Superconducting diode effect due to magnetochiral anisotropy in topological insulator and Rashba nanowires

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The critical current of a superconductor can depend on the direction of current flow due to magnetochiral anisotropy when both inversion and time-reversal symmetry are broken, an effect known as the superconducting (SC) diode effect [1]. In our work, we consider one-dimensional (1D) systems in which superconductivity is induced via the proximity effect [2,3]. In both topological insulator and Rashba nanowires, the SC diode effect due to a magnetic field applied along the spin-polarization axis and perpendicular to the nanowire provides a measure of inversion symmetry breaking in the presence of a superconductor. Furthermore, a strong dependence of the SC diode effect on an additional component of magnetic field applied parallel to the nanowire as well as on the position of the chemical potential can be used to detect that a device is in the region of parameter space where the phase transition to topological superconductivity is expected to arise [3-6].

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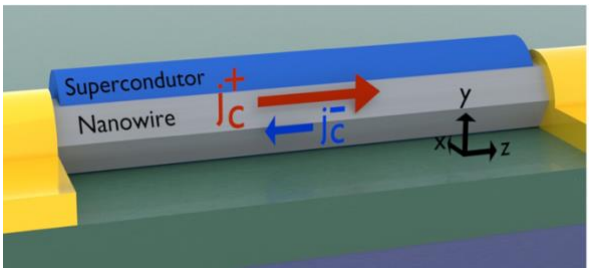

Figure 1: *SC diode effect due to magnetochiral anisotropy in nanowire devices.* When the subbands of a nanowire possess a finite spin polarization due to broken inversion symmetry, a magnetic field applied along the spin-polarization direction results in a relative Zeeman shift of the subbands. The magnetochiral anisotropy (MCA) of the energy spectrum can lead to MCA rectification in the diffusive normal state . On the other hand, if a nanowire is brought into proximity with a superconductor, the MCA of the energy spectrum results in a critical supercurrent in the proximitized nanowire that is different depending on whether current flows to the left or right of the device, the SC diode effect. The dependence of this diode effect on an additional magnetic field component parallel to the nanowire can be used to detect that the nanowire is in parameter regime where topological superconductivity is expected.