



Near-field microwave operations with $^{43}\text{Ca}^+$ qubits

Our recent work on performing near-field microwave qubit operations using $^{43}\text{Ca}^+$ ions will be reported.

Using intermediate-field “atomic clock” states, we have demonstrated single-qubit preparation, gates and readout each with 99.9% fidelity or better, with operation times much less than the qubit coherence time of $T_2^* = 50\text{s}$ [1]. These results were achieved in a room-temperature surface trap incorporating integrated microwave waveguides and resonators, using near-field microwaves to drive the qubit gates [2]. We have also used the same trap to implement two-qubit gates with approximately 90% fidelity, the best ever achieved using microwaves [3].

In a separate experiment, we have designed and fabricated a surface trap to implement scalable independent qubit addressing using near-field microwaves [4]. We drive qubit rotations with microwaves in one trap zone while nulling the microwave field in a neighbouring zone (1mm distant), achieving spin-flip addressing errors of order 10^{-6} .

We have also been working on improving the stability of our 146G magnetic field. This is the most significant source of error in our state preparation and readout in the intermediate-field scheme, and it also limits the quality with which diagnostics and characterisations can be carried out. We expect to be able to achieve a stability of below 1mG rms. Our progress will be reported.

References:

- [1] T. P. Harty et al., Phys. Rev. Lett. **113**, 220501 (2014).
- [2] Brown et al., Phys. Rev. A **84**, 030303(R) (2011) and D. T. C. Allcock et al., Appl. Phys. Lett. **102**, 044103 (2013).
- [3] C. Ospelkaus et al., Nature **476**, 181 (2011).
- [4] D. P. L. Aude Craik et al., Appl. Phys. B **114**, 3 (2014).

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