PhD thesis project

Quasiparticle dynamics in superconducting islands coupled to germanium-based quantum dots

General Scope:

The proposed PhD project focuses on the fundamental physics and mitigation of quasiparticle poisoning, a phenomenon where non-equilibrium excitations disrupt the parity and coherence of superconducting quantum circuits. This research shifts away from bulk statistical observations by employing semiconductor quantum dots as high-precision tools for both the controlled injection and the time-resolved detection of individual quasiparticles. By integrating these dots into hybrid superconductor-semiconductor architectures, the project aims to bridge the gap between microscopic charge dynamics and the macroscopic performance of qubits.

PhD Subject:

In this project, the PhD student will investigate the transport and relaxation dynamics of non-equilibrium quasiparticles in superconducting islands. To this aim, the student will carry out time-resolved "pump-probe" experiments using semiconductor quantum dots as energy- and spin-selective tools for single-particle injection and detection. Experiments will focus on both charge and spin dynamics with the goal to determine the respective time scales. The possibility to use spin-polarized quasiparticles as a vehicle for the long-range transfer of spin-based information may also be addressed in the last part of the PhD project.

The devices used in these experiments will be fabricated on existing Ge/SiGe high-mobility heterostructures, an emerging material system for hybrid superconductor-semiconductor devices. The student will be involved in device fabrication to be performed in the nearby PTA cleanroom. The host lab has a well-established expertise in this research field owning a variety of cryogenic setups equipped with high-frequency measurement electronics.

Required Skills:

- Strong background in solid-state physics and quantum mechanics
- Experimental abilities
- Pithon programming
- Team spirit, resilience, and project ownership
- Scientific communication

Laboratory: PHELIQS

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