Announcement

Condensed Matter Theory: Quantum Mechanics on Macroscopic Scales

Björn Kubala

Description

The course explores theoretical and experimental developments in solid state physics over the past twenty years that describe and access quantum mechanical properties on growing length scales and with growing complexity.

Low-temperature properties of condensed matter systems are governed by quantum mechanics. Many-body effects are crucial and may lead to completely new phenomena, determined by the dynamics of new collective degrees of freedom. In superconducting devices, the quantum dynamics of these collective variables can be observed, manipulated, and exploited for applications, e.g., for quantum-information technologies. In this course, we will study the physics underlying such devices and introduce tools for their analysis and description.

This course is part of the specialization module "Condensed matter". It is comprised of 3h lectures and 2h seminars (6 credit points).

Grading will be based on weekly assignments and a project presentation/seminar talk at the end of the semester.

Content

- Introduction
- Macroscopic quantum oscillator
- Nonlinear oscillator: Josephson junction
- From artificial atoms to circuit-QED
- Basics of open quantum systems: master equation
- Single charge transfer
- From circuit-QED to Josephson photonics

Prerequisites

Bachelor courses: Quantum mechanics & Thermodynamics/statistics

Literature

- Michel Devoret, Quantum fluctuations in electrical circuits, Les Houches Lectures, with Uri Vool, arXiv:1610.03438
- Tero T. Heikkilä,The Physics of Nanoelectronics: Transport and Fluctuation Phenomena at Low Temperatures
- P. Breuer and F. Petruccione, The Theory of Open Quantum Systems, Oxford University Press

Additional Information

3h lectures and 2h seminars
6 ECTS credits

Lecturer

Dr. Björn Kubala