Majorana bound states in topological insulator nanowire devices

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I will consider devices made from three-dimensional topological insulator (TI) nanowires. I show that a non-uniform chemical potential across the cross-section of the nanowire lifts the degeneracy between two one-dimensional surface state subbands. Such a nonuniformity in chemical potential can be induced, for example, by gating [1,3] or the induced potential at the interface to a superconductor [2]. A magnetic field parallel to the nanowire breaks time-reversal symmetry and, primarily due to orbital effects, lifts the Kramers degeneracy at zero momentum. As a result, when brought into proximity with an s-wave superconductor, Majorana bound states (MBSs), localised at the ends of the TI nanowire, emerge and are present for an exceptionally large region of parameter space in realistic systems[1,2]. Finally, I will show how this phase space can be dramatically enhanced further in a setup where the TI nanowire forms part of a planar Josephson junction [4].

References

[1] HF Legg, D Loss, J Klinovaja, Majorana bound states in topological insulators without a vortex, PRB 104, 165405 (2021)

[2] HF Legg, M Rößler, F Münning, D Fan, O Breunig, A Bliesener, G Lippertz, A Uday, AA Taskin, D Loss, J Klinovaja, Y Ando, Giant magnetochiral anisotropy from quantum confined surface states of topological insulator nanowires, Nature Nanotechnology 17, 696–700 (2022)

[3] HF Legg, D Loss, J Klinovaja, Metallization and proximity superconductivity in topological insulator nanowires, PRB 105, 155413 (2022)

[4] HF Legg, D Loss, J Klinovaja, Majorana bound states in topological insulators nanowire planar Josephson junction (in preparation)

Figures

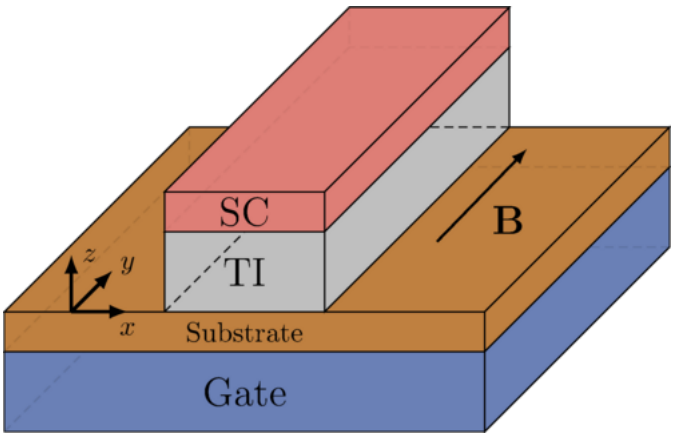

Figure 1: A schematic of a topological insulator nanowire devices.