

Abstract Submitted
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A Quantum Non-Demolition Parity measurement in a mixed-species trapped-ion quantum processor MATTEO MARINELLI, VLAD NEGNEVITSKY, HSIANG-YU LO¹, CHRISTA FLHMANN, KARAN MEHTA, JONATHAN HOME², ETH Zurich — Quantum non-demolition measurements of multi-qubit systems are an important tool in quantum information processing, in particular for syndrome extraction in quantum error correction. We have recently demonstrated a protocol for quantum non-demolition measurement of the parity of two beryllium ions by detection of a co-trapped calcium ion. The measurement requires a sequence of quantum gates between the three ions, using mixed-species gates between beryllium hyperfine qubits and a calcium optical qubit. Our work takes place in a multi-zone segmented trap setup in which we have demonstrated high fidelity control of both species and multi-well ion shuttling. The advantage of using two species of ion is that we can individually manipulate and read out the state of each ion species without disturbing the internal state of the other. The methods demonstrated here can be used for quantum error correcting codes as well as quantum metrology and are key ingredients for realizing a hybrid universal quantum computer based on trapped ions. Mixed-species control may also enable the investigation of new avenues in quantum simulation and quantum state control.

¹left the group and working in a company now

²group leader

Matteo Marinelli
ETH Zurich

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