SYDD 1: Driven-Dissipative Quantum Systems

Time: Monday 14:30–16:30 Location: P 1

Invited Talk SYDD 1.1 Mon 14:30 P 1

Controlling (?) Quantum Dynamics with Open Systems — •Dieter Meschede — Institut für Angewandte Physik, Universität Bonn, Bonn, Germany

In the real world quantum systems are always coupled to their environment, called a reservoir. They are therefore called "open systems" for which a simple hamiltonian description is insufficient. Coupling to the environment makes especially quantum superposition states very fragile which impairs applications in e.g. quantum information processing: In most cases the environment drives quantum systems into eigenstates defined by the measurement apparatus of the observer.

In a new line of research activities experimenters and theorist try to turn the game around: tame the environment ("control the open system") in such a way that interesting quantum dynamical processes can be initiated including e.g. the creation of entangled few particle states and the creation of novel states of matter in atomic many body systems.

In this presentation I will review the background of open system control physics and give an overview of some current research activities with special regard to experimental control.

Invited Talk SYDD 1.2 Mon 15:00 P 1

Many-body physics of driven, open quantum systems: optically driven Rydberg gases — •Michael Fleischhauer — Dept. of Physics & Research Center OPTIMAS, Univ. Kaiserslautern

Quantum optical realizations of many-body systems must often be considered as open systems, and ususally much effort is put into isolating quantum systems from the environment. However, with the tools available to manipulate reservoirs or the coupling to them, a new approach emerged in recent years. Reservoir couplings and external drive can be used deliberately to prepare and stabilize quantum states, to generate novel phases and drive phase transitions between non-equilibrium steady states. After giving an introduction into some of the tools to theoretically describe open many-body systems, the above questions will be addressed for the experimentally relevant example of optically driven Rydberg gases. Here there are two different regimes of the many-body dynamics depending on the resonance conditions of the optical excitation. Under conditions of resonant excitation the van-der Waals repulsion results in an effect called Rydberg blockade. The interaction drives the system towards a state with crystalline order but competes with fluctuations inherent to the open system. For off-resonant excitation, where the driving field is tuned out of resonance, an anti-blockaded situation is established. Here the presence of a single excitation shifts other atoms at a certain distance into resonance causing a fast excitation cascade. Mean field approximations to the many-body dynamics predict a bi-stable steady state, which will be critically reexamined.

Invited Talk SYDD 1.3 Mon 15:30 P 1

Theorie getriebener dissipativer Quantensysteme / theory of driven dissipative quantum systems — •Tobias Brandes — TU Berlin

Quantum master equations are an important tool in dealing with transport in open quantum systems. In this short lecture, I will give a survey of some basic and some more advanced topics, such as
- master equations and correlation functions: waiting times $w(\tau)$, $g^{(2)}(\tau)$ function etc.
- phase space representations
- feedback control
- cascaded baths/ photon BEC master equations
- periodic driving, Floquet master equations
(in German or English depending on the audience).

Invited Talk SYDD 1.4 Mon 16:00 P 1

Calorimetry of a Bose-Einstein-condensed photon gas — •Martin Weitz — Institut für Angewandte Physik, Universität Bonn, Wegelerstr. 8, 53115 Bonn, Germany

Bose-Einstein condensation has been observed with cold atomic gases, quasiparticles in solid state systems as polaritons, and more recently also with photons in a dye-filled microcavity. I will here report on recent measurements of my Bonn group determining the heat capacity of the photon gas in the dye-filled microcavity system. Thermalization of photons is achieved in a number-conserving way by repeated absorption re-emission cycles on the dye molecules, and the cavity mirrors provide both an effective photon mass and a confining potential. When the thermalization by absorption and re-emission is faster than the photon loss rate in the cavity, the photons accumulate at lower energy states above the cavity low-frequency cutoff, and the system finally thermalizes to a Bose-Einstein condensate of photons. On the other hand, for a small reabsorption with respect to the photon loss, the state remains laser-like. The measurements of the heat capacity were performed under the conditions of the thermalization being much faster than both photon loss and pumping. At the Bose-Einstein phase transition, the observed specific heat shows a cusp-like singularity, as in the λ-transition of liquid helium, illustrating critical behaviour of the photon gas.