NÉEL INSTITUTE Grenoble

Topic for Master 1 internship – Academic year 2019-2020

Quantum interference and single-electron detection with flying qubits

General Scope: Coherent manipulation of single electrons in solid-state devices is attractive for quantum information purposes because they have a high potential for scalability. Depending on the system used, the charge or the spin may code binary qubit information. A particular appealing idea is to use a single flying electron itself as the conveyor of quantum information. Such electronic flying qubits allow performing quantum operations on qubits while they are being coherently transferred. Information processing typically takes place in the nodes of the quantum network on locally controlled qubits, but quantum networking would require flying qubits to exchange information from one location to another. It is therefore of prime interest to develop ways of transferring information from one node to the other. The availability of flying qubits would enable the possibility to develop new non-local architectures for quantum computing with possibly cheaper hardware overhead than e.g. surface codes.

Research topic: The aim of the proposed M1 internship is to participate in an ongoing research project to realise flying qubit architectures using single-electron wave packets. This can be realized in an electronic Mach Zehnder interferometer (see fig. 1) where single-electron wave packets are manipulated in flight. During the M1 internship the student will learn how to generate such single electron wave packet and characterise them.

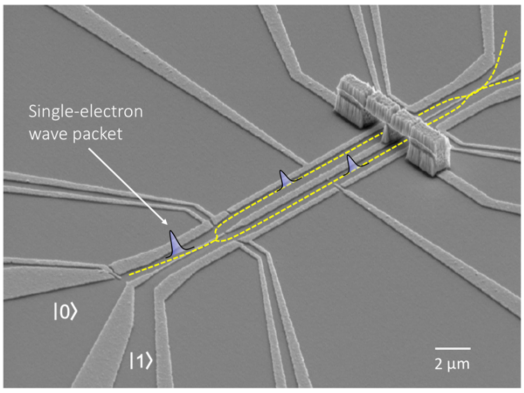

Fig. 1. *Scanning electron micrograph of a Mach-Zehnder type quantum interferometer operating as a flying qubit. A single-electron wave packet is prepared in a given quantum state (here |0> and injected in one of the arms of the interferometer and put into a quantum superposition.*

References:

- Hermelin et al., Nature 477, 435 (2011); Bertrand et al, Nature Nanotech. **11** 672 (2016), Takada et al., Nature Com. (to appear)
- Dubois et al., Nature 502, 659 (2013); Roussely et al. Nature Com. 9, 2811 (2018)

Possible collaboration and networking: This project is realized in close collaboration with the nanoelectronics group in Saclay (C. Glattli) and the theory group of CEA Grenoble (X. Waintal)

Required skills:
We are looking for a motivated candidate with a good background in quantum mechanics and solid-state physics.

Starting date: spring 2020

Contact:

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