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Spezialvorlesung FS 2012

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, (grade 1-6)
- + 2 credit points** optional: exercises, consisting of reading, presenting and discussing papers in class
- purpose** **of this lecture** of this lecture is to give an introduction to the physics of quantum transport in electronic nanostructures and qubits, discussing among other topics GaAs spin qubits. The lecture will inevitably discuss some simple condensed matter theory but will mainly focus on experiments
- lectures** **~10 lectures (2h each) introducing basics and background** (~10 weeks)
semiconductor surfaces and interfaces, 2D electron gas, quantum point contacts, quantum dots, conductance fluctuations, quantum phase coherence, Coulomb blockade, Kondo effect, few electron dots, spin blockade, spin relaxation, charge sensing, single spin measurement, spin manipulation and coherence, nuclear spins, electron spin resonance, spin qubits, quantum computation
- presentations** **by participants** (~2 - 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, dynamic nuclear spin polarization, carbon nanotubes, graphene, plus many more, see webpage

Literature: review articles (available on webpage)

- "*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)

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