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 interferometric 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 understand the challenges in
experimental implementation of QST and be familiar with the theoretical tools used to describe real quantum systems.