Measurement of central charge from local measurements

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Abstract

In this work, we utilize Shannon-Renyi entropy of local Pauli observables of one-dimensional quantum spin chains at a critical point and extract the central charge from the scaling behavior of its sub-leading term for two distinct universality classes, namely, transverse field Ising(TFI) chain with Z_2 symmetry, XXZ chain with U(1) symmetry. To this end, we first utilize simulated variational quantum eigen-solver (VQE) to prepare the ground state of the critical spin chains. We run our experiments on IBM quantum processors and leveraging the unique topology we measure the central charge both for open and periodic boundary conditions. The latter aids in reducing the finite size effect, even when the system size is L=12. Finally, equipped with advanced error mitigation schemes such as probabilistic error cancellation, we extract an estimate of the central charge for TFI and XXZ chains with an accuracy reaching 7% in the periodic boundary condition set up.

References

Swarndeep Majumdar, Nazli Ugur Koyluoglu, Mirk Amico, Sarah Mostame, Ewout van den Berg, Mohammad Ali Rajabpour, Zlatko Minev, Khadijeh Sona Najafi, Measuring central charge in a superconducting quantum processor, in preparation

Figures

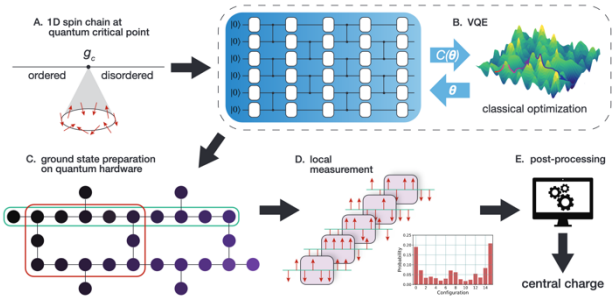

Figure 1: Schematic of measurement of central charge from local measurements in IBM quantum processors

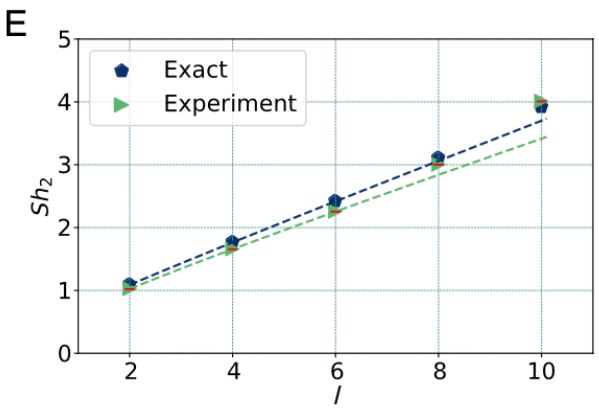

Figure 2: Second Renyi entanglement entropy of transverse field. Using the probabilistic error cancelation, we prepare state with fidelity of 96 percent leading to accurate values of central charge.