Nonlocal thermoelectricity in topological Josephson junctions

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Thermoelectrical effects are expected to be small in hybrid superconducting systems. In this talk, we will discuss how thermoelectricity can be instead developed and manipulated in such systems showing that could be a relevant method to address their physics.

In double quantum dot Cooper pair splitters [1] one recognises that the nonlocal thermoelectricity signals the entanglement induced by the Cooper pair breaking between the two quantum dots, i.e. the nonlocal Andreev reflection [2]. In this presentation, instead, we will demonstrate that linear nonlocal thermoelectrical effects in a three-terminal topological Josephson junction (JJ) can indeed address the helical (topological) nature of the edge states. In particular, we will show how the magnetic flux [3], via Doppler shift, in the topological JJ can trigger and manipulate (even its sign) strong nonlocal thermoelectric effects when the edge states are helical. We report a nonlinear Seebeck coefficient of tens of μV/K at sub-Kelvin temperatures that is 10^4 times bigger than standard metals at similar temperatures. We contrast these physics with the weaker nonlocal thermoelectric effects that can be similarly generated by Josephson phase biases [4] or gap asymmetry of the topological JJ [5]. In the end, we will discuss the thermodynamic and nonlinear performances of these coherent nonlocal thermoelectric generators [5].

[1] R. Hussein et al. "Nonlocal thermoelectricity in a Cooper-pair splitter" Phys. Rev. B 99 075429 (2019)

[2] Z.B. Tan et al. "Thermoelectric current in a graphene Cooper pair splitter" Nature Comm. 12, 138 (2021)

[3] G.Blasi, F. Taddei, L. Arrachea, M. Carrega, A. Braggio "Nonlocal Thermoelectricity in a S-TI-S Junction in Contact with a N-Metal Probe: Evidence for Helical Edge States" Phys. Rev. Lett. 124, 227701 (2020)

[4] G.Blasi, F. Taddei, L. Arrachea, M. Carrega, A. Braggio "Nonlocal thermoelectricity in a topological Andreev interferometer" Phys. Rev. B 102, 241302(R) (2020)

[5] G. Blasi, F. Taddei, L. Arrachea, M. Carrega, A. Braggio "Nonlocal thermoelectric engines in hybrid topological Josephson junctions" Phys. Rev. B 103, 235434 (2021)