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High-fidelity ground state preparation for quantum simulations of the two-dimensional Z2 lattice gauge theory

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We propose a new variational ansatz for the ground state preparation of the two-dimensional $\mathbb{Z}_2$ lattice gauge theory in digital quantum computers. It is similar to the well known QAOA, but it contains half Trotter step of an imaginary time propagator, which increases the fidelities reached around the phase transition of the gauge theory. We propose a non-probabilistic implementation for this non-unitary operation. The performance of this ansatz is demonstrated by showing its ability to approximate the critical exponents of the $\mathbb{Z}_2$ lattice theory apart from the usual fidelity arguments. A lattice with the geometry of the rotated surface code is used in the simulation in order to introduce ground state degeneracy in the topological phase for finite lattices. The proposed ansatz is able to prepare any of the degenerated ground states.

Authors: Mr BERMÚDEZ CARBALLO, Alejandro (Investigador científico (CSIC)); Mr LOCHER, David (Investigador predoctoral); Mr RICO ORTEGA, Enrique (Ikerbasque Research Associate); COBOS JIMÉNEZ, Jesús (Investigador predoctoral); Mr MÜLLER, Markus (Group Leader Theoretical Quantum Technology)

Presenter: COBOS JIMÉNEZ, Jesús (Investigador predoctoral)

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