EPFL

PHYS-744

Advanced Topics in Quantum Sciences and Technologies

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Cursus	Sem.	Type
Physics		Obl.

Language of teaching	English
Credits	4
Session	
Exam	Multiple
Workload	120h
Hours	**56**
Courses	28
Exercises	28
Number of positions	**40**

Frequency

Every year

Remark

Next time: Fall 2018

Summary

This course provides an in-depth treatment of the latest experimental and theoretical topics in quantum sciences and technologies, with a focus on quantum optics, cold atoms, and the theory of quantum measurements and open dissipative quantum systems.

Content

Quantum transport phenomena in cold atoms and nanoscale systems, Landauer formalism
Transport and relaxation of many-body quantum systems, implementation with cold atoms
Solid state quantum optics for quantum information processing

1. Theory of imperfect detection and projective measurement, introduction to time-correlated single photon counting
2. Generation of non-classical states of light and vibrations (deterministic vs. probabilistic schemes)

Theory of Linear Quantum Measurements and application to:

1. Quantum limits to interferometeric position measurements (Gravitational Wave detection, quantum cavity optomechanics)
2. Backaction evading techniques (Quantum non-demolition measurements and quadrature measurements of motion)

Introduction to the theory of open quantum systems.

1. Derivation of the quantum master equation, both in the Markovian and non-Markovian limits.
2. Stochastic unravelings (quantum trajectory or continuous homodyne measurement), phase space methods (truncated Wigner, P and Q representations, positive-P).
3. Examples of application to the driven dissipative Bose-Hubbard and Rabi models and hands-on efficient numerical implementations.

Keywords

Quantum Optics; Quantum simulation; Quantum measurement; Open systems; Cold atoms; Cavity optomechanics; Single photon detection

Learning Prerequisites

Required courses

Quantum Optics I and II

Expected student activities

To understand current research in the field of quantum science and technology; to undestand the challenges in experimental implementation of QST and be familiar with the theoretical tools used to describe real quantum systems.