Noise-aware variational eigensolvers: A dissipative approach for lattice gauge theories

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Abstract

We propose a novel variational ansatz for the ground-state preparation of the Z2 lattice gauge theory (LGT) in quantum simulators. It combines dissipative and unitary operations in a completely deterministic scheme with a circuit depth that does not scale with the size of the considered lattice. We find that, with very few variational parameters, the ansatz can achieve >99% precision in energy in both the confined and deconfined phases of the Z2 LGT. We benchmark our proposal against the unitary Hamiltonian variational ansatz and find a clear advantage of our scheme, especially when focusing on the nature of the confinement-deconfinement transition of the Z2 LGT. After performing a finite-size scaling analysis, we show that our dissipative variational ansatz can predict critical exponents with reasonable accuracies even for reduced qubit numbers and circuit depths. Furthermore, we investigate the performance of this variational eigensolver subject to circuit-level noise, determining variational error thresholds that fix the error rate $p\ell$ below which $p<p_\ell$ it would be beneficial to increase the number of layers $\ell \mapsto \ell' > \ell$. In light of these quantities and for typical gate errors p in current quantum processors, we provide a detailed assessment of the prospects of our scheme to explore the Z2 LGT on near-term devices.

References

[1] J. Cobos, D. F. Locher, A. Bermudez, M. Müller, E. Rico. arXiv:2308.03618 (2023)