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Thermal Stability in Universal Adiabatic Computation

Adiabatic quantum computation (AQC) is a method for performing quantum computation in the ground state of a slowly evolving local Hamiltonian, and in an ideal setting AQC is known to capture all of the computational power of the quantum circuit model. However, despite having an inherent robustness to noise as a result of the adiabatic theorem and the spectral gap of the Hamiltonian, it remains a longstanding theoretical challenge to show that fault-tolerant AQC can in principle be performed below some fixed noise threshold. There are many aspects to this challenge, including the difficulty of adapting known ideas from circuit model fault-tolerance as well as the need to develop an error model that is appropriately tailored for open system AQC. In this talk I will introduce a scheme for combining Feynman-Kitaev history state Hamiltonians with topological quantum error correction, in order to show that universal quantum computation can be encoded not only in the ground state but also in the finite temperature metastable Gibbs state of a local Hamiltonian. Using only local interactions with bounded strength and a polynomial overhead in the number of qubits, the scheme is designed to serve as a proof of principle that universal AQC can be performed at non-zero temperature, and also to further our understanding of the complexity of highly entangled quantum systems in thermal equilibrium.