# A predictive  simulation stack for the elements of a semiconducting quantum computer

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**PhD may follow:** Yes

**Summary :**

After being an object of studies for a few decades, quantum nanoelectronics is now moving forward to become the basis on which the first quantum computer could be build. The challenge is immense and even the most basic questions â€“ such as what should be the actual physical implementation of the quantum bits (qubit) â€“ do not have definite answers yet. The Grenoble community is actively following several experimental leads including GaAs/GaAlAs based spin or charge qubits, Silicon CMOS based qubits, superconducting qubits or flying qubits.

The transition from quantum science to quantum technology necessitates the ability to perform predictive simulations of the quantum devices that are reliable enough to be used as a basis for exploring new ideas as well as optimization. The theory group of Pheliqs at CEA Grenoble has been developing numerical tools for this purpose that include the open source Kwant platform , (http://kwant-project.org) and its various extensions to deal with real time dynamics, correlations and electrostatics.

In this internship we will setup a model for predicting the characteristics of semiconducting quantum devices. Our chief concern will be a systematic comparison of our predictions with tailor made experiments that will be performed in the group of C. Bauerle at institute NÃ©el, CNRS Grenoble. We will in particular carefully model the residual disorder present in these samples that, although small, can have a decisive impact on quantum dynamics. If times allows, we will implement machine learning algorithms to optimize the sample behavior.

The work will involve theoretical / formalism aspects (out of equilibrium many-body formalism, Feynman diagramsâ€¦), numerics (using modern approaches based on Python) and the modelisation of concrete physical systems. The internship will take place within the theory group of CEA Grenoble, INAC, PHELIQS (Photonics NanoElectronics and Quantum engineering). Our group contains 15-20 researchers working on nanoelectronics, superconductivity, magnetism and electronic correlations in close collaboration with experimental groups. The project will be done under the direction of Christoph Groth (christoph.groth@cea.fr) and Xavier Waintal (xavier.waintal@cea.fr).

We seek highly motivated students with a strong background in theoretical physics, quantum nanoelectronics and/or numerical simulations.

**Full description :**

After being an object of studies for a few decades, quantum nanoelectronics is now moving forward to become the basis on which the first quantum computer could be build. The challenge is immense and even the most basic questions â€“ such as what should be the actual physical implementation of the quantum bits (qubit) â€“ do not have definite answers yet. The Grenoble community is actively following several experimental leads including GaAs/GaAlAs based spin or charge qubits, Silicon CMOS based qubits, superconducting qubits or flying qubits.

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**Requested skills :**
theoretical physics, quantum nanoelectronics and/or numerical simulations