Drag of supercurrent in three-contact hybrid structure on surface of 3D topological insulator

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In our work we consider a model of a three-contact quantum interferometer of Fabri-Perot type which has two neutral 1D Majorana leads and a normal one. This three-contact setup is supposed to be a hybrid structure fabricated on 2D surface of a 3D topological insulator. The hybrid structure is the combination of magnetic islands and superconducting leads where the proximity effect with 2D surface results in formation of profiles with gapless 1D chiral channels. Namely, in our model we suppose that 2D surface electrons of a topological insulator are described by Dresselhaus or Rashba type Hamiltonian which couples momentum and real spin and have single Dirac cone in low energy spectrum. It is common that applied homogeneous Zeeman field or superconducting pairing potential induces a gap in 2D Dirac spectrum. Indeed, magnetic domain walls, where Zeeman field changes sign, or boundaries between magnet and superconductor support non-trivial gapless 1D chiral channels with charged or neutral Mejorana fermions. Quantum interferometers constructed from such a 1D channels have attracted a great interest recent years because they reveal unusual transport properties if they support Majorana states. Despite that Majorana excitations are neutral, their presence at the edges of two superconductors strongly affects the character of Cooper pair tunneling, resulting, for example, in anomalous 4 π-Josephson effect. In our three-contact hybrid structure the superconducting leads with 1D Majorana channels and the interferometer loop are coupled through a tunnel point contacts. We find that if the coupling between them is quite strong then voltage bias in the normal lead results in a strong drag of supercurrent between two superconducting leads, with the current in the normal contact being zero. We derive scattering matrices for the tunnel contacts of the interferometer and calculate analytically the drag current as a function of superconducting phase difference and voltage bias in the normal lead.