

Quantum information processing with trapped ions

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With exceptional coherence and gate fidelities, trapped ions offer unique opportunities to process quantum information. As a consequence quantum algorithms with up to 20 ions have been implemented on trapped-ion quantum computers. To take the next steps will require the research community to take on the engineering challenges as well as exploring improving fundamental aspects.

I will describe our new effort on learning how to handle a larger number of qubits by means of splitting, transporting and merging ion crystals in a chip trap. To aid in miniaturization and speeding up these operations, the ions need to be trapped within about 50 micrometers from the surface. I will discuss how to mitigate the ensuing electric field noise via surface treatment of the trap electrodes. Finally, I will argue that replacing the ions with trapped electrons would speed up ion trap quantum computers by more than two orders of magnitude while at the same reducing some of the engineering challenges of trapped ions by removing the need for laser sources.

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