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Approaching Lattice Gauge Theories with Matrix Product States and Gaussian States

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In recent years variational approaches based on efficient ansatzes for the wave function of a quantum many-body system have proven their power for addressing the Hamiltonian lattice formulation of gauge theories. For one, methods based on Matrix Product States, a particular kind of one-dimensional Tensor Network, have been successfully applied to various Abelian and non-Abelian lattice gauge models in $1+1$ dimension. Lately, we developed a variational ansatz based on Gaussian States for $(1+1)$-dimensional lattice gauge theories. These techniques do not suffer from the sign problem and allow for addressing problems which cannot be tackled with conventional Monte Carlo methods, such as out-of-equilibrium dynamics or the presence of a chemical potential.

In this talk I will present some results demonstrating the capabilities of these techniques using the Schwinger model and a $(1+1)$-dimensional SU(2) lattice gauge theory as a test bench. In particular, I will show that we can reliably simulate the static aspects as well as the real-time dynamics of string breaking in these models, and that these methods might be helpful for exploring questions relevant for an implementation in (analog) quantum simulators.

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