Sonderforschungsbereich 631

Festkörperbasierte Quanteninformationsverarbeitung

TECHNISCHE UNIVERSITÄT MÜNCHEN

Seminar Announcement

Friday, April 16, 2004, 13.00 h
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Double Quantum Dots as Spin Qubits

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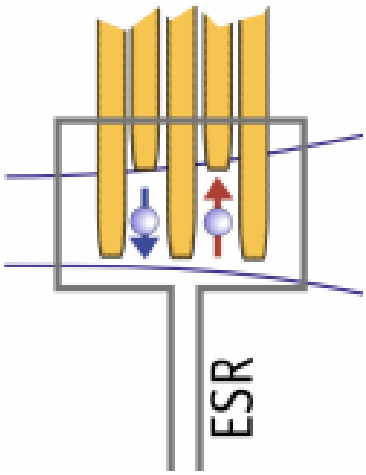
We review experiments on double quantum dots and evaluate their use for spin-qubit circuits. Our quantum dots [1] are defined by metallic gates in the two-dimensional electron gas of a semiconductor heterostructure. It has been demonstrated that two quantum dots can be coupled coherently via tunneling such that bonding/anti-bonding superpositions are formed [2]. The strength of the tunnel coupling can be tuned by means of gate voltages. Inelastic relaxation processes from an excited state to the ground state is strongly reduced when the transition involves a spin-flip. The relaxation times for transitions between 2-electron triplet and singlet states is of the order of milliseconds.

We presently focus on realizing spin-qubit circuits. These little circuits have to include a double quantum dot with controllable tunnel coupling between the dots; electron-spin resonance loop for performing single spin rotations; and a non-invasive read-out system. Our read-out is performed by a quantum point contact detector. Parts of this little qubit circuit are now being tested, some parts are already working.



A qubit can be formed by the coherent superposition of the up and down spin states of a single electron in a quantum dot. The manipulation between up and down should be controlled by single-spin ESR. Two-qubit operations (e.g. SWAP) can be performed by coupling adjacent spins by the exchange interaction over a controllable time scale. The final result needs to be read at the output with a single spin accuracy. This qubit setup was proposed by Loss and DiVincenzo.

[1] For a review on quantum dots see**:** *Few-electron quantum dots,* L.P. Kouwenhoven, D.G. Austing and S. Tarucha, Rep. Prog. Phys. **64**, 701-736 (2001). This review and other papers can be found at http://qt.tn.tudelft.nl/grkouwen/kouwen.html

[2] *Double transport through double quantum dots.* W. G. van der Wiel, S. De Franceschi, J. M. Elzerman, T. Fujisawa, S. Tarucha and L. P. Kouwenhoven, Reviews of Modern Physics **75**, No.1, 1-22 (2003)
See also http://qt.tn.tudelft.nl/grkouwen/leok/RMP03Wilfred.pdf

gez. R. Gross