Quantum Information Science and Technology

Module No.: MN-P-PN, MN-P-WaMa Version: 26.09.2019 DG, PN

Course: Quantum Information Theory

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

Requirements for participation:
Linear algebra, Quantum Mechanics

Type of module examinations:
Written or oral examination and one oral examination at the end of the module

Duration of the course:
1 semester

Aims of the course:
In the past 20 years, quantum information theory succeeded in demystifying many counter-intuitive phenomena, by turning them into quantitative questions about precisely defined tasks for information theory and theoretical computer science.
This course provides an introduction to the fundamental protocols of quantum communication and quantum computation.

Contents of the course:
The structure of quantum mechanics
- A first example: Quantum Teleportation
- Finite-dimensional quantum systems, tensor products, density matrices, partial trace, unitary gates, quantum circuits
- Entanglement, Bell Inequalities and the two levels of the No-Cloning Theorem

Quantum Information
- Intro to information theory: Entropies, channel capacities, random coding
- Quantum communication theory: Quantum channels, stabilizer codes
- Quantum key distribution

Quantum Computation
- Grover's algorithm
- Classical Public Key cryptography (about that green padlock in your browser)
- Shor's algorithm
- Brief intro to (quantum) complexity classes

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