REPORT ON THE PHD ACTIVITY – THIRD YEAR
2018-2019

Quantum transport in hybrid topological nanostructures

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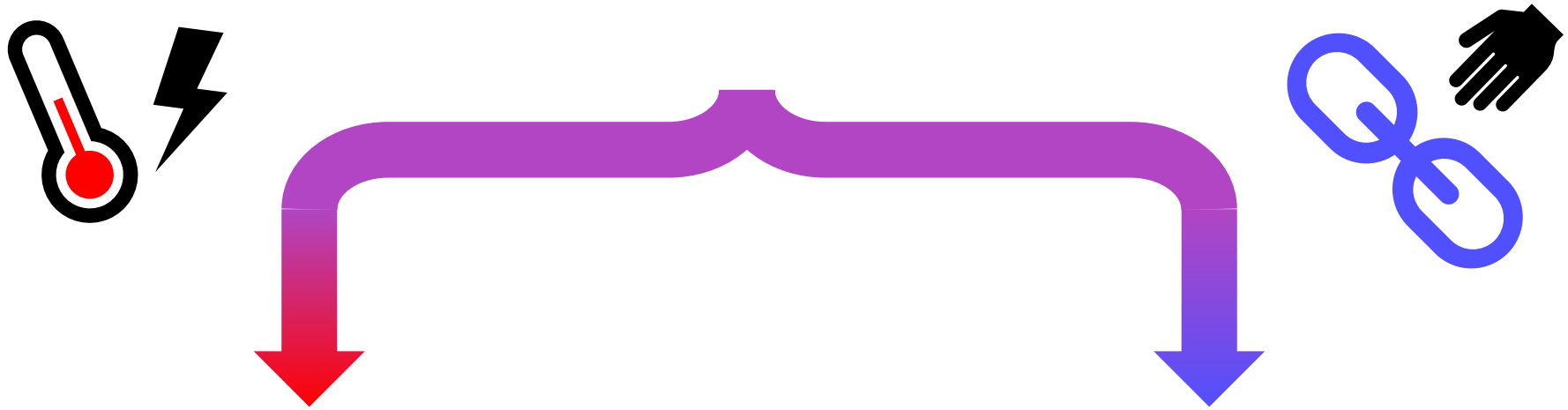
SYSTEM

- ✓ s-wave Superconductors
- ✓ Topological Insulators
- ✓ External controls

TOOLS

- ✓ Scattering Matrix
- ✓ Landauer–Büttiker Formalism



PROJECTS

Thermoelectric Effects

Doppler shift induced nonlocal thermoelectricity in topological Josephson junctions

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We consider a topological Josephson junction done with a quantum spin Hall (QSH) bar where one helical edge state is in contact with a normal-metal probe. We take into account of the doppler-shift as induced by the orbital phase Φ, induced by the magnetic field threading the junction, and of the gauge invariant phase difference bias ϕ. The combination of the helicality in the QSH edge and the doppler-shift induces an unique nonlocal thermoelectric effect. We show that, when a temperature bias is applied at the superconducting terminals, an electrical current is established at the contact with the unpolarized normal metal probe. This transversal thermoelectric effect is a unique feature originated in the helical nature of the edge states coupled to superconducting leads.

Entanglement Manipulation

Manipulation of Cooper pair entanglement in hybrid topological Josephson junctions

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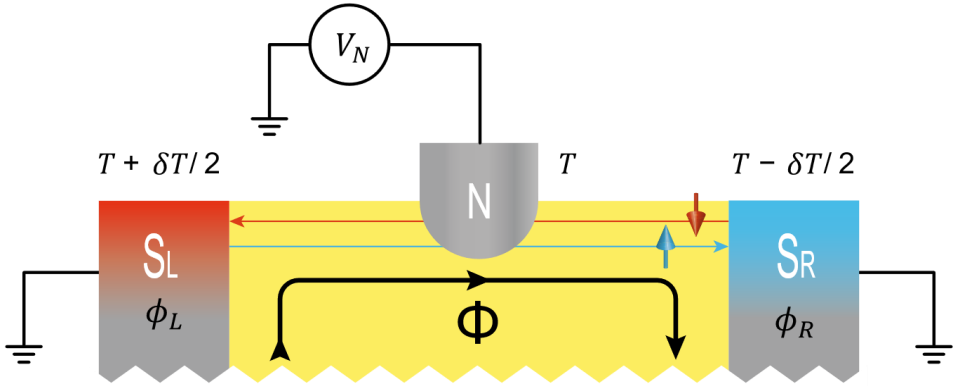
(Dated: February 6, 2019)

