UNIVERSITÄT LEIPZIG

BuildMoNa

SCIENTIFIC AND METHOD MODULES

Module name	**Quantum Coherent Structures**
Number	2014-A3
Aims	This module deals with coherent quantum states which occur in so-called mesoscopic systems, i.e. condensed matter systems intermediate between the atomic scale and the macroscopic world. While macroscopic objects are described by average properties derived from its constituent materials and usually obey the laws of classical mechanics, a mesoscopic object is affected by fluctuations around the average, and is subject to quantum mechanics. For example, in contrast to the conductance on the macroscopic level which increases continuously with the diameter of a wire, at the mesoscopic level, the conductance is quantized – the increase occurs in discrete steps. On the fundamental level, interference processes and the quantum Hall effects are part of mesoscopic physics. From a more applied point of view, mesoscopic physics is very relevant for the ongoing miniaturization of transistors and other electronic devices, which in the future will operate using quantum mechanical principles and in this way support solid state quantum information processing. The fundamentals of the field and several examples will be considered.
Basics	***Recommended knowledge:*** thematic module T3 ***Required knowledge:*** quantum mechanics, statistical mechanics, electron transport
Contents	Coherent transport, conductance quantization, quantum dots, nonequilibrium (shot) noise, anyons and fractional statistics, electronic and anyonic interferometers, dephasing and decoherence, quantum measurement, solid state qubits, solid state quantum information processing
Methods	Theoretical methods of modern solid state physics
Type	Two-day block course/ yearly recurrence with modification
Date (month/year)	6-7 October 2014
Time	
Work load	15 hours presence/ 45 hours self-study
Examination	Written
Credit points	2
Responsible scientists	Rosenow, Haase
International guest lecturers	Prof. Yuval Gefen, Weizmann Institute of Science
Industrial partners	
Recommendations for literature, e-learning	Y. Imry, Introduction to mesoscopic physics, Oxford University Press T. Ihn, Semiconductor Nanostructures, Oxford University Press Y.V. Nazarov and Y.M. Blanter, Quantum Transport: Introduction to Nanoscience, Cambridge University Press

SCHEDULE for Module 2014-A3

Time	Lecturer	Programme	Location
6 October 2014			
9:00-10:30	Prof. Gefen	Coherent transport, conductance quantization	ITP, SR 210
11:00-12:30	Prof. Gefen	Quantum dots	ITP, SR 210
14:00-15:30	Prof. Gefen	Nonequilibrium (shot) noise	ITP, SR 210
16:00-17:30	Prof. Gefen	Anyons and fractional statistics, electronic and anyonic interferometers	ITP, SR 210
7 October 2014			
9:00-10:30	Prof. Rosenow	Quantum Measurement	ITP, SR 210
11:00-11:45	Prof. Rosenow	Dephasing and decoherence	ITP, SR 210
13:30-15:00	Dr. Romito	Solid state qubits	ITP, SR 210
15:30 -17:00	Dr. Romito	Quantum information processing	ITP, SR 210

Didactic elements:
Lecture, discussions, problem solving

Expected performance:
Active participation in discussions of in-class examples etc.