WS06/07
Quantentheorie der Kondensierter Materie II:
Mesoscopic Physics
Lecture 52 271, 4st., Mo, Do 10:15 -11:45, H 35
Übungen: 52 272, 2st, Di 13-15, Phys. 7.1.21; 15-17, Phys. 5.1.03, 5.1.10

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SYLLABUS

I. Introduction to mesoscopics: persistent currents, Si MOSFET and GaAs/GaAlAs HEMT, important scales in mesoscopics, classification of transport, the many facets of the Drude formula.

II. Boltzmann semiclassical transport: Boltzmann equation, linearization, magnetogalvanic phenomena, conventional Hall effect, classical point contact.

III. Transverse modes: density of states in 1, 2, and 3 dimensions, electric and magnetoelastic transport modes (Landau levels) in a 2D quantum wire.

IV. Landauer formalism of quantum transport: quantum point contact, contact resistance, Landauer formula, Landauer-Buttiker formula, multiterminal resistance, Onsager relations, reciprocity relations, examples of multichannel transport. aharonov-bohm rings.

V. The transmission matrix: adiabatic approximation, S-matrix and T-matrix, single electron Green’s functions, self-energy, numerical algorithms.

VI. Integer Quantum Hall effect: Shubnikov-de Haas oscillations, edge states, Landauer-Buttiker formalism.

VII. Single-electron tunneling: tunneling through a rectangular barrier, transfer matrix, resonant tunneling, Coulomb blockade, tunneling Hamiltonian.

VIII. Linear response and Kubo formula: linear response, Green’s functions, current operator.

IX. Disordered conductors: introductory concepts, scaling theory of localization, coherent tunneling and localization, free particle Green’s function, perturbation theory and Feynman diagrams, Drude transport formula from diagrammatics and diffusons, weak localization and cooperons.

Attendance of recitation classes (übungen) is vital for successful completion and understanding of the course. The grade/credit will be given based on homework and a project presentation. Homework as well as the list of projects (reading assignments) will be posted on the course web site.

Literature:
S. Datta, Electronic transport in mesoscopic systems, Cambridge University Press 1995

Course Web site:
www.physik.uni-regensburg.de/forschung/fabian/pages/teaching_files/mesoscopic_physics.html