In this work we investigate the supercurrent in a hybrid topological Josephson junction consisting of two planes of topological insulator (TI) in a specific configuration, which allows both local (LAR) and crossed (CAR) Andreev processes at the interfaces with two conventional s-wave superconductors. We describe the effects of gate voltage and magnetic flux controls applied to the edge states of each TI. In particular, we demonstrate that the voltage gating allows the manipulation of the entaglement symmetry of non-local Cooper pairs associated to the CAR process. We establish a connection between the Josephson current-phase relationship of the system and the action of the two external fields, finding that they selectively modify the LAR or the CAR contributions. Remarkably, we find that the critical current of the junction takes a very simple form which reflects the change in the symmetry occurred to the entangled state and allows to determine the microscopic parameters of the junction.

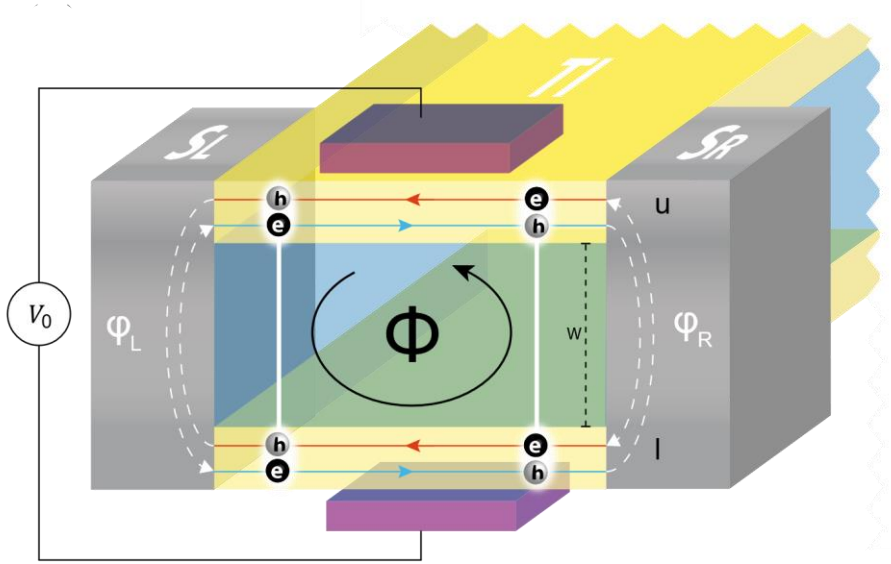
PACS numbers: 73.23.-b, 03.67.Bg, 74.45.+c

