Q 53: Quanteninformation (Quantencomputer I)

Zeit: Donnerstag 12:00–13:00 Raum: 5L

Q 53.1 Do 12:00 5L

Transport of Atoms in Arrays of Dipole Traps — •Andre Lengwenus, Jens Kruse, Manuel Scherer, Markus Wagner, and Gerhard Birkl — Institut für Angewandte Physik, Technische Universität Darmstadt, 64289 Darmstadt, Germany

For the experimental realization of quantum information processing it is essential to perform one- and two-qubit operations in a controlled fashion. In our approach, qubits are inscribed in the hyperfine states of rubidium atoms. The atoms are trapped in a two-dimensional array of well separated optical micro-potentials created by micro-fabricated lens arrays. We already demonstrated single-qubit operations by the coherent coupling of the hyperfine ground states of ^{85}Rb by stimulated Raman transitions.

We plan the realization of two-qubit gates by the use of ultracold collisions. For this, atoms have to be transported from one trap position to another. We demonstrate the transfer of atoms in microtraps using steering methods which are based on the variation of the incident angle of the laser beam illuminating the array of microlenses.

With this technique we achieved the transfer of atoms over a distance of more than half of the trap-to-trap separation. This is enough to move two initially well separated arrays on top of each other. Trap losses and temperature evolution during transfer are determined. Furthermore we present first data on an atomic shift register based on two independently switchable micro-trap arrays.

Q 53.2 Do 12:15 5L

Quantenzustandsmanipulation in segmentierten Paulfallen:Anwendungsmöglichkeiten der Optimal Control Theory — •Ulrich Poschinger, Kilian Singer und Ferdinand Schmidt-Kaler — Universität Ulm, AbteilungQuanteninformationsverarbeitung, Albert-Einstein-Allee 11, D-89069Ulm

Lasergekühlte Ionen in Paulfallen stellen zur Zeit das beste System für Quantenzustandsmanipulationen dar. In konventionellen Paulfallen besteht das derzeitige Limit in der deterministischen Verschränkung von acht Ionen[1]. Um deutlich mehr Ionen kohärent manipulieren zu können, wurden segmentierte Paulfallen vorgeschlagen. Hier sollen die Ionen in kleinen Gruppen durch Laser manipuliert und zwischen den verschiedenen Fallensegmenten bewegt werden. Wir präsentieren numerische Untersuchungen, inwiefern Optimal Control Theory (OCT) als Werkzeug verwendet werden kann, um die benötigten Prozessschritte schneller und mit höherer Genauigkeit auszuführen. Dies sind das Grundzustandskühlen der Ionen[2], die verschiedenen Verschiebeoperationen[3] und optische Quantengatter zwischen zwei Ionen[4]. Erste Resultate bestätigen, das OCT ein vielseitiges Werkzeug darstellt, um an die experimentellen Bedingungen angepasste Lösungen für die auftretenden Kontrollprobleme zu finden. [1] H. Häffner et al., Nature 438, 643 (2005) [2] S. Sklarz et al., quant-ph/0402143v1 [3] S. Schulz et al., Fortschr. Phys. 54, 648 (2006) [4] C. Rangan et al., PRL 92, 113004 (2004)

Q 53.3 Do 12:30 5L

Experimental investigation of ^{43}Ca^{+} as a new qubit candidate — •Jan Benhelm[1], Gerhard Kirchmair[1], Timo Koerber[1], Christian Roos[2], and Rainer Blatt[1,2] — [1]Institut für Experimentalphysik, Universität Innsbruck, Österreich — [2]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften

We have assembled a new ion trap apparatus capable of trapping strings of ^{43}Ca^{+} ions to investigate this ion species' applicability for quantum information processing. The major motivation is the existence of the clock states (F=4, m_F=0 and F=3, m_F=0) in the ground state manifold, which allows a qubit encoding that is insensitive to phase decoherence due to laser frequency and magnetic-field noise to first order. For sideband cooling and state initialization we want to make use of a narrow bandwidth laser on the quadrupole transition. In order to gain control over the complex level structure, the S-D quadrupole transition has been measured precisely. This enabled us to improve on the determination of the hypefine structure coefficients and the isotope shift of the $D_{5/2}$ state by more than two orders of magnitude. Furthermore we found a number of transitions starting from the stretched states that are first order magnetic-field independent for low magnetic fields ($< 10\ G$). These could also be used as qubits or in order to build an optical clock.

Q 53.4 Do 12:45 5L

Photoassociation phasegate for ultracold atoms in an optical lattice — •Christian Schwenke[1], Tommaso Calarco[2,3], and Christiane Koch[1] — [1]Institut fuer Theoretische Physik, Freie Universitaet Berlin, Arnimallee 14, 14195 Berlin — [2]CNR-INFM BEC Center, I-38050 Povo (TN), Italy; ECT*, I-38050 Villazzano (TN), Italy — [3]ITAMP, Harvard Smithsonian Center for Astrophysics, and Department of Physics, Harvard University, Cambridge, Massachusetts 02138, USA

Ultracold neutral atoms in optical lattice have been proposed as possible realization of a quantum computer [1]. In general, the most difficult part is to find the implementation of a two qubit gate. Here, the possibility to perform a phasegate using short shaped laser pulses inducing transitions between the ground and first electronically excited state will be studied. The qubits are encoded in the electronic spin states of an alkali atom such as Rb87. The gate operation corresponds then to achieving a relative phase between singlet and triplet states of the two-atom system. Optimal control theory [2] is employed to find suitable laser pulses.

[1] H.-J. Briegel, T. Calarco, D. Jaksch, J. I. Cirac, P. Zoller, J. Mod. Opt. Journal of Modern Optics 47, 415 (2000). [2] J. P. Palao, R. Kosloff, Phys. Rev. Lett. 89, 18 (2002)