

Ballistic electron transfer between quantum dots

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We observe ballistic transport of electrons from one quantum dot (QD) to another QD in Coulomb blockade. Our recent experimental efforts aim at realizing a weak-measurement protocol in a solid-state environment. The process of a quantum measurement and its resulting projection of the state vector on an eigenstate of the measurement Hamiltonian is a cornerstone of quantum mechanics. In 1988 Aharonov *et al.* [1] introduced the concept of a weak measurement. In a weak measurement the system is weakly coupled to the measuring device. In a second step a strong von Neumann measurement is performed to post-select the system. The introduced concept has since been successfully applied in a few experiments (e.g. [2, 3]).

Our system of choice is a top-gated GaAs/AlGaAs heterostructure. The sample consists of two double QDs with nearby quantum point contacts acting as sensitive charge detectors. A scanning electron micrograph of the sample is shown in Fig. 1. The two QDs can be tuned individually for selective energy filtering in the system.

An energy scheme describing the ballistic transport is shown in Fig. 2(a). The measurement data is shown in Fig. 2(b). The energy level of the detector dot is set to $\approx 200 \mu\text{eV}$ above the Fermi level. Now the source level is swept together with the emitter dot level and the current through the detector dot is recorded. The red peak around $V_{\text{emitter}} = -200 \mu\text{V}$ corresponds to ballistic transfer of electrons. The blue region at higher energies corresponds to electrons which are relaxed in the center reservoir. In the future we plan to implement a weak measurement protocol using one QD for the weak measurement while the post-selection will be done in the second QD.

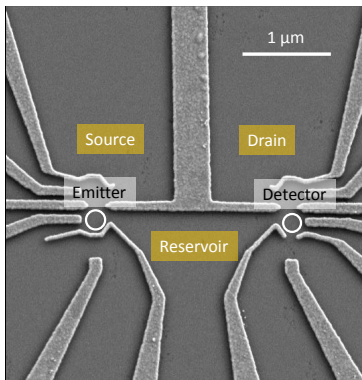


Figure 1: Scanning electron micrograph of a top gated AlGaAs heterostructure sample. The two quantum dots are indicated by circles.

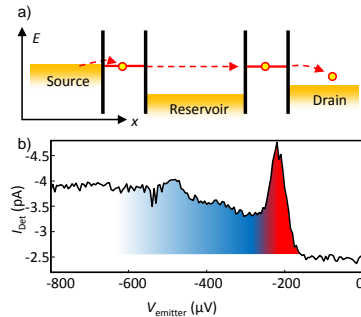


Figure 2: (a) Energy scheme describing the ballistic transport. (b) Detector current as a function of emitter voltage. A pronounced ballistic peak (red) and a region of energy relaxed electrons (blue) is observed.

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