Conductance Spectroscopy of Majorana Zero Modes in Superconductor-Magnetic Insulating Nanowire Hybrid Systems

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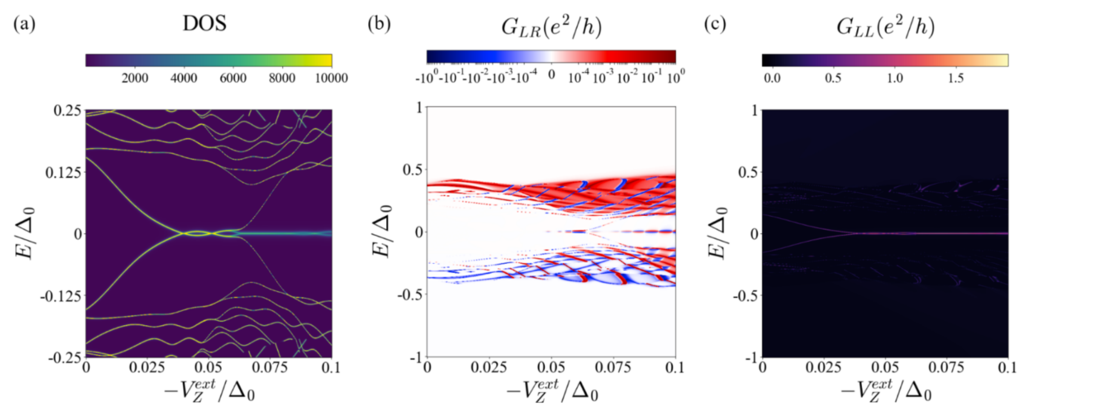
There has been a recent interest in superconductor-magnetic insulator hybrid Rashba nanowire setups for potentially hosting Majorana zero modes at smaller external Zeeman fields. Using the Keldysh nonequilibrium Green's function technique, we develop a detailed quantum transport approach that accounts for the hybrid structure comprising the Rashba nanowire coupled to the bilayer structure which includes the proximity-inducing superconductor and the magnetic insulator. We provide a detailed analysis of three-terminal setups [1] to probe the local and non-local conductance spectra in both the pristine as well as the disordered nanowire setups. We uncover the conductance quantization scaling with the bilayer coupling and the signatures of the gap closing followed by the emergence of near-zero energy states, which can be attributed to topological zero modes in the clean limit. However, in the presence of a smoothly varying disorder potential, trivial Andreev bound states may form with signatures reminiscent of topological zero modes in the form of a premature gap closure in the non-local conductance spectra. Our results, therefore, provide a transport-based analysis of the operating regimes that support the formation of Majorana modes in these hybrid systems of current interest, while investigating the effect of disorder on experimentally relevant device structures.

Reference

[1] R. Singh and B. Muralidharan, ArXiv:2203.08413, (2022).



Conductance spectra for the disordered nanowire. (a) Low Energy DOS (b) non-local and (c) local conductance spectra for a nanowire of length 4.5 μm, with a Gaussian potential profile

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