Entangling Power, Gate Typicality, and Measurement-induced Phase Transitions

Poster

Sourav Manna, Vaibhav Madhok and Arul Lakshminarayan

Department of Physics and Center for Quantum Information, Communication and Computing, Indian Institute of Technology Madras, Chennai, India

When subject to a nonlocal unitary evolution, qubits in a quantum circuit become increasingly entangled. Conversely, measurements applied to individual qubits lead to their disentanglement from the collective system. The extent of entanglement reduction depends on the frequency of local projective measurements. A delicate balance emerges between unitary evolution, which enhances entanglement, and measurements which diminish it. In the thermodynamic limit, there is a phase transition from volume law entanglement to area law entanglement at a critical value of measurement frequency. This phenomenon, occurring in hybrid quantum circuits with both unitary gates and measurements, is termed as measurement-induced phase transition (MIPT). We study the behavior of MIPT in circuits comprising of two-qubit unitary gates parameterized by Cartan decomposition. We show that the entangling power and gate typicality of the two-qubit local unitaries employed in the circuit can be used to explain the behavior of global bipartite entanglement the circuit can sustain. When the two-qubit gate throughout the circuit is the identity and measurements are the sole driver of the entanglement behavior, we obtain an analytical estimate for the entanglement entropy that shows remarkable agreement with numerical simulations. We also find that the entangling power and gate typicality enable the classification of the two-qubit unitaries by different universality classes of phase transitions that can occur in the hybrid circuit. For all unitaries in a particular universality class, the transition from volume to area law of entanglement occurs with the same exponent that characterizes the phase transition.