Graphene-based superconducting quantum bit

Project descrption:

The future of nanoelectronics will be quantum. The downscaling in electronics has now reached a point where the size of the devices (less than 10 nm) means that their quantum behavior must be taken into account. While this might be seen by some industries as a major problem this also gives a real opportunity to imagine and build devices with new quantum functionalities.

A key building block for future quantum electronics systems is the quantum bit. Such system has two possible states (0 and 1) that follow the laws of quantum mechanics. One example is that one might build any superposition of 0 and 1. This will have implications for building future quantum computers.

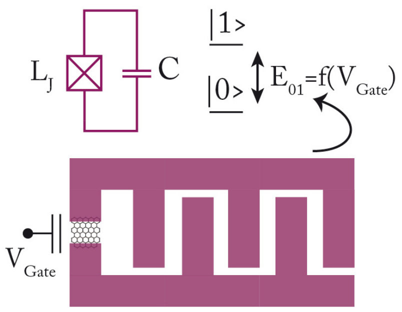

Figure 1: the equivalent electrical circuit shows that this device will behave as an electrically tunable quantum two-level system.

In this work we want to build a new type of device to implement a quantum bit that would have strong advantages over other competing systems. The idea is to use the know-how that has been developed in the superconducting quantum bit community over the past 20 years and integrate in the core of the system a semiconducting material to bring novel electrical functionalities to the device, in the form of a voltage-tunable energy. We will use graphene, a two-dimensional zero-band-gap semiconductor, because of the potential scalability of such approach. Such device is expected to behave as a quantum two-level system with an energy structure that can be tuned with an electric field (gate) thanks to graphene (see figure). The demonstration of such device will represent a major breakthrough in the field of quantum nanoelectronics.

Required skills:

The internship will require a solid background in solid state/condensed matter physics. The work will be mainly experimental. The candidate is expected to be strongly motivated to learn the associated techniques (nanofabrication in clean room, radiofrequency electronics, cryogenics...) and engage in an hands-on experimental work.

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