Simulating quantum field theories in a superconducting circuit

The aim of this project is to study the connection between the theory of **continuous matrix product states** (cMPS) and **dissipative criticality** in order to allow for a correct simulation of quantum field theories in a superconducting circuit.

Continuous matrix product states, introduced by Verstraete and Cirac in 2010 [1] are a class of states which correctly describe the properties of ground states of one-dimensional quantum field theories. The latter describe, for instance, confined bosonic gases in optical lattices.

The theory of cMPS establishes a connection between a quantum field theory and the dynamics of an auxiliary open or dissipative system such as a cavity or a superconducting resonator interacting with its environment. The auxiliary system correctly describes the ground state of the quantum field in the vicinity of a dissipative phase transition. Nevertheless, this last concept has not been exploited for experimental realizations yet [2].

Recently, new ideas have been developed in order to characterize phase transitions in open systems [3]. This, together with the theory of cMPS will allow for a more versatile quantum simulator exploiting superconducting circuit technologies.

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