Seminarankündigung

Dienstag, 6. Mai 2014
15:00 Uhr

WSI, Seminarraum S 101

"Experimental progress in quantum information processing using spins in self-assembled quantum dots"

A single electron trapped in a self-assembled quantum dot (SAQD) has been shown to be an excellent candidate qubit for quantum information processing applications: the ability to initialize, manipulate, and measure such a single qubit through optical means has been demonstrated in numerous studies over the past several years. The coherence times ($T2$) of such qubits have also been measured, and shown to exceed 1 μs, which is >104 times longer than the time required to perform an arbitrary single qubit operation (~50 ps).
One very important remaining challenge for SAQD-based spin qubits is the need to demonstrate an operation that can perform a two-qubit gate on neighboring spin qubits situated on a lattice. A number of proposals have been published that show how a two-qubit gate between QD spin qubits that are hundreds of nanometers distant may be implemented using nearby excitons and exciton-polaritons. Unfortunately, despite more than a decade having passed since the release of the first proposal, there has been scant progress in experimentally demonstrating such schemes.
I will begin with a synopsis of experimental results in spin-based QIP using SAQDs from the past several years, with emphasis on our somewhat more recent work showing entanglement between a spin and an emitted photon.
I will summarize our recent proposal for implementing single-shot spin readout using exciton-polaritons, which is another remaining challenge. This scheme relies on a very similar setup to the exciton-polariton-based two-qubit gate proposals: the QD is grown near a quantum well (QW), so that excitons created in the QW have a non-negligible spatial wavefunction overlap with the spatial wavefunction of the qubit electron in the QD. This results in an exchange interaction between the qubit electron and the electrons that form part of the exciton-polaritons. I will present results from experiments in which we have succeeded in demonstrating this exchange coupling, which several proposals rely on.

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