Coupling CMOS silicon hole spin qubits to superconducting resonators

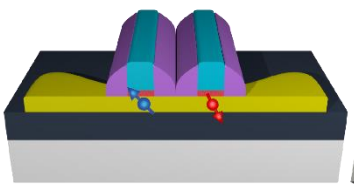
PhD & Postdoc Positions

With the miniaturization of electronic devices, the semiconductor industry has to deal with complex technical barriers and is forced to introduce novel and innovative concepts. The present project is exactly in line with this new paradigm as it proposes to divert CMOS technology to explore a new path for quantum spintronics. Concretely the project aims at using spin-orbit interaction present in the valence band of silicon to drive ultra-fast and ultra-coherent hole spin quantum bits (qubits). The project builds on the first demonstration by our Lab of a hole spin qubit electrically driven in silicon [1].

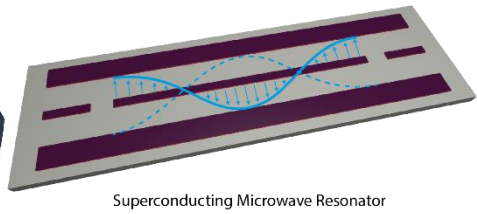
While spins are excellent quantum bits, their long-range coupling remains a challenge to tackle towards complex quantum computing architectures. Here we propose to take up this challenge using a microwave photon as a quantum mediator between qubits in silicon [2-5]. The project presents a unique approach by leveraging a standard silicon-on-insulator CMOS process for the implementation of the qubits co-integrated with superconducting microwave resonators.

In this project you will work with silicon CMOS hole spin qubits to explore the physical limitations to hole spin coherence and to qubit gate fidelity. You will fabricate superconducting microwave resonators on silicon co-integrated eventually with the spin qubits. You will work at temperatures as low as 10 mK and magnetic fields as high as 9 Tesla. High frequency electronic measurements to manipulate the spin states and to readout the superconducting resonators will be applied.

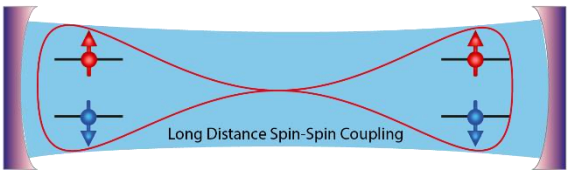
References:
[1] Maurand, R. et al. Nat. Commun. 7, 13575 (2016).
[2] Landig, A. J. et al. ArXiv1711.01932v1 1-8 (2017).
[3] Mi, X. et al. ArXiv1710.03265v1 1-19 (2017).
[4] Samkharadze, N. et al. ArXiv1711.02040v1 1–5 (2017).
[5] Nigg, S. E. et al.Phys. Rev. Lett. 147701, 1-6 (2017).



CMOS qubit



Superconducting Microwave Resonator



Requirements for students

- Enthusiasm for experimental physics
- Ability to work independently and in a team
- (Some) experience with programming
- Knowledge in the field of solid-state physics
- Excellent grades

Requirements for Postdocs

- Enthusiasm for experimental physics
- Ability to work independently and in a team
- Experience with programming
- Experience with low temperature technics
- Background in microwave techniques and/or nanofabrication

See: quantumsilicon-grenoble.eu

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