

Quantum Information Science and Technology

Module No.: MN-P-PN, MN-P-WaMa

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Course: Platforms for Quantum Technologies

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Category	Type	Language	Teaching Hours	CP	Semester
Specialized Course	Lecture	English	3+1	6	

Requirements for participation:

Quantum mechanics, basic knowledge of condensed matter physics

Type of module examinations:

One written examination at the end of the module

Duration of the course:

1 semester, might be offered as block course

Aims of the course:

Recently, elusive concepts of quantum mechanics such as superposition and entanglement - which have long been regarded as curiosities of quantum mechanics with no practical purposes - have become the key elements of several technological applications. These fledging quantum technologies define a new field of physics and engineering, and may be roughly structured into quantum communication, quantum sensing, quantum simulations, and, last but not least, quantum computing. This lecture will give an overview of the most promising platforms and first applications, following up on a crisp introduction to the basic theoretical concepts needed for their understanding.

Contents of the course:

The lecture is organized in four modules. Topics covered are:

- Basics of quantum information processing
Qubits, quantum operations, measurements, circuit model, quantum teleportation, Deutsch and Grover algorithms, quantum error correction
- AMO (atomic, molecular, optical) platforms
Cavity quantum electrodynamics: single photon sources, implementation of phase gates; quantum simulators: Gases of cold atoms, optical lattices, ground state and excitation dynamics
- Solid state platforms
Charge and electron spin qubits; superconducting qubits; qubit dynamics and control; decoherence; quantum supremacy
- Topological platforms
Topological insulators and superconductors; braiding; Majorana qubit design; topological surface code

Recommended literature:

- Michael Nielsen and Isaac Chuang, Quantum Computation and Quantum Information (Cambridge University press, 2010)