Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Applications of Tensor Network Algorithms in Quantum Many-Body Physics

By

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The classical simulation of many-body quantum systems is an essential tool in understanding many fundamental aspects of condensed matter physics. But a major obstacle arises from the number of degrees of freedom involved in describing such systems, which is exponential in the system size. Recently, however, a class of numerical techniques based on structures called "tensor networks" has emerged, which allows many "typical" quantum states (such as the ground states of gapped, local Hamiltonians) to be represented much more efficiently.

In this work we extend and apply these techniques to consider several central topics in quantum many-body physics. First, we demonstrate a method for computing high order moments and cumulants of operators with respect to such states, including the so-called "Binder's cumulant," a powerful tool for detecting phase transitions. Next, we employ tensor network algorithms to characterize the ground state phase diagram of quantum spin models, including both symmetry-breaking phases and symmetry protected topological order (SPT), and find a significant variety of phases and phase transitions. Finally, we consider the entanglement properties of quantum states exhibiting many-body localization, using a combination of exact diagonalization and tensor network techniques.

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