Quasiparticle transport measurements in attoampere scale in metallic devices

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Virtually in all devices based on superconducting tunnel junctions, the practical performance is degraded to some degree by excess quasiparticle processes. More precisely, the processes in question are those that do not follow from an application of the orthodox theory of single-electron tunneling assuming full thermal equilibrium, zero-impedance environment, and Bardeen-Cooper-Schreiffer form for the quasiparticle density of states in the superconducting electrodes. Reflecting on the extensive body of prevous work on single-electron transport, we reach the conclusion that shielding against microwave noise originating from both on and off-chip sources is a crucial factor in suppressing the observed quasiparticle processes. In my presentation, I will describe transport measurements performed on Al/AlOx/Cu single-electron transistors where we obtained quasiparticle tunneling rates well below 10 Hz over a 1 MΩ tunneling resistance in the absence of bias. The results allow us to infer upper bounds $n_{\rm qp} < 0.6\ \mu{\rm m}^{-3}$ for the density of non-equilibrium quasiparticles and $\gamma < 10^{-7}$ for the Dynes parameter γ characterizing density of quasiparticle states in the gap of the aluminum electrode. Both figures are at least an order of magnitude better than previously reported values in comparable settings.

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