Atomphysik-Seminar

Mittwoch, 08. November, 13:15 Uhr, KBW Hörsaal Seitenraum

Scalable Quantum Computing with Trapped Ions

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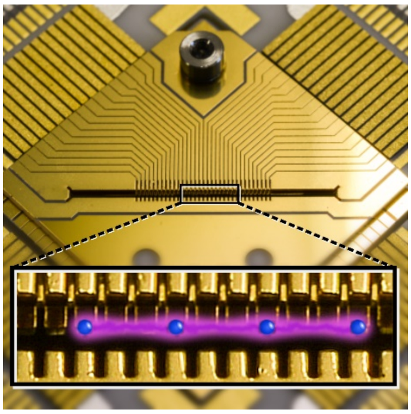
The last two decades have seen tremendous progress towards the realization of scalable quantum computing based on trapped-ion qubits. The challenges lie in establishing and operating devices which allow for control of a sufficiently large number of qubits, and in pushing qubit operations such as readout and gates to shorter durations and higher fidelities. This is expected to soon converge to the point where error correction thresholds are surpassed and fault-tolerant operation can be achieved. In our group, we employ miniaturized Paul trap arrays, which allow for storing small ion crystals and reordering of the qubit register via shuttling operations, along the lines of the seminal proposal of the “quantum CCD” by D. Wineland et al. We explain how our $^{40}Ca^{+}$ spin qubits are operated and elaborate on the underlying technology, in particular microchip based ion traps and scalable voltage waveform generators. We present recent experimental results, including the generation of high-fidelity four-qubit entanglement using scalable methods, and the demonstration of a novel quantum-enabled magnetometry scheme based on spatially distributed entangled ions.
Furthermore, we review recent work and ongoing activities towards the realization of a trapped-ion based quantum computer of sufficient complexity to actually show quantum supremacy.



D. Kielpinsky, C. Monroe, D. J. Wineland, Nature **417**, 709 (2002)
H. Kaufmann et al., PRL **119**, 150503 (2017)
T. Ruster et al., PRX **7**, 031050 (2017)