Quantum thermodynamics with spin qubits

Job description

We are seeking for a talented experimental physicist to be hired as a post-doc in the Lateqs team [1], at CEA Grenoble. This position can start from January 2024 but is flexible depending on candidate's availability and schedule. We propose a 2-years post-doc position, which can be further extended upon mutual agreement. Competitive salary will be adapted to candidates' experience.

Project

Worldwide efforts to build the first useful quantum processor are ongoing. Among the possible physical realizations, those based on semiconductor quantum dots are attracting increasing interest owing to their scalability prospects. In this approach, the elementary bits of quantum information (the so-called "qubits") are encoded in the spin degree of freedom of individual electronic charges localized in gate-defined potential wells. Up to six-qubit systems have been recently demonstrated using silicon or germanium quantum dots [2-3]. However, the fragile nature of quantum information requires operation of these quantum devices at extremely low temperature, typically below 1 K. Unfortunately, the heat generated by the manipulation and read-out of qubits is pointed out as a bottleneck for the efficient operation of large-scale quantum processors [4]. This concerns the heat load from massive wiring, the power dissipation of cryogenic control electronics, but also the local heating associated with high-frequency qubit operations (initialization, control, readout). Characterizing and managing heating effects at the quantum chip level is therefore of crucial importance. This constitutes a new, barely unexplored field of fundamental research. We recently developed in the team a real-time thermometry technique, enabling to read phononic and electronic temperatures on us timescales, comparable with spin qubits operation times [5]. The candidate will leverage this novel technique to establish the heat balance of hole spin qubits operation in silicon and/or germanium, quantify the amount of heat dissipated to the environment and pinpoint the consequences on qubits coherence times and gate fidelities. On a longer term, she/he will develop active cooling techniques and thermal machines based on quantum information, entering the largely unexplored field of quantum thermodynamics.

Research environment

The Lateqs research group is based at CEA, and part of University Grenoble Alps. It offers a fruitful, well-equipped research environment. The main research axis are hole spin qubits in silicon [6] (fabricated in an industrial 300 mm cleanroom), germanium-based spin qubits and hybrids (state-of-the-art Ge/SiGe growth in-house), and cQED with spin qubits [7]. A close collaboration with theory colleagues expert in these thematics is a strong asset. The growing team offers a secure and joyful social environment. Aside the world-class scientific environment, Grenoble is a paradise for outdoor sport lovers, and this student-city also offers plenty of cultural activities.

Contact

To apply, write an e-mail to boris.brun-barriere@cea.fr or clemens.winkelmann@cea.fr including a CV, list of publication and motivation letter.

[1] LATEQS: https://www.lateqs.fr/ [2] N. W. Hendrickx et al. Nature (2021). [3] Philips et al. Nature (2022). [4] B. Undseth et al. arXiv:2304.12984 (2023) [5] V. Champain et al. arXiv:2308.12778 (2023) [6] C. Yu, S. Zihlmann et al. Nature Nanotechnology 18, 741 (2023). [7] N. Piot, B. Brun et al. Nature Nanotechnology 17, 1072 (2022).