

Observation of Majorana Bound States using Scanning Gate Microscopy

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Observing zero-bias conductance peaks in hybrid nanowires in the presence of Rashba spin-orbit coupling and the Zeeman effect [1] has been considered as one of the signatures of the existence of Majorana-Bound states (MBS). However, this is not the conclusive proof of MZMs as the ZBCPs might arise due to the disorder present in the system [2]. The splitting of Zero-Bias Conductance Peaks (ZBCPs) with oscillatory behavior in the varying Zeeman field or system size is considered as a potential route to confirm the existence of MBS [3] although the experimental demonstration of this effect still is a challenge. In our work, we theoretically consider the Scanning Gate Microscopy (SGM) technique, where a charged atomic force microscopy tip locally depletes the electron gas [4], as a tool to distinguish the trivial and topological origin of the ZBCPs. We show that SGM can induce the localization of two additional pairs of Majorana and that the variation of the position of the tip changes the overlap between the MBS which leads to conductance oscillations. We also demonstrate, that for the disorder-induced ZBCPs, the conductance oscillations are missing.

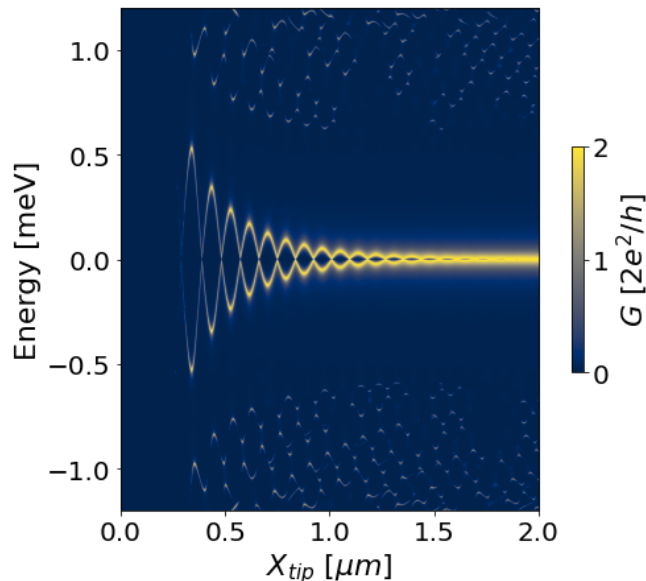


Figure 1: Conductance versus position of the SGM tip at constant magnetic field. Clear oscillations of Majorana zero-bias peaks are visible.

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- [4] S. Maji, K. Sowa, and M. P. Nowak, *Phys. Rev. B* **109**, 115410 (2024).