (Landauer-Büttiker formalism, symmetry relations, shot noise)
- quantum dots (level spectrum, Coulomb blockade, stability diagram)

Chapter 2: *Superconductivity* :
- attractive interaction and Cooper pairing
- BCS theory and excitation spectrum
- order parameter and coherence length
- critical field and vortices
- Cooper pair tunneling in Josephson junctions

Chapter 3: *Topological phases* :
- topological invariants, spinors, Berry phase
- 1D SSH model, Kitaev chain, Majorana modes
- 2D systems, Dirac fermions, graphene, Klein tunneling
- quantum Hall effect, Chern numbers, conductance quantization

Bibliography for the lessons and tutorials :

Introduction to mesoscopic physics - Yoseph Imry - 1997 (first edition) **2002** (second edition)
Electronic transport in mesoscopic systems - Supriyo Datta - **1995** (printed) **2013** (numeric)
Quantum transport, introduction to nanoscience - Yuli Nazarov - **2009** (printed) **2012** (numeric)
Electronic quantum transport in mesoscopic semiconductor structures - Thomas Ihn - **2004** (printed and numeric)
Introduction to superconductivity - Michael Tinkham - 1975 (first edition) 1996 (second edition) **2004** (reprint)

Heures d'enseignement

CM	CM	24h

Période : Semestre 9

Infos pratiques

Campus

Grenoble - Domaine universitaire

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