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An efficient finite-resource formulation of non-Abelian lattice gauge theories beyond one dimension

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We construct an efficient scheme for the quantum and classical simulation of non-Abelian lattice gauge theories beyond one spatial dimension. First, we show how to reformulate two-dimensional non-Abelian lattice gauge theories in terms of loop variables and conjugate loop electric fields, using canonical transformations on the initial degrees of freedom. By explicitly solving the Gauss law on the lattice, we efficiently rewrite the Hamiltonian in terms of physical independent quantities, without any constraint left in the case of periodic boundary conditions. This dualization procedure simplifies the magnetic part of the Hamiltonian, while introducing non-localities in the electric terms. Then, we determine a convenient representation of the Hamiltonian by choosing the local basis for small and big loops variationally, minimizing the truncation error and allowing us to compute the running of the coupling with finite resources for all coupling regimes on small tori. This method enable computations at arbitrary values of the bare coupling and lattice spacing with current quantum computers/simulators and tensor-network calculations, in regimes otherwise inaccessible.

Title

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