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Early Fault-Tolerant Quantum Algorithms in Practice for Ground State Energy Estimation

Wednesday, 8 May 2024 11:30 (30 minutes)

In this talk, we will explore the practicality of early fault-tolerant quantum algorithms, where quantum computers are error-corrected, but still severely limited in depth, focusing on ground-state problems. Specifically, we address the computation of the cumulative distribution function (CDF) of the spectral measure and the identification of its discontinuities. Scaling to bigger system sizes unveils three challenges: the smoothness of the CDF for large supports, the absence of tight lower bounds on the overlap with the actual ground state, and the complexity of preparing high-quality initial states. To tackle these challenges, we introduce a signal processing technique for identifying the inflection point of the CDF. Our claims are supported by numerical experiments conducted on a 26-qubit fully connected Heisenberg model using a truncated density-matrix renormalization group initial state of low bond dimension.

Along the way, we also develop error mitigation techniques and provide proof-of-concept experiments that these algorithms can be run on current superconducting quantum devices.

Presenter: KISS, Oriel (CERN)

Session Classification: Talks