How hard is Many-Body Quantum Mechanics?

Michael Wall

Department of Physics

Colorado School of Mines, Golden, CO 80401

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Abstract

Quantum many-body theory is host to many problems which remain unsolved despite decades of intense research. For example, the Hubbard model, which is the simplest model of interacting fermions on a lattice, remains unsolved in dimensions higher than one. In this seminar we will discuss what makes these problems difficult using concepts from computer science and quantum information theory. We will also address how to attack these hard problems numerically. In particular, we will discuss three modern methods for simulating strongly correlated systems: exact diagonalization, Quantum Monte Carlo, and variational matrix product states. We conclude with a discussion of problems still unsolved with these techniques and current research on new methods.