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Current-phase relations in low carrier density graphene Josephson junctions PHILIP KRATZ, Stanford University, FRANCOIS AMET, Duke University, CHRISTOPHER WATSON, KATHRYN MOLER, Stanford University, CHUNG KE, Duke University, IVAN BORZENETS, University of Tokyo, KENJI WATANABE, TAKASHI TANIGUCHI, National Institute for Materials Science, Namiki, RUSSELL DEACON, Center for Emergent Matter Science, RIKEN, MICHIHISA YAMAMOTO, University of Tokyo, YURIY BOMZE, Duke University, SEIGO TARUCHA, University of Tokyo, GLEB FINKELSTEIN, Duke University — Ideal Dirac semimetals have the unique property of being gate tunable to arbitrarily low electron and hole carrier concentrations near the Dirac point, without suffering from conduction channel pinch-off or Fermi level pinning to band edges and deep-level charge traps, which are common in typical semiconductors. SNS junctions, where N is a Dirac semimetal, can provide a versatile platform for studying few-mode superconducting weak links, with potential device applications for superconducting logic and qubits. We will use an inductive readout technique, scanning superconducting quantum interference device (SQUID) magnetometry, to measure the current-phase relations of high-mobility graphene SNS junctions as a function of temperature and carrier density, complementing magnetic Fraunhofer diffraction analysis from transport measurements which previously have assumed sinusoidal current-phase relations for junction Andreev modes. Deviations from sinusoidal behavior convey information about resonant scattering processes, dissipation, and ballistic modes in few-mode superconducting weak links.

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