Universität Konstanz

Seminar

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Towards analog quantum simulations of Z2 lattice gauge theories

Z2 lattice gauge theories (LGTs) are of high interest in condensed matter physics and topological quantum computation. The investigation of strongly-interacting regimes, however, is especially challenging and in general difficult to access with conventional numerical methods. Here, I want to discuss a first step towards analog quantum simulations of Z2 LGTs and present an approach with a two-component mixture of ultracold bosonic atoms. The scheme uses the interplay of two strongly-interacting components with resonant periodic driving of an optical two-site potential. For particular driving parameters, the effective Floquet Hamiltonian exhibits Z2 symmetry. The dynamics of the system is studied for different initial states and well described by a full time-dependent description. Moreover, the dynamics is non-trivial due to the imposed gauge constraints and in agreement with predictions from the ideal Z2 LGT. However, we reveal challenges that arise due to symmetry-breaking terms, which may be relevant for any experimental implementation, and outline potential pathways to overcome them. Furthermore, I will sketch an alternative approach for experimental implementation of Z2 LGTs in static, undriven systems, which may be suitable for realization with superconducting qubits coupled to coplanar-waveguide resonators.