Postdoc positions available in HQC lab (EPFL-Switzerland)

We, the Hybrid Quantum Circuits-lab (HQC), are looking for a highly motivated post-doctoral researcher to work on the design, fabrication, and characterization of superconducting-semiconducting hybrid devices and superconducting metamaterials. The work will be part of the SNF project '***High Impedance Metamaterials for Quantum Simulation with Semiconductor/Superconductor Hybrid Circuits***.' This position is immediately available, and we will be continuously evaluating applications. All applications filled in by July 15, 2021 will receive full consideration.

The project

In the last few years, a series of experiments have been realized where semiconducting QDs have been successfully embedded in a circuit quantum electrodynamics (cQED) architecture, enabling the study of double [1, 2] and triple quantum dots [3] via their electric dipolar interaction with a microwave resonator. Strong coupling between the resonator microwave photons and charge [4-6] and spin [3, 7, 8] degrees of freedom in the quantum dots has been achieved. In addition, we have recently demonstrated methods to reach the ultrastrong coupling (USC) regime, $g/\omega>0.1$, by in-situ tuning the size of the double QD (DQD) electric dipole moment [9].

In this research project, we will realize hybrid nanocircuits combining two-level systems defined in semiconductor quantum dots (QDs) to a multimode high-impedance superconducting environment. For the two-level systems, we will make use of charge or spin degree of freedom of electrons/holes hosted in planar Ge, Si, and GaAs semiconductors. The multimode high impedance bath will be defined by arrays of coupled cavities based on superconducting Josephson junctions/SQUIDs or high kinetic inductance disordered thin films (NbTiN, NbN, TiN).

While both superconducting and semiconducting quantum hardware presents a strong potential on its own, this project will explore novel opportunities emerging at the intersection between them in the context of analog quantum simulation. We will adopt this hybrid platform with QDs interacting with a multimode high impedance microwave system to develop analog quantum simulation of quantum impurity models (Kondo, Spin-Boson) and to emulate polaronic/vibrational physics (Franck-Condon blockade, Holstein polaron model).

References:

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[4] X. Mi, J. V. Cady, D. M. Zajac, P. W. Deelman, and J. R. Petta, *Science* **355**, 156 (2017).

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[6] L. E. Bruhat, T. Cubaynes, J. J. Viennot, M. C. Dartiailh, M. M. Desjardins, A. Cottet, and T. Kontos, *Phys. Rev. B* **98**, 155313 (2018).

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[9] Scarlino, P. et al., ArXiv210403045 Cond-Mat (2021).

Job description / Responsibilities

The successful candidate will integrate gate-defined quantum dots devices with superconducting high impedance resonators and metamaterials. The fabrication of semiconducting QDs and microwave superconducting devices will be realized in the Center of Micro-Nanotechnology (CMi) cleanroom at EPFL, equipped with all the conventional tools for nanofabrication. We will have access to high-quality GaAs, Ge/Si 2D, and 1D semiconductor platforms and fabrication processes through our project partners.

The hybrid structures will be tested in a dilution refrigerator at 10 mK via cryogenic and room temperature microwave electronics. The candidate will perform low-noise cryogenic low- and high-frequency measurements to characterize the coupling of charge and spin artificial atoms with a multimode high impedance environment.

To succeed, the candidate will leverage our in-house expertise in nanofabrication and state-of-the-art microwave measurements and the diverse and complementary knowledge available in the EPFL community, from material science to system integration and transport measurements.

This novel hybrid approach attracts high interest in the community, given its versatility. Its experimental success will open new research paths at the interface between semiconductor and superconducting quantum technology. The long-term ambition of this project is to coherently merge the two platforms to significantly broaden the range of problems that the solid-state quantum information hardware can address and propose new strategies and solutions for quantum information technology.

The candidate may be responsible for:

- concept, circuit design and physical design of microwave superconducting circuits
- device fabrication
- microwave and time-domain characterization measurements

Qualifications

You hold a Ph.D. degree in areas such as Physics, Engineering/Applied Physics, Microtechnology, Microwave Engineering. The degree should generally not be older than three years. Ideally, you have hands-on experience in at least some of the following: mesoscopic physics, quantum physics, nanofabrication, cryogenics, microwave design, microwave measurements. You see yourself as pursuing a career in research & development or education, either in academia or in the industry. You can confidently read, write, and discuss science in English. We will consider outstanding candidates with a proven track record in any field of physics or engineering.

Application procedure

The application should be written in English. The application should be sent electronically to pasquale.scarlino@epfl.ch and be attached as pdf-files, as below:

CV, including education*,* previous employments*,* publication list*,* contact details of at least two references.

Personal letter where you: introduce yourself*,* describe your previous research fields and main research results *and* describe your future goals and future research focus.

For questions, please contact:

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