Nonlocality of local Andreev conductances as a probe for topological Majorana wires

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Identifying topological phases via zero-bias conductance peaks in superconducting Majorana wires is not trivial. Here we propose a method of distinguishing trivial and topological phases in realistic three-terminal proximitized superconducting (disordered) nanowires coupled to normal leads by exploiting a peculiar nonlocality of the Majorana-mediated local Andreev reflection (LAR). By combining the scattering matrix formalism and the Green's function approach, we calculate the conductance and the local density of states (LDOS). We show that when left and right leads are asymmetrically coupled, i.e., when the ratio Γ_L/Γ_R is increased, the local conductances G_{LL} and G_{RR} are equally suppressed in the topological phase. In the trivial phase, on the other hand, G_{LL} is essentially constant while G_{RR} is exponentially suppressed. These distinct behaviors can be understood by analyzing the LDOS; a zero-energy gap develops at the left end of the wire as the asymmetry in the couplings increases. In addition, the local conductances show the exact same dependence on the lead-asymmetry in the presence of Majorana zero modes (MZMs), in stark contrast to trivial subgap states arising from inhomogeneities in the wire. Our work shows a distinctive signature of the Majorana nonlocality in terms of nonlocal effects on LAR. Finally we propose a protocol for identifying zero-bias peaks signaling topological phases that rely on only local conductance measurements [1].

References

1. Rodrigo A. Dourado, Poliana H. Penteado, J. Carlos Egues, arXiv:2303.01867.

Figures

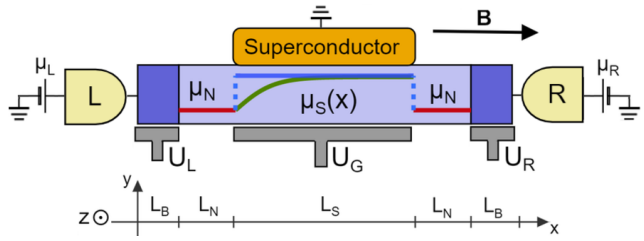

Figure 1: Semiconductor-superconductor Rashba nanowire with a magnetic field B along the x axis coupled to left (L) and right (R) normal leads, via the gates U_L and U_R, respectively.

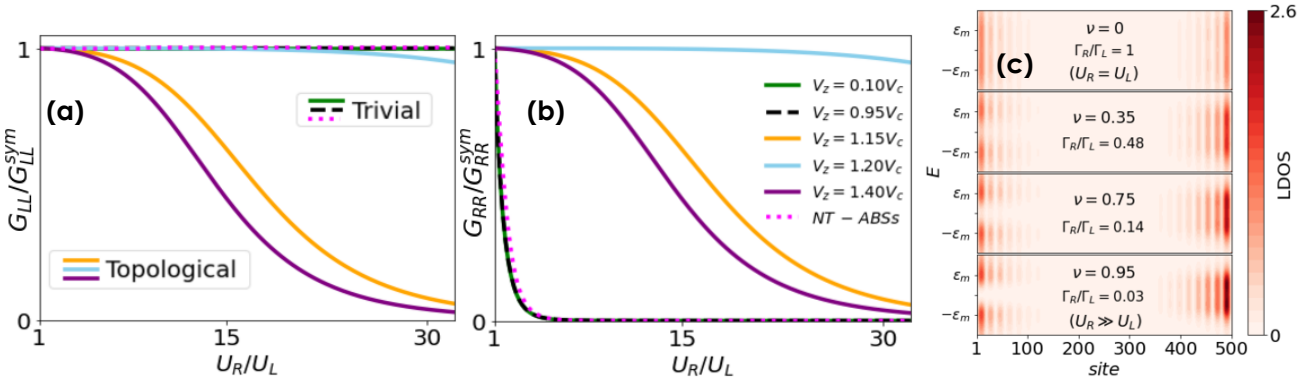

Figure 2: (a) G_{LL} and (b) G_{RR} as functions of UR/UL. (c) LDOS color map for different values of the asymmetry ν.