

Condensed Matter Physics

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

Course: Quantum nanoscience with a low-temperature scanning probe microscope

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Category	Type	Language	Teaching Hours	CP	Semester
Specialized Course	Lecture	English	2	3	WiSe

Requirements for participation:

Basic knowledge of condensed matter physics

Type of module examinations:

Oral examination

Duration of the course:

1 semester

Aims of the course:

Provide a practical introduction that helps orienting in the emerging field of quantum nanoscience and encourages further self-study.

Contents of the course:

Quantum nanoscience aims to understand, engineer and technologically exploit the effects of such quantum phenomena as superposition and entanglement in various nanostructures. This course introduces quantum nanoscience mainly from the perspective of its low-temperature scanning probe microscopy (LT-SPM) studies.

Topics covered include:

- SPM instrumentation and methodology at low temperature and high magnetic field
- Electron tunneling in ultra-small vacuum junctions
- Forces acting on atoms and molecules on surfaces
- SPM manipulation of single atoms and molecules
- Electronic and spin states of artificially built nanostructures and lattices
- Entanglement of individual electron spins in nanostructures
- Kondo effect produced by individual atomic and molecular adsorbates

Recommended literature:

- Skriptum (available during the course)
- Voigtländer, Scanning Probe Microscopy
- Pobell, Matter and Methods at Low Temperatures
- Israelachvili, Intermolecular and Surface Forces
- Printouts of scientific publications (will be distributed during the course)