INSTITUT NEEL Grenoble

Topic for Master 2 internship – Academic year 2021-2022

Emulating spin qubit on ATOS QLM machine

Context : In quantum nanoelectronics, one of the major goals is the use of quantum mechanics for the development of nanoprocessors that are more and more efficient. This requires the ability to control quantum phenomena at the single electron scale within nanostructures. In this context, the degree of freedom of the electron spin has been identified as a potential candidate for the support of quantum information. We can define the elementary block of the nanoprocessor by capturing a single electron (and therefore its spin) inside quantum dot. The development of a quantum circuit will follow the same methods of microelectronic circuits conception, by connecting the elementary bricks, while respecting the constraints of controlling the individual spins. Nowadays, in quantum dots systems, all the elementary operations required for the functioning of a quantum processor have been demonstrated and characterized in trapped spins of AsGa heterostructures. The effort of the spin qubits community turns to the transposition of these demonstrations for trapped spins in silicon structures, whose fabrication is compatible with CMOS industrial processes. An important question still on debate is the precise architecture of the quantum processor. This is the purpose of the internship to evaluate on a classical computer different spin qubit architectures.

The ATOS QLM machine is able to emulate up to 40 qubits and is suitable to incorporate decoherence mechanisms and quantum operation errors.

Objectives and means available: The candidate will develop research on the simulation of electron spin qubits. The tasks will be to model precisely the decoherence properties and the characteristic of the quantum operations in order to emulate specific algorithms on QLM type of computers. Such a program will aim to test various architectures of quantum processors based on spin qubits.

Interactions and collaborations: This work is part of a large collaborative effort between the CEA-IRIG, CEA-LETI and CNRS-Institut Néel to develop and push the technology of spin qubit in silicon and investigate its potential scalability. This consortium is collaborating with ATOS for simulating spin qubits.

Skills and training: The project relies on the knowledge accumulated in the field of few-electron quantum dots and its new implementation in Si devices. All along this project, the candidate will acquire important skills in the field of condensed matter physics: spin qubit basic operations, emulation of quantum systems, quantum algorithms, …

Foreseen start for the beginning of the internship: From January to April 2022

Possibility of continuation as a PhD on the same subject with funding already secured.

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