Universität Ulm

Master of Science Physics (PO 2019)

Seminar Quantum Technology

Code	8812875293
ECTS credits	3
Attendance time	2
Language of instruction	English
Duration	1
Cycle	irregular
Coordinator	Dean of Physics Studies
Instructor(s)	Prof. Martin Plenio, Dr. Jan Haase
Allocation of study programmes	Physics M.Sc., elective module
Recommended prerequisites	Fundamentals of quantum mechanics
Learning objectives	Students who successfully completed this module • have an overview on the most important aspects in quantum technology (2nd generation) • are able to analyse relevant scientific literature and to report on its contents.
Syllabus	Quantum Technologies are currently in their biggest upswing and the daily progress promises high impacts in many aspects of science and our daily live. The applications range from the simulations of molecules and high-energy physics, finance and complex optimization problems to high-resolutions sensing and medical imaging. In this seminar, we will learn about the quantum hardware, but also the software that is necessary to achieve the quantum advantage and where we stand today. Topics:

- How to build a quantum computer
- Hardware platforms: Ion traps, Superconducting qubits, NV centers, Photonics
- Hardware-related programming: Realization of Quantum Gates
- Software: Shor’s algorithm, Gate and Measurement based computation, Quantum Error Correction
- Quantum-classical Hybrid Devices for Quantum Chemistry: Quantum Approximate Optimization and Variational Quantum Eigensolver
- Feynman’s Dream: The Quantum Simulator
- Fundamentals of Quantum Metrology
- The fierce enemy: Quantum Noise
- Quantum Technologies for Medical Imaging: Hyperpolarization
- Dynamical Decoupling, NMR
- Google: Quantum Supremacy
- Future and near-term applications

Literature	-
Teaching and learning methods	Seminar (2 hours per week)
Workload	30 hours presence time 60 hours preparation of a scientific talk Total: 90 hours
Assessment	The module examination consists of completing an assignement on a given topic and a graded oral presentation of the results as well as participating in the discussion.
Grading procedure	The module grade is equal to the examination grade.
Basis for	Specialisation in the field of quantum information and quantum technology