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Focusing of microwave-driven gate interactions using dynamical decoupling

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In trapped-ion quantum computing, quantum logic gates are often performed using lasers. Alternatively, gates can also be driven by microwave fields for which the technology is cheaper and more reliable, making it simpler to scale up. However, due to their centimetre wavelength, microwaves cannot be focused to a small spot size, making it difficult to address an individual ion within a cluster of ions confined by the same potential well.

We have proposed and demonstrated a method to enable microwave-driven entangling gate operations only in micron-sized zones, corresponding to 10^{-5} microwave wavelengths, whilst suppressing this interaction everywhere else [1]. This is done by utilising the variation in phase of a microwave-field across a surface trap. We find that the required interaction introduces $3.7(4) \times 10^{-4}$ error per emulated gate in a single-qubit benchmarking sequence. We then model the scheme for a 17-qubit ion crystal, and find that any pair of ions should be addressable with an average crosstalk error of $\sim 10^{-5}$.

[1] M. C. Smith et al., arXiv:2309.02125 (2023).

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