Electron Spin Qubits in Quantum Dots

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Spin-1/2 particles are natural quantum bits (qubits), which can have very long coherence times and can be coherently controlled with remarkable accuracy [1]. The use of electron spins in GaAs/AlGaAs quantum dots as qubits is particularly attractive, for it combines an accessible technology with a potential for scaling to large numbers of qubits [2]. We have developed a set of ideas for the initialization, coherent manipulation, read-out and characterization of electron spins in quantum dots [3], and have taken the first steps towards the realization of these ideas. First, we succeeded to place one electron on each of two lateral, coupled quantum dots [4]. Then we have directly observed the Zeeman splitting of a single electron via electrical transport through a one-electron quantum dot [5]. Next, we have performed a pulsed transport experiment [6] in order to measure the relaxation time for a single electron in a quantum dot, obtaining a lower bound of 50 μs [5]. We are now preparing experiments to achieve single-shot read-out and coherent manipulation of the spin of a single electron on a quantum dot.

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