

ANALOGUE MAJORANA STATES IN ANTI-HERMITIAN ELECTRICAL CIRCUITS

M1 or M2 Internship

Laboratory and research group: IFW Leibniz institute – Institute for Solid State Research, Quantum Transport Group

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Internship location: Dresden, Germany

Thesis possibility after M2 internship: (to be discussed)

Topoelectronic circuits are fascinating devices that connect topology in condensed matter with electronics. Using only basic electronic components it is possible to conceive devices exhibiting a large variety of phenomena [1] e.g. topologically protected edge states, high-order topology, hyperbolic lattices etc..

More recently, it has been shown in our group that anti-hermitian electrical circuits obey Schrödinger-type dynamics allowing the reproduction of time-dependent phenomena [2]. This have been used to simulate a (1+1) dimensional anti-de-Sitter spacetime with a synthetic event-horizon using it's correspondence with a one dimensional tight-binding model [3,4]. On this circuit, the trajectories of massless particles travelling towards the event-horizon were reproduced and thermalization effects [5] were observed.

Those results lead to new ways of describing voltage and current dynamics in electrical circuits using a quantum formalism allowing a new approaches to conceive and design electrical devices. In particular, it has been observed that anti-hermitian circuit exhibit naturally Majorana-type excitations with an experimentally accessible amplitude and phase. This observation raise the question about the manipulation of those excitation and the possibility to simulate quantum algorithms using them.

Based on previous works on anti-hermitian circuit, the intern will have to conceive a circuit design which enable basic operations on the Majorana-type excitation. This circuit will then be simulated using python and the software LTSpice and potentially experimentally realized in collaboration with the electronic workshop at the IFW Dresden.

[1] Huanhuan Yang, Lingling Song, Yunshan Cao, Peng Yan, Physics Reports, Volume 1093,ISSN 0370-1573 (2024)

[2] Ivan Scoln *et al*, in preparation

[3] C. Morice, A. G. Moghaddam, D. Chernyavsky, J. van Wezel and J. van den Brink, Phys. Rev. Research 3,L022022 (2021)

[4] C. Morice, D. Chernyavsky, J. van Wezel, J. van den Brink and A. G. Moghaddam, SciPost Phys. Core 5, 042 (2022)

[5] L. Mertens, A. G. Moghaddam, D. Chernyavsky, C. Morice, Corentin, J. van den Brink and J. van Wezel Phys. Rev. Research 4, 043084 (2022)