INSTITUT NEEL Grenoble

Proposition de Thèse - Année universitaire 2015-2016

Spin-sensitive Tunneling in Superconductor - Quantum Dot junctions

When inserting a single quantum dot (QD, a molecule or a nanoparticle) between two superconducting (S) contacts, the resulting device has fascinating electronic conduction properties, which reflect the coupling of discrete orbital quantum energy levels to superconductivity. We have recently demonstrated the dynamical properties of such devices, which show up when probed at high frequencies. In particular, the probability and direction of tunneling of each single electron can be very precisely tuned. With S-QD-S junctions, we have thereby built and studied a quantum metrological electron source demonstrating a quantized current.

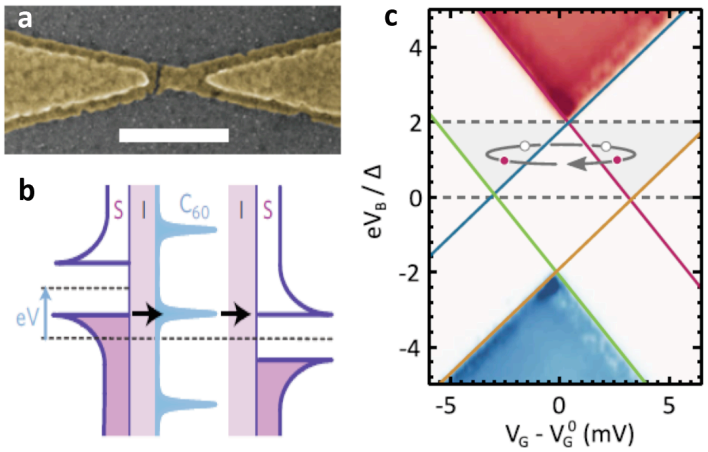

***Figure**: **(a)** SEM image of a superconducting break junction in which the QD is inserted. **(b)** Energy diagram of S-QD-S device showing possible electron tunneling events. **(c)** Current map of device. DC current flows through a S – Quantum Dot – S device only for values of bias and gate voltages (V_B,V_G) corresponding to the red and blue regions. A trajectory of (V_B,V_G) along the line shown however allows exactly one electron to be transferred across the device.*

The goal of this thesis is to study the above tunneling properties spin-selectively. Zeeman splitting the orbital quantum dot levels can lift the electronic spin degeneracy. Thereby, only electrons of a given spin are allowed to tunnel to/from the superconductor. From this, one can obtain a spin-polarized single electron current source.

This experimental work involves nanofabrication of superconducting nano-junctions relying on a technique well mastered in the group, at *Nanofab* platform. The student will perform ultra-sensitive electronic transport measurements in a dilution refrigerator below 0.1 K, both at low and high frequencies.

Interactions and collaborations:
This project is in close collaboration with theoreticians from LPMMC in Grenoble (D. Basko and coworkers). We are also collaborating with Prof. Jukka Pekola (Helsinki) on this topic in the frame of his *chaire d'excellence* in Grenoble.

Formation / Compétences :
Master ou équivalent en cours dans les domaines de la Matière Condensée, Physique Quantique, Nanophysique.

Période envisagée pour le début de la thèse: Summer 2016

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