

Field-Induced Effects on the Phase Structure of a One-Dimensional \mathbb{Z}_2 Lattice Gauge Theory with Second-Nearest-Neighbor Interactions

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One-dimensional \mathbb{Z}_2 lattice gauge theory provides a simplified and versatile framework for exploring fundamental phenomena in quantum field theory and condensed matter physics. In this work, we investigate the ground-state phase diagram of a one-dimensional \mathbb{Z}_2 lattice gauge theory with hard-core bosons at half filling, extending previous studies [1,2] by incorporating second-nearest-neighbor (2NN) interactions. Using matrix product state techniques within the density matrix renormalization group framework, we compute the charge gap, static structure factor, and pair-pair correlation functions over a wide range of interaction strengths and field parameters. We place particular emphasis on the role of the magnetic field sign in determining the stability of the emergent phases, including the Luttinger liquid, Mott insulating, and charge-ordered insulating phases.

References:

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- [2] Y. Zambrano, A. Alekseev, K.J. Kapcia, K. Cichy and A. Cichy, *Phase structure of the one-dimensional \mathbb{Z}_2 lattice gauge theory with second nearest-neighbor interactions*, <https://arxiv.org/abs/2512.10755>, (2025).