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Quantum algorithms for dynamics and dynamical observables

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Response functions are a fundamental aspect of physics; they represent the link between experimental observations and the underlying quantum many-body state. In particular, dynamical response functions are part of the toolbox that physicists use to unravel the nature of correlated matter. In this talk, I will discuss some aspects of obtaining response functions on quantum computers. First, I will introduce a new method for measuring response functions by using a linear response framework and making the experiment an inextricable part of the quantum simulation. This method can be frequency- and momentum-selective, avoids limitations on operators that can be directly measured, and is ancilla-free. As prototypical examples of response functions, we demonstrate that both bosonic and fermionic Green's functions can be obtained, and apply these ideas to the study of a charge-density-wave material. The linear response method provides a robust framework for using quantum computers to study systems in physics and chemistry. It also provides new paradigms for computing response functions on classical computers. Second, I will highlight some of our recent work using Lie algebraic methods to analyze and simulate dynamics on quantum computers. Lie algebras are a natural way to investigate certain properties of quantum circuits, and conversely use them to build desired quantum circuits. I will overview some of our work in this area, including building exact unitaries via Cartan decomposition, performing circuit compression, and analyzing barren plateaus.

Keyword-1

Quantum

Keyword-2

Dynamics

Keyword-3

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