INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: Laboratoire de Physique et Modélisation des Milieux Condensés
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Internship location: Grenoble

Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: laboratory

Dissipative dynamics of a phase slip in a Josephson junction

Superconducting circuits are a promising platform for quantum engineering. They have many applications ranging from amplifiers and detectors to quantum computers and quantum metrological standards. One of the key building blocks of superconducting circuits is the Josephson junction between two superconductors which are connected by a weak link or a thin tunnel barrier [1].

When a Josephson junction is closed into a loop by an inductance, the potential energy of the system as a function of the superconductor phase difference may exhibit several local minima, whose position and shape can be controlled by applying an external magnetic flux through the loop [1]. The phase can slide from one minimum to the neighboring one, either spontaneously or due to some perturbation, which is called a phase slip. In a recent experiment at Néel Institute, a single phase slip in a Josephson junction based on a superconducting-normal-superconducting (SNS) junction could be detected thanks to a measurabletemperature rise of the electrons in the normal link between the two superconductors, which absorbed the energy released during the phase slip [2].

The goal of this internship is to construct a time-dependent solution for the slipping phase. The non-trivial point is the presence of a back-action of the electrons in the normal link, which are being heated up by the phase slip, on the superconducting condensate. Thus, we will have to solve coupled equations for the superconducting phase and for the distribution of normal electrons. This work will involve both analytical and numerical calculations. This internship work can be continued as Ph.D.

Necessary background: quantum mechanics, solid-state physics, basics of superconductivity

Bibliography: [1] M. Tinkham, "Introduction to superconductivity" (McGraw-Hill, 1996).
[2] E. Gümüş et al., "Calorimetry of a phase slip in a Josephson junction", Nature Physics 19, 196 (2023).

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: YES Soft Matter and Biological Physics: NO
Quantum Physics: YES Theoretical Physics: YES