Demonstration of long-range state quantum teleportation

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Abstract

Quantum state teleportation is one of the first and most fundamental examples of real-time quantum-classical processing, which includes mid-circuit measurements, classical computation, and feedforward operations, all done well within the coherence time, to achieve transmission of quantum information. Long range quantum teleportation is a more advanced version of quantum state teleportation, which allows transmitting quantum information across a large scale quantum processor using a constant depth circuit. In this work we demonstrate, for the first time, long range quantum teleportation performed across 7 qubits in the Sycamore processor. We demonstrate teleportation across 3, 5, and 7 qubits respectively and compare the result with a SWAP-based protocol. Our results show the feasibility of using teleportation for efficient state transfer across quantum processors of increasing size with nearest-neighbors connectivity. Moreover, our work unlocks the usage of real-time quantum-classical processing for further protocols that could increase efficiency of quantum algorithms towards quantum advantage.