

GS_Quantum_UE_ Condensed Matter



Level
Baccalaureate
+5



ECTS
3 credits



Component
UFR PhITEM
(physique,
ingénierie, terre,
environnement,
mécanique)



Semester
Automne

- > **Teaching language(s):** English
- > **Open to exchange students:** Yes
- > **Code d'export Apogée:** PAX9QIAB

Presentation

Description

Teacher : Hermann Sellier (UGA)

Objectives :

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)
- 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)

Course parts

UE Quantum Condensed Matter - CMTD

Lectures (CM) & Teaching Unit (UE)

24h

Period : Semester 9

Useful info

Campus

> Grenoble - University campus