Abstract

The fragility of quantum information and the error-prone nature of quantum operations make building large-scale, fault-tolerant quantum computers a prominent challenge. To combat errors, pioneering experiments have demonstrated a variety of quantum error correction codes. Yet, many existing codes — including surface codes — suffer from low encoding efficiency and require prohibitively high resource overhead, limiting their scalability. In this talk, I will introduce more general quantum low-density parity-check (qLDPC) codes, which would achieve quantum fault tolerance with a much higher encoding efficiency. In particular, I will focus on a special family of qLDPC codes known as bivariate bicycle codes, discussing their construction, decoding strategies, and experimental implementation. In collaboration with experimental teams, we report the first experimental demonstration of a distance-4 bivariate bicycle code on our latest superconducting processor, Kunlun, featuring 32 long-range-coupled transmon qubits.