RobustSuperQ – Job offer

2 year postdoc position

Helical Andreev Qubits

The goal of the research is to investigate the dynamical properties of helical Andreev qubits, i.e. qubits based on two level systems made from the ground and excited Andreev levels of a Josephson junction built with 1D helical states. Helical states are spin-momentum locked, meaning that their spin orientation is given by the propagation direction. They are found at the edges of 2D topological insulators or at the hinges of 3D second-order topological insulators. Our past research has demonstrated that crystalline bismuth is a second order topological insulator, possessing 1D states that conduct ballistically even in high magnetic fields [1-4]. We have also recently found ballistic 1D conduction in WTe_2 as well as in Bi_4Br_4 (unpublished).

In addition to spin-momentum locking, the narrow spatial extension and long parity lifetime of these states endow them with a unique robustness, prompting their investigation as possible topologically protected qubits. The postdoctoral researcher will, in collaboration with a PhD student and the members of the group, develop a high frequency probe of these helical Andreev states. To this end, an ac-SQUID with the helical conductor as the weak link will be coupled to a resonator, probed with high frequency techniques such as second tone spectroscopy and time-resolved techniques to demonstrate coherent manipulation of these helical Andreev states.

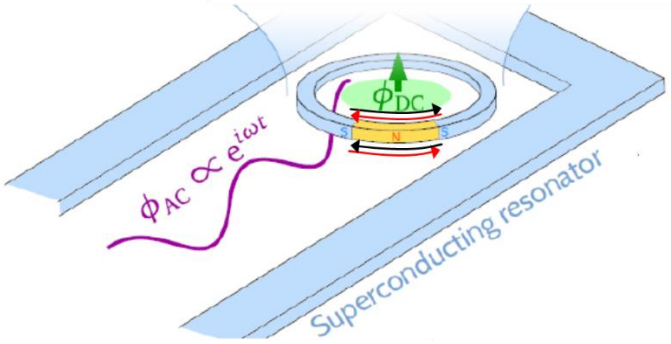

Figure1 Sketch of a superconducting ring built around a Higher Order Topological Insulator with helical states at its hinges, coupled to a superconducting resonator.

[1] Bernard, A et al., Peng, Y, Kasumov, A, Deblock, R, Ferrier, M, Fortuna, F, Volkov, V T, Kasumov, Yu A, Oreg, Y, von Oppen, F, Bouchiat, H, and Guéron, S Long-lived Andreev states as evidence for protected hinge modes in a bismuth nanoring Josephson junction. Nature Physics, 19: 358 (2023).

[2] Murani, A, Dassonneville, B, Kasumov, A Yu, Basset, J, Ferrier, M, Deblock, R, Guéron, S, and Bouchiat, H Microwave Signature of Topological Andreev level Crossings in a Bismuth-based Josephson Junction. Physical Review Letters, 122(7): 076802 (2019).

[3] Schindler, F, Wang, Z, Vergniory, M G, Cook, A M, Murani, A, Sengupta, S, Kasumov, A Yu, Deblock, R, Jeon, S, Drozdov, I, Bouchiat, H, Guéron, S, Yazdani, A, Bernevig, B A, and Neupert, T, Higher-order topology in bismuth. Nature Physics, 14(9): 918–924 (2018).

[4] Murani, A, Kasumov, A, Sengupta, S, Kasumov, Y A, Volkov, V T, Khodos, I I, Brisset, F, Delagrange, R, Chepelianskii, A D, Deblock, R, Bouchiat, H, and Guéron, S Ballistic edge states in Bismuth nanowires revealed by SQUID interferometry. Nature Communications, 8: 15941 (2017).

Mesoscopic Physics group,
Laboratoire de Physique des Solides, Université Paris Saclay, Orsay
https://equipes2.lps.u-psud.fr/meso/

Starting date: After Feb 1, 2024

The candidate must have a PhD in Physics, and preferably experience with low temperature physics, superconductivity, low noise and high frequency measurements

To apply, contact Sophie Gueron, sophie.gueron@universite-paris-saclay.fr

PROGRAMME ET EQUIPEMENTS PRIORITAIRES DE RECHERCHE QUANTIQUE

LPS ORSAY

FRANCE QUANTUM BASIC RESEARCH PROGRAMME

https://www.robustsuperq.fr