7th European Conference on Trapped Ions

Contribution ID: **69**   Type: **Poster**

Mixed qubit types in registers of individually addressed trapped barium ions

Tuesday, 26 September 2023 19:30 (2 hours)

Registers of different qubit types, where one qubit type is insensitive to the other's light fields, are a promising avenue for scaling the quantum information processing capabilities of trapped-ion systems [1]. This approach mitigates scattering errors and allows for advanced qubit control schemes by enabling partial projective measurements, mid-circuit measurements, and in-sequence cooling.

Barium is particularly well suited for realizing mixed qubit type registers: using just a single atomic species, qubits can be implemented in both barium's ground level and its long-lived (~ 30 s) metastable level. Additionally, qubit transitions within both the ground and the metastable level manifolds can be driven using the same laser wavelength at 532 nm, leading to a significantly reduced experimental overhead.

In our experiment, we use ^{137}Ba$^+$ ions with a nuclear spin of $3/2$. The resulting hyperfine structure allows for the implementation of magnetically-insensitive 'clock' qubits.
We present an all-fibre system capable of single-ion addressing in large qubit registers by utilizing a laser-written waveguide device. Using a trapped ion as a light-field sensor, we characterize the performance of the addressing system by measuring the Stark shifts induced by the individual beams and observe $< 10^{-3}$ crosstalk between neighbouring channels.
We further demonstrate simultaneous manipulation of ground-level and metastable-level qubits and present post-selection schemes that enhance the fidelity of state preparation and effectively identify and eliminate population leakage errors.

[1] D. T. C. Allcock et al., Appl. Phys. Lett. \textbf{119}, (2021).

Primary authors: POKORNY, Fabian (University of Oxford); SOTIROVA, Ana (University of Oxford); LEPPARD, Jamie (University of Oxford); VAZQUEZ-BRENNAN, Andres (University of Oxford); BALLANCE, Chris (Oxford Ionics, University of Oxford)

Presenter: POKORNY, Fabian (University of Oxford)

Session Classification: Tuesday Poster