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# Microwave-driven quantum logic in Ca43+ at 288 Gauss

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Magnetic field gradients, generated by microwave circuitry in the proximity of trapped ions, can couple the ions internal and motional degrees of freedom to implement two-qubit gates [1,2]. This approach presents many advantages with respect to laser-driven gates: the hardware is cheaper and more readily scalable, phase control is facilitated, and photon scattering errors are eliminated.

In the past, we have demonstrated gate fidelities of 99.7% [3], approaching the state of the art for laser-based gates. Critically, this number is above the minimum threshold of 99% required for implementing quantum error correction. But the drawback of microwave-driven quantum logic is that gate durations are orders of magnitude longer than their laser-driven counter-parts.

Here, we present a novel ion trap design and qubit, which aims to improve both gate fidelity and speed. The chip features a simple single-electrode microwave geometry which passively minimizes the field amplitude whilst producing a large gradient. Operating Ca43+ at 288 Gauss detunes transitions to "spectator" states, whilst offering a $\pi$-clock transition which is more sensitive to magnetic fields. Finally, by cooling the trap to cryogenic temperatures, we are able to reduce anomalous heating of the ions motion, allowing a reduced distance between the microwave electrode and the ions and hence a more effective delivery of microwaves.

References:
[1] C. Ospelkaus et al., Phys. Rev. Lett. 101, 090502 (2008)
[2] C. Ospelkaus et al., Nature 476, 181 (2011)
[3] T. P. Harty et al., Phys. Rev. Lett. 117, 140501 (2016)

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