Optimal quantum algorithm for Gibbs state preparation

Daniel Stilck França
Cambyse Rouzé, Álvaro Alhambra

Deparment of Mathematical Sciences, University of Copenhagen, Copenhagen, Denmark

dsfranca@math.ku.dk

It is of great interest to understand the thermalization of open quantum many-body systems, and how quantum computers are able to efficiently simulate that process. A recently introduced disispative evolution, inspired by existing models of open system thermalization, has been shown to be efficiently implementable on a quantum computer. Here, we prove that, at high enough temperatures, this evolution reaches the Gibbs state in time scaling logarithmically with system size. The result holds for Hamiltonians that satisfy the Lieb-Robinson bound, such as local Hamiltonians on a lattice, and includes long-range systems. To the best of our knowledge, these are the first results rigorously establishing the rapid mixing property of high-temperature quantum Gibbs samplers, which is known to give the fastest possible speed for thermalization in the many-body setting. We then employ our result to the problem of estimating partition functions at high temperature, showing an improved performance over previous classical and quantum algorithms.

Figures

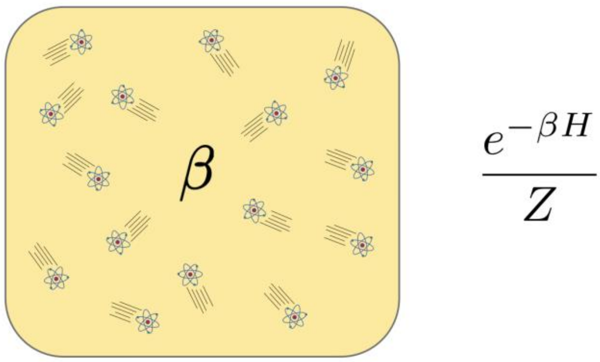

Figure 1: caricature of quantum system in thermal equilibrium.