MODELS

Thermoelectrical Currents

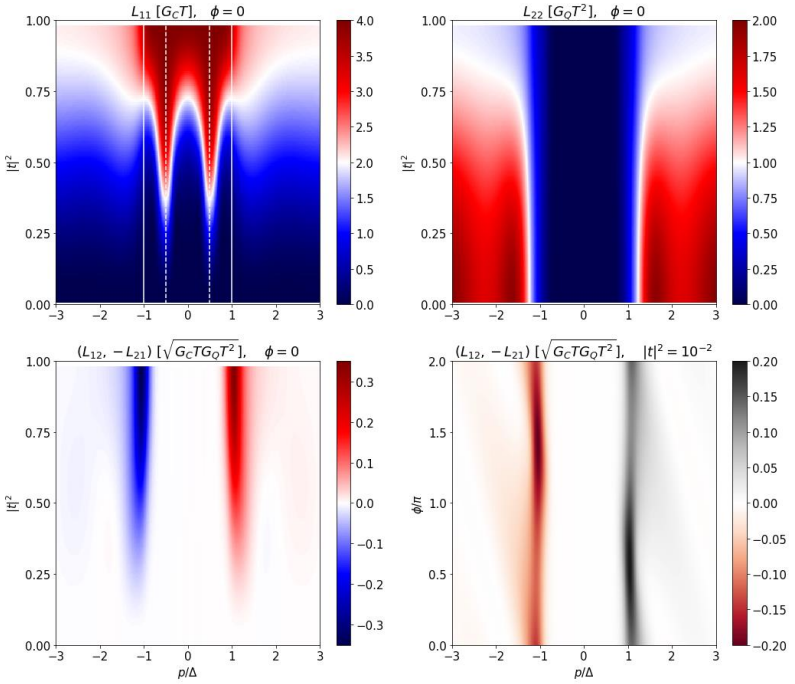


Josephson Current



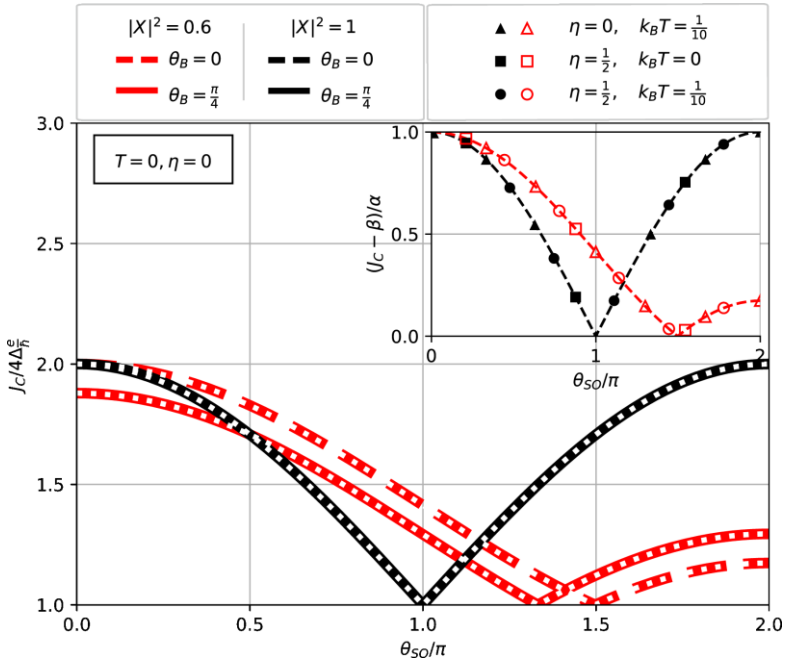
RESULTS

Helicality + Doppler Shift

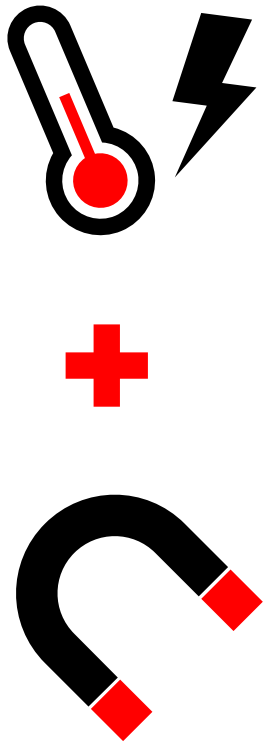


Non-local thermoelectricity

CAR + Voltage Gating

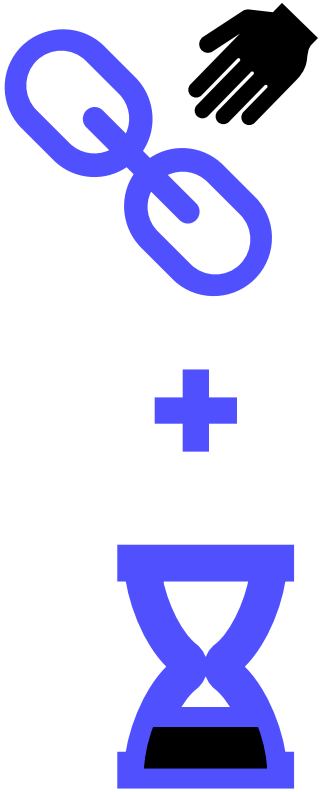


