Quasiparticles in Superconducting Qubits with Asymmetric Junctions

Gianluigi Catelani
Giampiero Marchegiani, Luigi Amico

Quantum Research Center, Technology Innovation Institute, Abu Dhabi, UAE

gianluigi.catelani@tii.ae

Single-particle excitations, known as Bogoliubov quasiparticles, threaten the operation of superconducting qubits. In this work [1], we theoretically revisit and generalize the qubit-quasiparticle interaction, including the gap asymmetry in Josephson junctions, which generally arises in the deposition of aluminum layers with different thicknesses.
We show how the interplay of generation, tunneling, and relaxation mechanisms determines the steady state of non-equilibrium quasiparticles. Two substantially different regimes are identified: 1) small gap difference, where quasiparticles are mainly located at the larger gap energy in both leads and the excited state of the qubit is depleted; 2) strong gap asymmetry, similar to or higher than qubit frequency, with quasiparticles trapped in the lower gap superconductor and reduced relaxation rate. Our results may be relevant to the design of qubits with improved suppression of quasiparticle poisoning.

References

[1] Giampiero Marchegiani, Luigi Amico, and Gianluigi Catelani, PRX Quantum **3** (2022) 040338

Figures

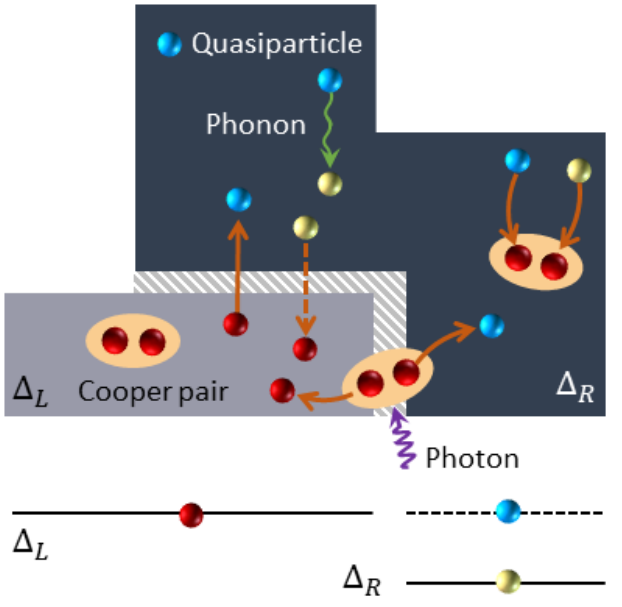

Figure 1: Schematic representation of an asymmetric junction and the relevant quasiparticle processes