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Lattice Gauge Theories at finite density with Tensor Networks

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Gauge theories are of paramount importance in our understanding of fundamental constituents of matter and their interactions, ranging from high-energy particle physics to low-temperature quantum many-body physics. However, the complete characterization of their phase diagrams and the full understanding of non-perturbative effects are still debated, especially at finite charge density, mostly due to the sign-problem affecting Monte Carlo numerical simulations. In recent years, a complementary numerical approach, Tensor Networks (TN) methods, in strict connection with emerging quantum technologies, have found increasing applications for studying Lattice Gauge Theories (LGTs) in low-dimensional systems. In this talk, I will present some recent results concerning the extension of TN algorithms to high-dimensional LGTs including dynamical matter. In particular, I will focus on their application to a compact Quantum Electrodynamics at zero and finite charge densities, addressing questions such as the characterization of collective phases of the model, the presence of confining phases at large gauge coupling, and the study of charge-screening effects.

Main references:
- G. Magnifico, T. Felser, P. Silvi, and S. Montangero, Nature Communications 12, 3600 (2021).
- M. Rigobello, S. Notarnicola, G. Magnifico, and S. Montangero, Phys. Rev. D 104, (2021).

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