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【407】Towards a two-qubit gate with grid states encoded in the motion of a trapped ion

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Gottesman-Kitaev-Preskill (GKP) states, also known as grid states, can encode a logical qubit into a quantum harmonic oscillator. Motional modes of a trapped ion are naturally accessible harmonic oscillators. They have coherence times of tens of milliseconds, and can be controlled by their coupling to the electronic degree of freedom of the ion. This enables the preparation and readout of GKP states in these modes. Quantum error correction of GKP states and a universal single-qubit gate set have already been shown in trapped ions and in superconducting circuits. A two-qubit gate remains to be experimentally demonstrated. Following a recent theory proposal from our research group, a controlled-NOT between two logical GKP states can be decomposed into a product of squeezing and beamsplitter operators. We experimentally prepare two grid states encoded in the motional modes of a single ion of Calcium, by applying quantum error correction. We demonstrate the ability to squeeze them and couple them via a beamsplitter interaction. This showcases the necessary ingredients for an entangling gate for GKP qubits.

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