Etanglement symmetry manipulation

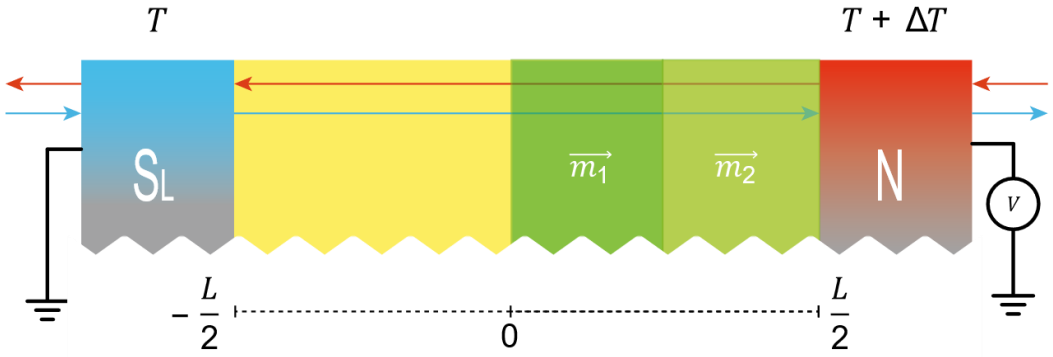


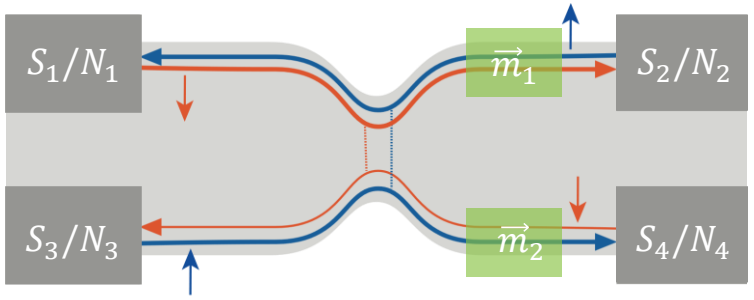
FUTURE WORKS

- ✓ **Better figure of merit**
- ✓ **Isolate single shot**

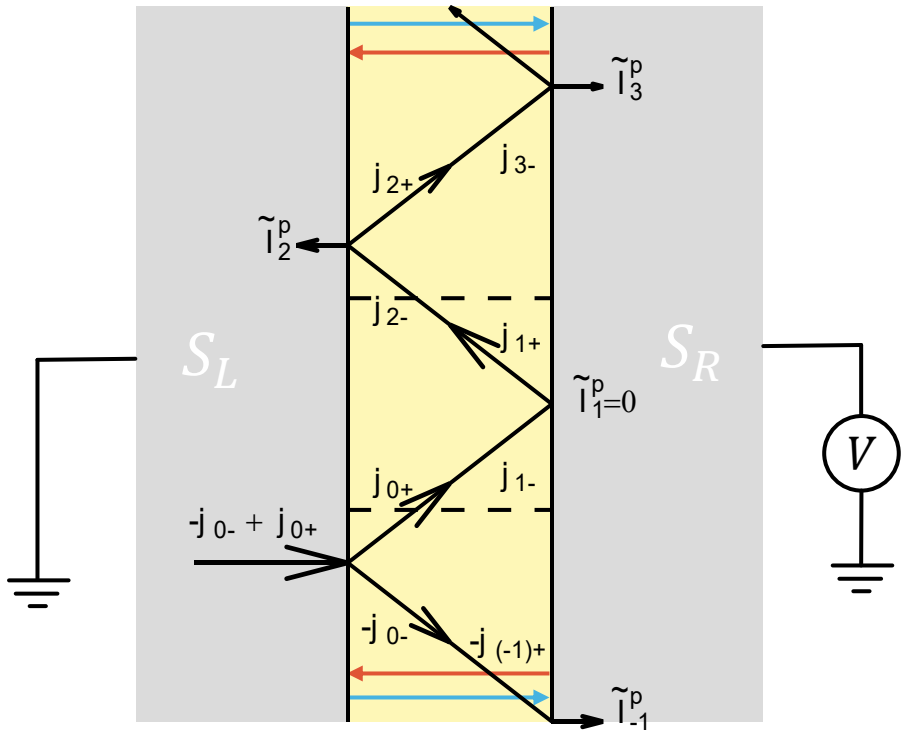


S-TI-N with magnetic islands





Multiple Andreev Reflections



Thnks