Spin based Quantum Information Processing in Nanostructures

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Spins of electrons offer the opportunity to store and manipulate phase coherence over length and time scales much larger than for charge, with promising applications in conventional and in quantum information processing [1,2]. The qubit is defined in terms of the spin of an electron, being localized in structures such as an atom, molecule, quantum dot etc. The desired manipulation of the spins (qubits), which includes single spin rotations, spin-spin interactions, and spin read-out, can be achieved by purely electric means in terms of gates which are externally controlled by voltage pulses (spin-charge-conversion). I discuss schemes for using a single quantum dot as a spin filter and spin read-out device [3], and show how the spin decoherence time can be measured in a transport set-up [4]. I address the issue of spin decoherence due to non-uniform hyperfine interactions with nuclei (being the dominant source of decoherence) and show that for electrons confined to dots the spin decay is non-exponential [5]. If time permits I will also address the issue of entanglement in electron transport for quantum communication in nanostructures [6,7].

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