Samuel Scalet
(University of Cambridge)

Thursday, April 13, 2023, 14:30

A subpolynomial-time algorithm for the free energy of one-dimensional quantum systems in the thermodynamic limit

University of Tübingen, Mathematics Department, C4H33 and via Zoom:
https://zoom.us/j/94274376976?pwd=YVBvU2tNMTBXSGxGYVg4eUoyV1ZiQT09
Meeting-ID: 942 7437 6976
Passcode: 929851

Abstract: We introduce a classical algorithm to approximate the free energy of local, translation-invariant, one-dimensional quantum systems in the thermodynamic limit of infinite chain size. While the ground state problem (i.e., the free energy at temperature T=0) for these systems is expected to be computationally hard even for quantum computers, our algorithm runs for any fixed temperature T>0 in subpolynomial time, i.e., in time O(1/E^c) for any constant c>0 where E is the additive approximation error. Previously, the best known algorithm had a runtime that is polynomial in 1/E where the degree of the polynomial is exponential in the inverse temperature 1/T. Our algorithm is also particularly simple as it reduces to the computation of the spectral radius of a linear map. This linear map has an interpretation as a noncommutative transfer matrix and has been studied previously to prove results on the analyticity of the free energy and the decay of correlations. We also show that the corresponding eigenvector of this map gives an approximation of the marginal of the Gibbs state and thereby allows for the computation of various thermodynamic properties of the quantum system.