Dietrich Leibfried
(NIST National Institute of Standards and Technology, Boulder, USA)

Quantum information processing and quantum control with trapped ions*

This talk will give an overview of different aspects of quantum engineering with trapped ions at NIST.
By simultaneous manipulation of two ion species including single qubit rotations, two-qubit gates, transport in a linear trap array and sympathetic re-cooling we were able to prepare an entangled state of two spatially separate harmonic oscillators and to implement repeated one and two-qubit gates with interspersed transport. These experiments constitute the most complete demonstration of building blocks towards a scalable architecture for quantum information processing with trapped ions to date. Moreover, we demonstrated ion transport through trap array junctions in a two-layer and a micro-fabricated surface electrode trap. We are also working on implementing quantum logic by oscillating magnetic fields and their gradients with the goal of improving scalability and fidelity of gate operations.
Moreover, trapped ions offer exciting prospects for quantum simulation and quantum limited sensors. In collaboration with R. Schmid (MPQ Garching) and J. Wesenberg (U. Oxford) we proposed new methods to implement quantum spin models in arrays of trapped ions. In collaboration with R. Maiwald and G. Leuchs (U. Erlangen) we demonstrated a “stylus” trap geometry that might enable detection of very weak (zepto-Newton) forces or, in combination with a deep parabolic mirror, enable coupling of the trapped ion to a single mode fiber with near unit efficiency. The latter application could potentially improve protocols for entangling ions, atoms or quantum dots by interference of spontaneously emitted photons without resorting to enhanced emission into optical cavities.

* Work supported by IARPA and the NIST quantum information program.

14. Dezember 2009, 14:00 Uhr

Universität Stuttgart, NWZII, Raum 2.136
Pfaffenwaldring 57, 70569 Stuttgart

CO.CO.MAT