SYDI 1: Dissertation Prize Symposium

Zeit: Dienstag 10:30–12:30 Raum: VMP 8 HS

Hauptvortrag SYDI 1.1 Di 10:30 VMP 8 HS
Experimental manipulation of atoms and photons: the application in quantum information processing — •Yu-Ao Chen — Physikalisches Institut, Universität Heidelberg, Philosophenweg 12, 69120 Heidelberg, Germany

Quantum information science and atom optics are among the most active fields in modern physics. In recent years, within the frame of quantum repeaters, which solves the formidable obstacles of photon loss and decoherence in long-distance quantum communication, many theoretical efforts have been made to combine these two fields. On the one hand, the experimental technique multi-photon entanglement is further developed to study fundamental issues in quantum mechanics, remarkable applications to quantum communication and quantum computation. On the other hand, utilizing the interaction between laser pulses and atomic ensembles we theoretically and experimentally investigate the potentials of atomic ensembles in the gas phase to build quantum memory for large scale quantum information processing. By combining the techniques of quantum memory and multi-photon interference, we experimentally achieved quantum teleportation between photonic and atomic qubits, efficient entanglement generation via classical feed-forward and further demonstrated a proof-in-principle quantum repeater. The techniques that are being developed will lay the basis for future large scale quantum information processing with atoms and photons.

Hauptvortrag SYDI 1.2 Di 11:00 VMP 8 HS
Cavity QED with a Bose-Einstein Condensate — •Tobias Donner[1], Stephan Ritter[2], Ferdinand Brennecke[3], Anton Oettl[4], Thomas Bourdel[5], Michael Koehl[6], and Tilman Esslinger[3] — [1]JILA, University of Colorado, Boulder CO, USA — [2]Max-Planck-Institut fuer Quantenoptik, Garching, Germany — [3]Institute for Quantum Electronics, ETH Zurich, Switzerland — [4]Universityof California, Berkeley, USA — [5]Laboratoire Charles Fabry, Palaiseau, France — [6]University of Cambridge, Cambridge, UK

The combination of a Bose-Einstein condensate (BEC) with an ultra-high finesse optical cavity in one setup allows for a large variety of experiments.

Due to the strong coupling of individual atoms to the cavity mode, this system can be used as a highly efficient single-atom detector. We exploit the single-atom resolution to study the phase transition from a thermal gas to BEC in the critical regime. We observe how the correlation length diverges when the temperature approaches the critical temperature, and determine the critical exponent of the correlation length.

In a second set of experiments, the BEC is confined inside the cavity. This realizes a situation where we coherently couple a single mode of a matter-wave field to a single cavity mode, and effects involving more than 10^5 quantum degenerate atoms identically and strongly coupled to the cavity can be studied.

Hauptvortrag SYDI 1.3 Di 11:30 VMP 8 HS
Poking and probing strongly correlated gases in optical lattices — •Simon Fölling[1], Artur Widera[2], Stefan Trotzky[2], Olaf Mandel[2], Tatjana Gericke[2], Torben Müller[2], Fabrice Gerbier[2], Patrick Cheinet[2], and Immanuel Bloch[2] — [1]Harvard-MIT Center for Ultracold Atoms and Department of Physics, Harvard University, Cambridge, MA, USA — [2]WA QUANTUM, Institut für Physik, Johannes Gutenberg-Uni Mainz, 55099 Mainz

Ultracold quantum gases in optical lattices are powerful model systems for implementing solid state physics models. This is especially true for the strongly correlated domain, which is even hard to access computationally. Several novel methods are demonstrated that probe the special properties of strongly correlated states in lattice potentials.

The normal methods of probing ultracold weakly interacting gases can be hard to use on strongly correlated systems, as they are mostly sensitive only to first-order correlations. On the other hand, the methods from "classical"solid state physics such as conductivity measurements can often not be employed directly to work with ultracold atom clouds.

The methods shown use the special properties of optical lattice systems such as the ability to manipulate the lattice depth and geometry as well as the direct access to particle-particle correlations and internal states of the particles. In this way, the system can be manipulated and probed in the deeply correlated regime to explore the many-body properties of the quantum gas.

Hauptvortrag SYDI 1.4 Di 12:00 VMP 8 HS
Discrete optics in femtosecond-laser written photonic structures — •Alexander Szameit — Institut of Applied Physics, Friedrich-Schiller-University, Max-Wien-Platz 1, 07743 Jena, Germany

Tailoring the fundamental properties of light is a basic requirement for a majority of optical applications, in terms of technological aspects as well as fundamental research. During the last years it was theoretically shown that arrays of evanescently coupled waveguides are a particular representation of a functionalized optical material, in which the temporal and spatial dispersion of propagating light can be specifically tuned. A novel technique, with which waveguides can be directly "written" into various optical bulk materials using femtosecond laser pulses, allows for the realization of a variety of these innovative concepts. This includes applications with a more technical background, such as schemes for imaging, all-optical routing and switching, as well as fundamental problems, e.g. analogs to similar physical systems like Bose-Einstein condensates, solids or abstract quantum-mechanical settings, and even optics on a non-euclidian curved topology. In this presentation I will review recent results and give a short outlook on future activities.