Experimentalphysik 1 and SFB 631-Seminar

Wednesday October 24th 2012 – 15:45h

Seminar room 344-R

Coherent optical control of spin qubits in self-assembled quantum dots molecules

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Ultrafast photocurrent spectroscopy provides exquisite sensitivity, facilitating coherent charge and spin control in individual quantum dot (QD) nanostructures [1]. Here, we apply pump-probe photocurrent spectroscopy to directly probe few-Fermion charge and spin dynamics in individual quantum dots and QD-molecules formed from a pair of vertically stacked self-assembled InGaAs dots. While for single quantum dots the tunnel rates out of the molecule are well described by WKB theory [2], the results obtained for quantum dot molecules elucidate the comparative roles of ultrafast (<5ps) elastic and inelastic intra-molecule electron tunneling and directly map out the spectrum of exciton-acoustic phonon coupling in the system [3]. In polarization resolved measurements we utilize the ultrafast electron tunneling to initialize a single hole spin in <5ps with a purity of > 96% (only limited by noise). The time-dependent spin configuration is probed by the spin selective optical absorption of the resulting few fermion complex. Measurements in a lateral magnetic field monitor the coherent Larmor precession of a single hole spin with no observable loss of spin coherence within the ~300 ps hole lifetime [4].

References

[1] M. Zecherle et al. PRB 82 (2010)
[2] K. Müller et al. Annalen der Physik (2012), accepted for publication
[3] K. Müller et al. Phys. Rev. Lett. 108, 197402 (2012)
[4] K. Müller et al. Phys. Rev. B 85, 241306(R) (2012)