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Critical current 1/f noise in graphene Josephson junction

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Short ballistic graphene Josephson junctions (GJJ) sustain superconducting current with a strongly non-sinusoidal current-phase relation (CPR) up to a critical current threshold. The CPR, arising from proximitized superconductivity, is gate-voltage tunable and exhibits peculiar skewness observed in high-quality graphene-superconductors heterostructures with clean interfaces. These properties make GJJ promising sensitive quantum probes of microscopic fluctuations underlying relativistic transport in 2D. We demonstrate that fluctuations with 1/f power spectrum of the critical current of a short ballistic GJJ directly probe carrier density fluctuations of the graphene channel. Tunability with the chemical potential, close to and far from the charge neutrality point, and temperature dependence of the noise amplitude are clear fingerprints of the underlying material-inherent processes. These results provide also relevant figure of merits in view of the envisaged implementation of coherent quantum circuits in hybrid quantum information architectures.

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