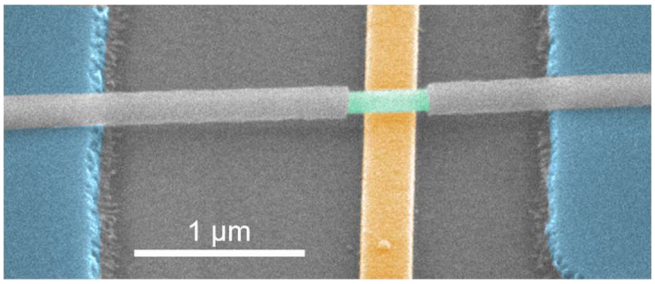
Postdoctoral Opportunity in Quantum Circuits in Quantronics group, CEA-Saclay, France

Project Overview: Superconducting quantum circuits rely on a fundamental component, the Josephson junction, in which a tunnel barrier links two superconducting electrodes. This junction serves as the building block for creating non-dissipative, non-linear electromagnetic oscillators of a bosonic nature. The two lowest energy levels of these oscillators are harnessed as qubit states. A radically different family of quantum circuits involved the use of fermionic localized states known as Andreev states. They arise in Josephson weak links like atomic contacts and semiconductor nanowires (see Figure) connecting superconductors [1-6]. We propose to explore experimentally a new quantum circuit integrating both bosonic and fermionic degrees of freedom. This approach should result in a qubit with inherent protection against relaxation and dephasing.



Nanowire Josephson weak link (green) linking superconducting electrodes (grey), suspended above an electrostatic gate (yellow).

Your Role: you will take a leading role in designing, fabricating, and measuring this new circuit, in collaboration with a PhD student, interns and permanent group members.

Required qualifications:

- PhD in experimental physics;
- Practical skills in nanofabrication and microwave techniques;
- Solid Python programming expertise.

Starting date: 2024; two-year contract.

How to Apply: Send your CV, a cover letter outlining your research interests, and contact information for at least 2 references, to marcelo.goffman@cea.fr and/or hugues.pothier@cea.fr

[1] L. Bretheau, Ç. Ö. Girit , H. Pothier , D. Esteve , and C. Urbina, "Exciting Andreev pairs in a superconducting atomic contact" Nature 499, 312 (2013). arXiv:1305.4091
[2] C. Janvier *et al.*, "Coherent manipulation of Andreev states in superconducting atomic contacts" Science **349**, 1199 (2015), arXiv:1509.03961
[3] L. Tosi, C. Metzger, M. F. Goffman, C. Urbina, H. Pothier, Sunghun Park, A. Levy Yeyati, J. Nygård, P. Krogstrup, "Spin-Orbit Splitting of Andreev States Revealed by Microwave Spectroscopy", Phys. Rev. X **9**, 011010 (2019).
[4] C. Metzger, Sunghun Park, L. Tosi, C. Janvier, A. A. Reynoso, M. F. Goffman, C. Urbina, A. Levy Yeyati, H. Pothier, "Circuit-QED with phase-biased Josephson weak links", Phys. Rev. Research **3**, 013036 (2021).
[5] F. J. Matute Cañadas, C. Metzger, Sunghun Park, L. Tosi, P. Krogstrup, J. Nygård, M. F. Goffman, C. Urbina, H. Pothier, A. Levy Yeyati, "Signatures of interactions in the Andreev spectrum of nanowire Josephson junctions", Phys. Rev. Lett. 128, 197702 (2022), arXiv:2112.05625
[6] C. Meztger, "Spin & charge effects in Andreev Bound States", PhD thesis (2022)

Quantronics group website