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Cavity QED systems simulating field theories using Continuous Matrix Product States (cMPS) as variational states[1] AIZAR ENCISO DOMINGUEZ, SEAN BARRETT, DAVID JENNINGS, Imperial College London
— The methods to understand quantum many body systems have been based in the proper representations of their ground states such as Matrix Product States (MPS). Those techniques have been recently extended to describe the low energy states of quantum field theories (QFTs), which involve infinite dimensional objects described in a continuous region of space. The resulting many-body variational wave functions (for 1-D field theories) are known as Continuous Matrix Product States (CMPS). They can be understood as the quantum fields that arise when a system with a finite number of levels (e.g. an atom) is allowed to interact, sequentially, with a quantum field (e.g. light in the cavity) at different points in 1-D space. The internal Hamiltonian of this finite system, and it's coupling to the 1-D field, are treated as variational parameters that allow a succinct description of the state of the field. Based on a recent connection made by Verstraete between CMPS's, and the states that are output from an optical cavity we are looking to simulate the response of one dimensional gases with optical cavities by connecting the CMPS that describe the gas with the physical variables involved in the description of the internal dynamics of the cavity. Indeed, the input-output formalism, for describing the quantum state of the field leaking out of a cavity bears similarities with the equations describing a CMPS.

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Aizar Enciso Dominguez
Imperial College London

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