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Critical current noise and junction resonators in Josephson junction from interacting trap states MOHAMMAD H. ANSARI, Institute for Quantum Computing, IQC and University of Waterloo, FRANK K. WILHELM-MAUCH, Institute for Quantum Computing, IQC and University of Waterloo —

We analyze the impact of trap states in the oxide layer of superconducting tunnel junctions on the fluctuation of the Josephson current. These are known to inhibit the coherent operation of superconducting qubits. These have a twofold effect: Occupying trap states blocks out parts of the critical current of the Josephson junction. Electrons can also cross the junction via hopping across a trap. We are extending previous studies of noninteracting traps to the case where the traps have on-site electron repulsion. We use second order perturbation theory which allows to obtain analytical results but limited to small and intermediate repulsion. Remarkably, it still reproduces the main features of the model as identified from the Numerical Renormalization group. We present analytical formulations for the subgap bound state energies, the singlet-doublet phase boundary, and the spectral weights, which are in agreement with recent Numerical Renormalization Group analysis. We show that interactions can reverse the supercurrent across the trap. We finally work out the resonance noise spectrum in the presence of on-site repulsive electrons and suggest a criteria for the fabrication of parameters that may help to suppress low frequency noise from superconducting quantum computation devices.

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