A Ballistic Graphene Based Cooper Pair Splitter

P. Pandey[1,*], R. Danneau[2], D. Beckmann[2]

[1]Institute of Nanotechnology, Karlsruhe Institute of Technology, Karlsruhe, Germany
[*]Present affiliation: Department of Applied Physics, Aalto University, Espoo, Finland
[2]Institute for Quantum Materials and Technologies, Karlsruhe Institute of Technology, Karlsruhe, Germany

We present an experimental study of a Cooper pair splitter where ballistic graphene acts as a weak link between two superconducting electrodes [1]. Our devices are fabricated by using h-BN encapsulated graphene which is connected to two superconducting electrodes on two parallel edges and to two normal metal electrodes on the other two edges. As a result, two transverse junctions are formed, namely the superconductor/graphene/superconductor (SGS) junction and normal metal/graphene/normal metal (NGN) junction. The electronic transport properties of a Josephson weak link can be modified by applying a normal current/voltage in the transverse direction to the Josephson junction [2]. In a recent theoretical report, multiterminal Josephson junctions are studied and expected to serve as a testbed for nonlocal transport processes [3]. Here, we study the low temperature electronic transport across the SGS junction as a function of control voltage applied across the NGN junction and vice versa. The tuning of charge transport in graphene from n-type to p-type by an applied gate voltage provides us an additional experimental knob to tune. We observe clear signatures of the Cooper pair splitting in our device that are most prominent close to the charge neutrality point of the graphene weak link. The observed signatures become less pronounced at higher charge carrier densities due to the presence of supercurrent in the device. The experimental data can be very well described by a three-terminal beam splitter model. Our results show the possibilities to design new experiments for the detection of entangled states.

References:

[1] Pandey, P. et al., **Phys. Rev. Lett. 126,** 147701 (2021).
[2] Baselmans, J. J. A. et al., **Nature 397,** 43 (1999).
[3] Nowak, M. P. et al., **Phys. Rev. B 99,** 075416 (2019).