DY 23: Quantum Dynamics, Decoherence and Quanten Information

Time: Tuesday 14:00–15:15 Location: H48

DY 23.1 Tue 14:00 H48

Distortion of a reduced equilibrium density matrix — •Iris Schwenk and Michael Marthaler — Institut für Theoretische Festkörperphysik, Karlsruher Institut für Technologie

We study a system coupled to external degrees of freedom, called bath, where we assume that the total system, consisting of system and bath is in equilibrium. An expansion in the coupling between system and bath leads to a general form of the reduced density matrix of the system as a function of the bath selfenergy. The coupling to the bath results in a renormalization of the energies of the system and in a change of the eigenbasis. We study the influence of bosonic degrees of freedom on the state of a six qubit system similar to the eight qubit unit cell of a quantum annealing processor examined by Lanting et al.[1].

[1] T. Lanting et al., Phys. Rev. X 4, 021041 (2014).

DY 23.2 Tue 14:15 H48

Diagrammatic description of a quantum system coupled to strong noise — •Michael Marthaler and Juha Leppäkangas — Karlsruhe Institute of Technology

We study a system-bath description in the strong coupling regime, where it is not possible to derive a master equation for the reduced density matrix by a direct expansion in the system-bath coupling. A particular example is a bath with significant spectral weight at low frequencies. Through a unitary transformation it can be possible to find a more suitable small expansion parameter. Within this approach we construct a formally exact expansion of the master equation on the Keldysh contour. The lowest-order expansion is similar to the so-called P(E)-theory or non-interacting blip approximation (NIBA). The analysis of the higher-order contributions shows that there are two different classes of higher-order diagrams. We study how the form of the spectral function affects their convergence.

DY 23.3 Tue 14:30 H48

Lindblad dynamics of Gaussian states in the semiclassical limit — •Bradley Longstaff[1], Eva-Maria Graefe[1], and Roman Schubert[2] — [1]Imperial College London, UK — [2]University of Bristol, UK

The time evolution of wave packets forms the basis of many semiclassical methods for closed systems. An important ingredient is Heller's method in which the centre of a wave packet moves along a classical trajectory and the width follows a linearised classical flow. Here this method is extended to open systems described by the Lindblad equation. By considering Gaussian Wigner functions, semiclassical equations of motion are derived for both the centre of the wave packet and the covariance matrix. The approximation is exact for maximally quadratic Hamiltonians and linear Lindblad operators. As an illustration, the Gross-Pitaevskii equation for a Bose-Einstein condensate in an optical lattice with particle losses is derived.

DY 23.4 Tue 14:45 H48

A positive tensor network approach for simulating open quantum many-body systems — •Albert H. Werner[1], Daniel Jaschke[2], Pietro Silvi[3], Martin Kliesch[1], Tommaso Calarco[3], Jens Eisert[1], and Simone Montangero[3] — [1]Dahlem Center for Complex Quantum Systems, Freie Universität Berlin, 14195 Berlin, Germany — [2]Department of Physics, Colorado School of Mines, Golden, Colorado 80401, USA — [3]Institute for Complex Quantum systems (ICQ), Universität Ulm, 89069 Ulm, Germany

Open many-body quantum systems play an important role in quantum optics and condensed-matter physics, and capture phenomena like transport, interplay between Hamiltonian and incoherent dynamics, and topological order generated by dissipation. We introduce a versatile and practical method to numerically simulate one-dimensional open quantum many-body dynamics using tensor networks. It is based on representing mixed quantum states in a locally purified form, which guarantees that positivity is preserved at all times. Moreover, the approximation error is controlled with respect to the trace norm. Hence, this scheme overcomes various obstacles of the known numerical open-system evolution schemes.

DY 23.5 Tue 15:00 H48

Simulation of Heat Transfer in Quantum Chains Far From Equilibrium — •Thomas Motz, Joachim Ankerhold, and Jürgen T. Stockburger — Institute for Complex Quantum Systems, Ulm University, Albert-Einstein-Allee 11, D-89069 Ulm, Germany

We study heat exchange in open harmonic quantum chains by means of a scalable method also for large system sizes and long relaxation times. Starting from a stochastic Liouville-von Neumann equation that models the coupling of systems to quantum reservoirs by an exact c-number representation [1], we turn this approach to a deterministic set of equations correctly accounting for system-bath correlations for any combinations of harmonic systems arbitrarily strong coupled to ohmic reservoirs [2].

We investigate the time-dependence of the energy fluxes and the corresponding steady-states for various couplings, dampings and temperatures [3,4]. A distinct sensitivity of the fluxes with respect to couplings and impurities is found while correlations reveal a ballistic behavior and recurrence effects for a mismatch of coupling strengths and damping.

[1] J. T. Stockburger and H. Grabert, PRL 88, 170407 (2002).
[2] J. Ankerhold and J. P. Pekola, PRB 90, 075421 (2014).
[3] R. Schmidt et al., PRL 107, 130404 (2011).
[4] R. Schmidt et al., PRA 88, 052321 (2013).