Half-integer Shapiro steps in the Al shell of hybrid InAs nanowires

I. Casal Iglesias[1]
G. Moraes[1], Á. Ibabe[1], M. Gómez[1], G. O. Steffensen[2], T. Kanne[3],J. Nygård[3], A. Levy Yeyati[2] and E. J. H. Lee[1]

[1]Condensed Matter Physics Department, Universidad Autónoma de Madrid, 28049 Madrid, Spain.
[2]Department of Theoretical Condensed Matter Physics, Universidad Autónoma de Madrid, 28049 Madrid, Spain.
[3]Center for Quantum Devices & Nano-science Center, Niels Bohr Institute, Univ. of Copenhagen, Copenhagen, Denmark.

ignacio.casal@uam.es

In the past decade, hybrid superconductor-semiconductor nanostructures have attracted great attention as a promising platform for the search of topological superconductivity [1, 2] and for the development of hybrid superconducting qubits [3]. Recent progress in this field has been enabled by the development of growth methods that warrant a clean interface between superconductor and semiconductor, such as the epitaxial growth of superconductors onto InAs and InSb nanowires [4-6]. Among these cleaner crystals, hybrid InAs-Al wires have been developed first and have been, by far, explored the most. Despite the significant role that the superconducting shell plays in the above experiments, there are few works that fully characterize it [7]. In this work, we present measurements of an intermediate resistance regime in the superconducting Al shell in InAs nanowires when applying a current bias (I_b) and a perpendicular magnetic field ($B_\perp$). We observe that under microwave radiation these regions in the I_b-$B_\perp$ map develop a variety of features reminiscent of Shapiro steps, which are a well-known manifestation of the AC Josephson effect. This behaviour suggests that a weak link is forming in the Al shell when driven out of equilibrium. To the best of our knowledge, this is the first observation of Shapiro phenomena in the superconducting shell of hybrid nanowires. This suggests that the out of equilibrium physics of the superconducting Al shell is yet not fully understood.

References

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Figures

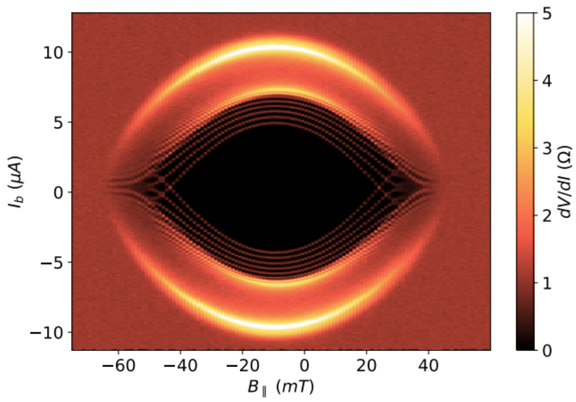

Figure 1: Shapiro steps measurement under an applied $B_\perp$.