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Addressing individual ions with microwaves

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Microwave driven operations offer a scalable approach to trapped ion quantum computing, with cheap and reliable components; stable phase and amplitude control; and potentially higher fidelity gates. However, whilst laser beams can be focussed onto individual ions, the centimeter-wavelength of microwaves requires alternate techniques to address individual qubits. Here, we experimentally demonstrate new ion addressing techniques for both single- and two-qubit gates.

For two-qubit gates, we demonstrate the effective focusing of a spin-dependent force through the spatially varying microwave phase of a dynamical decoupling drive. For addressed single qubit gates, we utilize the spatial variation in microwave amplitude in a 4-pulse scheme. For the latter, parallel randomized benchmarking on two ions yields an average error of 3.4×10^{-5} per logical gate. Both methods demonstrate strong potential for microwave-driven addressed gates — far below error-correction thresholds — in registers of tens of ions confined within a single potential well.

Primary authors: GELY, Mario (University of Oxford); LEU, Aaron; SMITH, Molly; WEBER, Marius; NADLINGER, David; LUCAS, David

Presenter: GELY, Mario (University of Oxford)

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