Contribution ID: **11** Type: **Talk 22min**

Cycle Error Reconstruction on a trapped ion quantum computer

Friday 12 July 2024 11:23 (22 minutes)

The presence of noise in quantum system makes the precise and efficient characterization of errors necessary. A myriad of benchmarking and tomography routines have been developed over the years to address this challenge. However, most of these suffer from scalability problems in implementation and the information extracted is frequently lacking in predictive or diagnostic utility. A major challenge towards practically useful error characterization techniques is to determine which errors of the exponentially many possible are relevant. The cyclic error reconstruction (CER) protocol tackles this issue by producing error marginals successively, giving the experimenter the choice of how much knowledge is extracted. CER is an extension of the cycle benchmarking protocol expanding its diagnostic utility –giving insight not only in how large the overall error is but also of its origin. In contrast to randomized benchmarking CER uses only single-qubit Pauli twirling and therefore is amenable to characterize multi-qubit processes. Here we apply the CER protocol to a trapped ion quantum computer learning error rates and crosstalk of gates in their natural context scaling from a single qubit gate to logical gadgets.

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Session Classification: Quantum Information & Computing

Track Classification: Quantum Information & Computing