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Ballistic Graphene Josephson Junctions from the Short to the Long Junction Regimes: Part II- Critical current scaling of the Short and Long Junctions. CHUNG-TING KE, Duke Univ, IVAN BORZENETS, University of Tokyo, FRANCOIS AMET, Appalachian State University, ANNE DRAELOS, MING-TSO WEI, ANDREW SEREDINSKI, Duke Univ, KENJI WATANABE, TAKASHI TANIGUCHI, National Institute for Materials Science, YURIY BOMZE, Duke Univ, MICHIHISA YAMAMOTO, SEIGO TARUCHA, University of Tokyo, GLEB FINKELSTEIN, Duke Univ — The Josephson effect describes the phenomenon of coupling a supercurrent between superconductors through a weak link. Using graphene as this weak link has seen much interest due to its tunable density and related Dirac fermion physics. Previously we have studied the critical current scaling in diffusive graphene samples with different junction lengths. For ballistic junctions, however, knowledge about transport properties remains scarce. With clean encapsulated graphene, studying the supercurrent transport mechanism in ballistic samples has now become feasible. We present measurements of ballistic graphene Josephson junctions from short to long junction limits. From their temperature dependence, we characterize the critical current in both the short and long junction cases by using the characteristic energies Δ and δE, where Δ is the superconducting gap and δE is the level spacing in the long junction case. At low temperatures, as $K_BT < \Delta$ for short junctions and $K_BT < \delta E$ for long ones, we show that the critical current saturates at a level determined by the product of Δ (or δE) and the number of the junction's transversal modes.

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