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Spezialvorlesung FS 2013

Mesoscopic Physics and Quantum Dots

2hr course for 6. Semester bachelor and master students (Physics III/KOMA is a prerequisite)

2 credit points moderate reading assignments, final presentation, grade 1-6

+ 2 credit points optional exercises: 3-4 problem sets, reading, presenting, 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, *Solid State Physics*, 44, 1-228 (1991) (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 proceedings* (Kluwer, Dordrecht, 1997).

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

"Electron transport through double quantum dots", W. G. van der Wiel, S. De Franceschi, J. M. Elzerman, T. Fujisawa, S. Tarucha, and L. P. Kouwenhoven, *Rev. Mod. Phys.* **75**, 1-22 (2003).

"Spins in few-electron quantum dots", R. Hanson, L. P. Kouwenhoven, J. R. Petta, S. Tarucha, and L. M. Vandersypen, *Rev. Mod. Phys.* **79**, 1217-1265 (2007) pdf

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/teaching>