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**Length and density dependence of the critical current in long diffusive graphene-based Josephson junctions** CHUNG-TING KE, Duke Univ. Dept. of Physics, IVAN BORZENETS, Tokyo University, Dept. of Physics, ANNE WATSON, YURA BOMZE, GLEB FINKELSTEIN, Duke Univ. Dept. of Physics
— We study the critical current in graphene-based Josephson junctions as a function of the channel length and gate voltage. Previous works on normal metal SNS junctions have established that the product of the critical current, Ic, and normal resistance, Rn, is determined by the Thouless energy Eth. Several recent studies have addressed the IcRn $\sim$ Eth/e relationship in Josephson junctions made of graphene. These measurements are challenging, especially near the Dirac point, where the critical current of long junctions is small; many of these junctions also tend to be underdamped, resulting in premature switching to the normal state before the critical current is reached. In this work, we study several junctions of different lengths fabricated in CVD graphene, which allows for wider junctions with larger critical currents. We present the dependence of the critical current on the channel length, both away from and close to the charge neutrality point. The latter regime is particularly interesting because the phase coherence should be established through the electron and hole puddles on the length scales of up to 800 nm.

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