25: Seeing real-time electron tunneling processes

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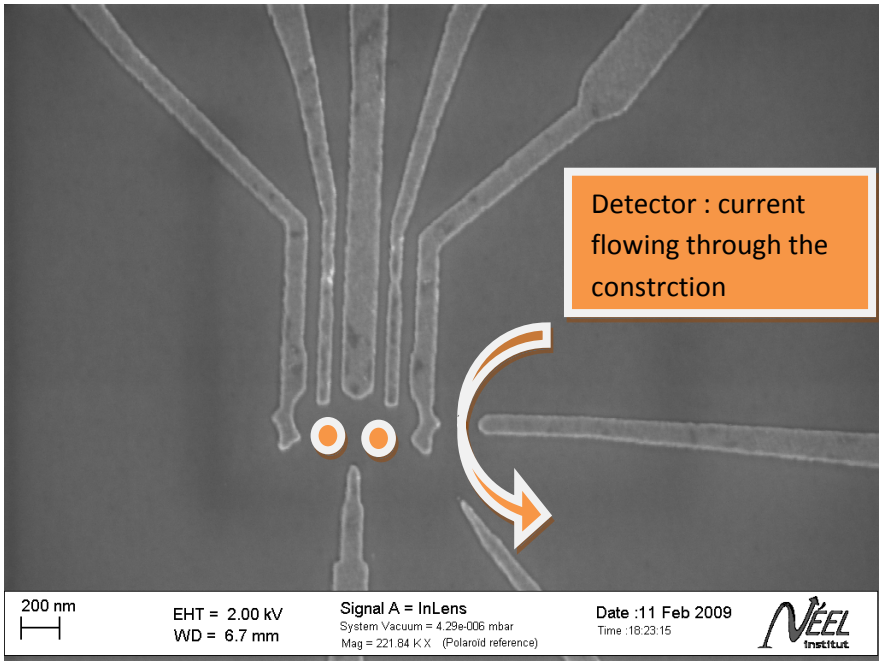
Nowadays, a single quantum particle, for instance an electron, can be isolated and manipulated in semiconductor GaAs nanostructures. It opens the path towards the investigation of coherence effects and realization of entangled states in nanostructures.

In GaAs heterostructures, to isolate a single electron one can define an electrostatic trap for electrons called a quantum dot by applying negative voltages on fine gates defined on top of the nanostructure (see the picture, the center of the trap is the orange circle). All the quantum dot parameters can be controlled electrostatically. In particular, the time for the electron to get out from the dot can be tuned from almost Hz to GHz.

To detect the presence or the absence of the electron in the quantum dot, an electrometer is defined on chip. It consists of a narrow constriction where current can flow (see picture). Due to its small width, of the order of the wavelength of the electron, the current flowing through this constriction is very sensitive to its electrostatic surroundings and therefore to the presence or the absence of the electron.

The purpose of this practice course is to observe single electron tunneling events from the quantum dot to the reservoir in real time.



Ref.: T. Meunier et al, Phys. Rev. B 74, 195303 (2006).