Implementation of Lattice Gauge-Higgs Model in Quantum Simulators of Cold Atoms

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In this work, we show how to implement the U(1) gauge-Higgs model with asymmetric nearest-neighbor Higgs coupling by using a system of cold atoms in an optical lattice[1]. The gauge-Higgs coupling in the imaginary time direction naturally arises from the violation of the U(1) local gauge invariance of the simulators caused by the deviation from the fine-tuned system parameters. A general method to supply the Higgs coupling in all space-time directions may be realized by coupling atoms in an optical lattice to another particle reservoir filled with the Bose-condensed atoms via laser transitions. Clarification of the dynamics of this gauge-Higgs model sheds some lights upon various unsolved problems including the inflation process of the early universe. We study the phase structure of this model by Monte Carlo simulation, and also discuss the atomic characteristics of the Higgs phase in each simulator.

1. K. Kasamatsu, I. Ichinose, and T. Matsui, arXiv:1212.4952.

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