SYDP 1: Dissertationspreis Symposium

Zeit: Dienstag 10:30–12:30 Raum: 5D

Hauptvortrag SYDP 1.1 Di 10:30 5D

A quantum gas of magnets — •Axel Griesmaier — 5. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany

Interactions in gaseous Bose-Einstein condensates are usually governed by the contact interaction which is caused by isotropic s-wave scattering. It leads to many exciting phenomena in quantum gases ranging from solid state physics to non-linear dynamics. In a chromium gas, magnetic dipole-dipole interaction (MDDI) plays an important role. In contrast to the contact interaction, MDDI is anisotropic and long-range. Since the physical properties of the systems change with the strength, range, and symmetry of the interactions, the dipolar interaction paves the way for the investigation of novel phenomena.

We present our experiments on the MDDI in a gas of chromium atoms. We confirm the dipolar character of the chromium BEC by observing a modification of the expansion dynamics with different alignments of the spins and are able to quantify the relative strength of the magnetic dipole-dipole interaction. Already in a thermal gas, the MDDI leads to a coupling of internal (atomic spin) and external (orbital angular momentum) degrees of freedom. We have also used this coupling to realize a unique cooling scheme, proposed in 1950 by A. Kastler [1], that makes use of the demagnetization of a spin-polarized gaseous sample.

[1] A. Kastler, Le Journal de Physique, 6, 255 (1950).

Hauptvortrag SYDP 1.2 Di 11:00 5D

An atom-sorting machine — •Yevhen Miroshnychenko[1], Wolfgang Alt[2], Igor Dotsenko[2], Leonid Foerster[2], Mkrtych Khudaverdyan[2], Arno Rauschenbeutel[2], Sebastian Reick[2], and Dieter Meschede[2] — [1]Institut d'Optique, Campus Polytechnique R.D. 128, 91127 Palaiseau CEDEX, France — [2]Institut fuer Angewandte Physik, Uniwersitaet Bonn, Wegelerstr. 8, 53115 Bonn, Germany

We have realized a technique for building equidistant strings of individually addressable neutral atoms stored in a standing wave optical dipole trap. Initially, atoms are stored in random potential wells of a standing wave. Individual atoms are then extracted using "optical tweezers" and inserted at predetermined positions. Using this method, the distance between simultaneously trapped atoms can be controlled with a high efficiency and a precision corresponding to only several potential wells of the standing wave trap. Moreover, we have experimentally demonstrated that this technique is compatible with the insertion of an atom into the potential of the standing wave already occupied by another atom.

Such strings of individually addressable atoms could serve as a scalable, neutral-atom quantum register for storing and manipulating quantum information. The placement of two atoms into the same potential well would allow the investigation of collisional dynamics or chemical reactions on the level of individual atoms including the coherent and deterministic creation of a single trapped molecule from its constituents.

Hauptvortrag SYDP 1.3 Di 11:30 5D

From Entangled Photons to Quantum Computation — •Philip Walther[1,2], Mikhail Lukin[2], and Anton Zeilinger[1,3] — [1]Institute for Experimental Physics, University of Vienna, A-1090 Vienna, Austria — [2]Physics Department, Harvard University, Cambridge, Massachusetts 02138, USA — [3]Institute for Quantum Optics and Quantum Information (IQOQI), Austrian Academy of Sciences, A-1090 Vienna, Austria

Photons are robust and efficient carriers of quantum information, while atoms are well-suited for storage of quantum states. The first part of the present talk contains a review of several experimental demonstrations using linear optics and spontaneous parametric down-conversion. Depending on which sort of entangled photon-state was created, different experiments concerning quantum metrology and quantum computing, including the recent progress towards error-corrected linear optics quantum computing by the implementation of active feed-forward in a one-way quantum computer, could be demonstrated.

However, for the realization of a quantum network or efficient generation of multi-photon states quantum repeaters, which utilize quantum memory to store and release single-photons, are required. Recent experiments demonstrating the generation of narrow-bandwidth single photons using a room-temperature ensemble of 87Rb atoms and electromagnetically induced transparency should emphasize the progress towards a quantum network.

Hauptvortrag SYDP 1.4 Di 12:00 5D

Fermi-Bose mixtures with tunable interactions in 3D optical lattices — •S. Ospelkaus, C. Ospelkaus, O. Wille, M. Succo, L. Humbert, P. Ernst, K. Sengstock, and K. Bongs — Institut für Laser-Physik, Universität Hamburg

We present the first experimental realization of a Fermi-Bose quantum many-body system in a 3D optical lattice with bright perspectives for quantum simulation and strongly correlated phases. In these experiments, the effect of a small fermionic ^{40}K "impurity" fraction on the coherence properties of a bosonic ^{87}Rb sample is investigated and found to strongly affect the coherence properties of the bosonic cloud. The surprisingly large effect has triggered an intense discussion on possible explanations in terms of thermodynamic properties, mean field models and disorder-related localization scenarios.

Combining Feshbach-tunable interactions with 3-dimensional optical lattices, formation of heteronuclear Feshbach molecules in single wells of the lattice is demonstrated for the first time. Creation of molecules by means of rf association allows a precise determination of the molecular binding energy across the Feshbach resonance. Molecule formation in the optical lattice results in long lifetimes between 20 and 150 ms. The binding energy, lifetime and efficiency of rf association across the resonance can be understood in terms of a pseudopotential model developped together with F. Deuretzbacher, K. Plassmeier, F. Werner and D. Pfannkuche. We discuss current efforts towards the transfer of these Feshbach molecules into their internal ground state where they exhibit a permanent electric dipole moment.