INTERNSHIP PROPOSAL

Laboratory name: Laboratoire de Physique, Ecole Normale Supérieure de Lyon
CNRS identification code: UMR5672
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Internship location: ENS de Lyon
Thesis possibility after internship: YES
Funding: YES

Autonomous quantum error correction by inelastic Cooper-pair tunneling

Cat codes offer a very promising path towards the full quantum error correction of quantum processors based on superconducting circuits. Our group, in collaboration with Alice&Bob, demonstrated autonomous correction protocols based on Josephson junctions [1]. The intern will take part in our group's ongoing effort to develop new cat-code paradigms, by studying a circuit that utilizes an original mechanism to stabilize a cat-qubit.

This new mechanism makes use of the steady flow of Cooper pairs against a dc-voltage to power up an interaction between two superconducting resonators which effectively protect the cat-qubit against errors. It is predicted to yield a much larger error correction rate than current implementations, which directly translates into longer quantum processing time. During the internship, the candidate will study an existing device and demonstrate its effectiveness at protecting the cat-qubit against one type of error (the bit-flip). In particular, they will measure the impact of random voltage noise on the cat-qubit coherence and how to mitigate it using injection-locking. If the internship goes well, the student will be offered a PhD position in order to work on the follow-up of this project. It will include the design, fabrication and measurement of a more ambitious device, which will be able to protect the cat-qubit against both bit-flip and phase-flip errors, making it the first completely protected qubit, a crucial milestone for quantum computing.

The student will be in charge of performing experiments in close collaboration with a postdoctoral fellow. The activities involve superconducting circuit fabrication, microwave engineering, quantum-limited measurements in the microwave domain, temporal shaping and analysis of microwave pulses, numerical simulations, data post-processing, and manuscript writing. The position requires a sound knowledge of quantum information, a taste for both experiment and theory, and a positive attitude to working in a team.

The intern will work within the framework of the RobustSuperQ PEPR (part of the French Quantum Plan) which aims at accelerating French R&D on superconducting qubits protected against decoherence. The project takes place in collaboration with Alice and Bob as well as with the theory group of Ulm University.

[1] A. Marquet et al., https://arxiv.org/abs/2307.06761

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