Single Electron Transfer Between Distant Quantum Dots

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GaAs lateral quantum dots have proven to be good candidates for spin qubit implementation: qubit initialization, rotation and two qubit operations have been demonstrated successfully. However, in order to build quantum information devices, it is necessary to be able to entangle distant qubits. Transferring coherently a single electron spin between two distant quantum dots is a viable solution towards this goal. We demonstrate the experimental realization of high efficiency single electron source and single electron detector for a quantum medium where a single electron is propagating isolated from the other electron. The moving potential is excited by a surface acoustic wave (SAW), which carries the single electron along a gate defined 1D-channel at a speed of 3 μm/ns. When such a quantum channel is placed between two quantum dots, a single electron can be transported from one quantum dot to the other, which is several micrometres apart, with high quantum efficiencies of emission and detection. Furthermore, the transfer of the electron can be triggered on a timescale shorter than the coherence time T2* of GaAs spin qubits. Our work opens new avenues to study the teleportation of a single electron spin and the distant interaction between spatially separated qubits in a condensed matter system.