



UNI
BASEL

Prof. Dr. Dominik Zumbühl
Klingelbergstrasse 82

Tel +41 61 267 3693
Fax +41 61 267 3784

dominik.zumbuhl@unibas.ch
<http://ZumbuhlLab.unibas.ch>

Dept. of Physics
CH-4056 Basel

University of Basel
Switzerland

Spezialvorlesung HS 2008

Introduction to Mesoscopic Physics and Quantum Dots

- 2hr course** for 6. Semester bachelor and master students (Physics III/IV is a prerequisite)
- 2 credit points** no problem sets, moderate reading assignments, final presentation, pass/fail
- + 2 credit points** optional: exercises, consisting of reading, presenting and discussing papers in class
- purpose** **of this lecture** is to bring the audience up to date on current experimental research in the field of quantum transport through nanostructures, focusing mainly on quantum dots in GaAs, spin-qubits in coupled dots and quantum computation. The lecture will inevitably discuss some simple condensed matter theory but will mainly focus on experiments.
- 10 lectures** **lectures introducing basics and background** (~10 weeks)
2D electron gas, magnetotransport, interger and fractional quantum Hall effect, Landauer-Büttiker formalism, ohmic contacts, lateral gating, nano fabrication techniques, low temperature methods, *quantum point contacts and conductance quantization, quantum dots, conductance fluctuations, weak localization, phase coherence, Coulomb blockade, Kondo effect, double quantum dots, spin qubits, topological qubits, quantum computation*
- presentations** **by participants** (~3 weeks)
each talk covers a subtopic, focusing on one or two research articles, ca. 25mins plus 5min discussion

possible topics include:
charge sensing, charge manipulation, spin blockade, spin relaxation, single spin readout, nuclear spins, spin qubit coherence, electron spin resonance

Literature

review articles (available on webpage, to be updated soon)

"*Quantum Transport in Semiconductor Nanostructures*", C. W. J. Beenakker and H. van Houten, published in *Solid State Physics*, 44, 1-228 (1991) (out of print, available at arXiv:cond-mat/0412664)

"*Electron Transport in Quantum Dots*", L. P. Kouwenhoven, C. M. Marcus, P. L. McEuen, S. Tarucha, R. M. Westervelt and N. Wingreen, NATO ASI conference proceedings, edited by L. L. Sohn, L. P. Kouwenhoven and G. Schön (Kluwer, Dordrecht, 1997).

"*Coulomb Blockade Oscillations in Semiconductor Nanostructures*", H. van Houten, C. W. J. Beenakker and A. A. M. Staring, published in *Single Charge Tunneling*, edited by H. Grabert and M. H. Devoret, NATO ASI series B294 (Plenum, New York, 1992), (out of print, avail. arXiv:cond-at/0508454).

"*Few-Electron Quantum Dots*", L. P. Kouwenhoven, D. G. Austing and S. Tarucha, *Rep. Prog. Phys.* **64**, 701 (2001).

books

"*Mesoscopic Electronics in Solid State Nanostructures*", Thomas Heinzl, Wiley-VCH (2003)

"*Electronic Transport in Mesoscopic Systems*", Supriyo Datta, Cambridge University Press (1995)

"*The Physics of Low-Dimensional Semicond.*", John H. Davies, Cambridge University Press (1998)

<http://zumbuhlLab.unibas.ch/pages/teaching/MesoDotsHS08.htm>