Thermoelectric signatures of Bogoliubov Fermi Surface in superconducting 3D Topological Insulator Heterostructures

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A weak magnetic field applied to a superconductor (SC) can selectively close the superconducting gap, giving rise to a segmented Fermi surface. These so-called Bogoliubov Fermi surfaces (BFSs) have been observed in recent experiments in a three-dimensional topological insulator (3DTI) in proximity to a SC. In this work, we employ a scattering matrix formalism to reveal signatures of the BFS in the thermoelectric transport properties of a superconducting hybrid junction on the surface of a 3DTI. We consider a setup with two normal probes (N) connected to a SC (N-SC-N configuration) to study local and nonlocal transport under an applied in-plane magnetic field. With a temperature gradient, the magnetic field creates equal local and nonlocal electric Seebeck currents which follow the orientation of the BFS. Furthermore, we predict a switch in the required voltage bias enabling local and nonlocal Peltier cooling, which again depends on the orientation of the BFS. As a result, our work opens new perspective applications in spintronics and provides novel ways of exploring unconventional superconducting phases.

Figures

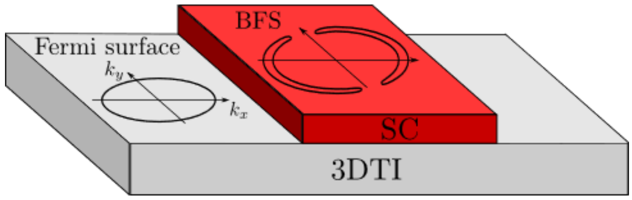

Figure 1: Sketch of the N-SC-N junction where a superconductor is deposited on the surface of a 3DTI. On each region, N and SC, we show an energy contour of the bands at the Fermi level. When $m_0>\Delta$ the superconducting gap closes in a finite region creating a Bogoliubov Fermi surface: a gapless superconducting state.

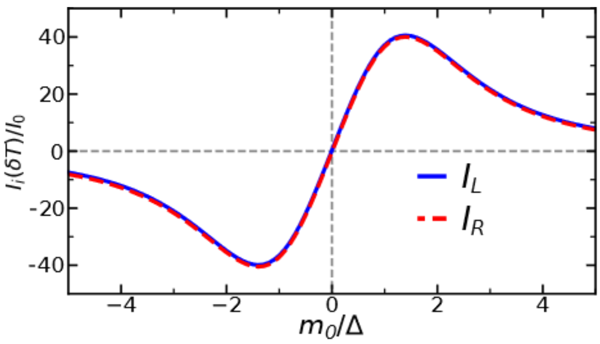

Figure 2: Zero bias electric current in the normal left (I_L) and right (I_R) regions for a given temperature gradient across the junction δT, plotted as a function of applied the magnetic field, m_0, that induces the BFS. We predict a BFS induced Seebeck coefficient of S≈30μV/K in typical topological insulator-superconductor junctions.