

Detection of Majorana bound states by scanning gate microscopy

Shalini Maji

Michał P. Nowak

AGH University of Krakow, Academic Centre for Materials and Nanotechnology, Al. Mickiewicza 30, 30-059 Krakow, Poland

maji@agh.edu.pl

mpnowak@agh.edu.pl

The zero-bias conductance peaks in hybrid nanowires with Rashba spin-orbit coupling and the Zeeman effect [1] have been considered as one of the signatures of the presence of Majorana-bound states (MBS). Nevertheless, the sole observation of a peak at zero energy cannot be considered as unambiguous hallmark of the presence of MBS as the peaks can originate also from the disorder present in the system [2]. Splitting of zero-bias conductance peaks (ZBCPs) with oscillatory behavior in the Zeeman field or varied system size has been regarded as one of the possible routes to evidence the presence of Majorana-bound states [3]. The experimental demonstration of this effect remained challenging. In our work we theoretically study the scanning gate microscopy technique (SGM) which is applied to such hybrid systems [4] and can be used to discriminate between the trivial and topological origin of the zero bias peaks. We show that the scanning probe can induce the localization of two additional Majorana pairs and that the change of the position of the probe changes the overlap between MBS which in turn induces conductance oscillations. We show that the oscillations are absent in the trivial case, where the ZBCPs are induced by the disorder.

References

[1] Y. Oreg, G. Rafael, F. von Oppen, Phys. Rev. Lett. 105, 177002 (2010).

[2] S. Das Sarma, H. Pan, Phys. Rev. B, 103, 195158 (2021).

[3] S. Das Sarma, Jay D. Sau, Tudor D. Stanescu, Phys. Rev. B, 86, 220506(R) (2012).

[4] S. Maji, K. Sowa, M. P. Nowak, arXiv:2310.03523 (2023).

Figures

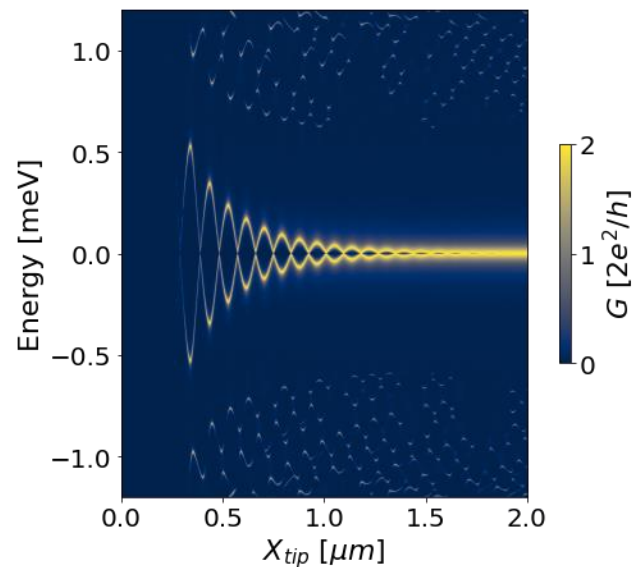


Figure 1: Conductance versus position of the SGM tip at constant magnetic field. Clear oscillations of Majorana zero-bias peaks are visible.