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Topological Order in the Rydberg Blockade on the Kagome Lattice with PEPS

The Rydberg blockade model on the Kagome lattice has recently been realized experimentally [1] and shown numerically—via 2D DMRG [2]—to host a $\mathbb{Z}_2$ topologically ordered phase. In this work, we investigate its phase diagram using the inherently two-dimensional tensor network ansatz: Projected Entangled Pair States (PEPS). To this end, we perform state-of-the-art variational ground state optimization, with energy gradients computed via automatic differentiation applied to the fixed point equations of the VUMPS algorithm [3], which is used to contract the infinite PEPS. The resulting ground states are analyzed to identify various types of order, with particular focus on topological order. This study provides a complementary PEPS-based perspective on the model and offers insight into the robustness of topological order in a highly frustrated, experimentally relevant setting.

[1] Semeghini, G. et al. Science 374, 1242–1247 (2021)
[2] R. Verresen, M. D. Lukin, and Ashvin Vishwanath, Phys. Rev. X 11, 031005 (2021)
[3] A. Francuz, N. Schuch and B. Vanhecke, Phys. Rev. Research 7, 013237 (2025).

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