Universität zu Köln

Mathematisch-Naturwissenschaftliche Fakultät

Meeting — **UoC Forum**
"Interacting particle systems — **a quantum dynamical point of view**"

Monday, February 5, 2018
Seminar Room 0.03, Institute for Theoretical Physics (new building)
University of Cologne
Zülpicher Straße 77a
50937 Köln

Program

10:00 — 10:45 Semyon Klevtsov (UoC)

Mathematics of the Fractional Quantum Hall wave functions

Quantum Hall effect is one of the most interesting examples quantum many-particles systems. It occurs in certain two-dimensional electron systems at low temperatures and in high magnetic fields, which exhibit plateaux with the quantized values of the Hall conductance. The Fractional Quantum Hall effect (FQHE), when the Hall conductance takes on fractional values, is an example of the strongly-interacting quantum many-particles. The standard physics approach to the FQHE is to assign a certain many-body wave function to each plateaux. I will talk about a program as to how one can use a combination of probabilistic, asymptotic and geometric methods to learn more about the physics and mathematics of the FQHE wave functions, in particular, describe the electromagnetic and gravitational responses, asymptotics for a large number particles, novel quantized coefficients for the adiabatic transport.

10:45 — 11:05 Coffee Break

11:05 — 11:50 Jean-Sebastian Bernier (U Bonn)

Propagation of correlations in dissipative systems: ballistic, diffusive and aging dynamics

In recent years, considerable experimental efforts have been devoted to dynamically generate complex states and monitor their evolution. Despite remarkable advances, the theoretical principles behind the non-equilibrium dynamics of strongly correlated quantum matter are still far from being fully understood. In particular, very few studies have sought to clarify the influence of environmental couplings on the propagation of correlations. We attempt here to fill this gap. Considering first an interaction quench in the Bose-Hubbard model under the effect of dephasing, we observe that dissipation effectively speeds up the propagation of single-particle correlations while reducing their coherence. In contrast, for two-point density correlations, the initial ballistic propagation regime gives way to diffusion at intermediate times. In a second time, considering the XXZ spin-1/2 model in contact with a similar environment, we find this system to display aging. A dynamical phenomenon characterized by a breakdown of time-translation invariance, a slow non-exponential relaxation of two-time correlations and the presence of dynamical scaling.

14:30 ─ 15:15 Wojciech de Roeck (KU Leuven)

Dynamics and slowdown of quantum spin systems

I will discuss several results (also in the mathematical sense) about the dynamics of quantum spin systems. The main theme will be 'localization' which is a term that has been much in vogue in the last years. Usually, it is understood as 'absence of dissipative behaviour'. I will explain what this means and how it comes about. The phenomenon that is probably to be expected to apply more broadly than 'localization' is 'sparsity of resonances', sometimes also called 'asymptotic localization' or 'quasi-localization'. It manifests itself in quantum and classical systems, where transport and thermalization take place only due to effects that are non-perturbative (smaller than any power) in the natural parameters of the system.

15:20 ─ 16:05 Gunter Schütz (Forschungszentrum Jülich)

Exact density matrix for the dissipative Heisenberg quantum spin chain

We demonstrate that the exact nonequilibrium steady state of the one-dimensional Heisenberg XXZ spin chain driven by boundary Lindblad operators can be constructed explicitly with a matrix product ansatz for the nonequilibrium density matrix. For spin 1/2 the matrices satisfy the quantum algebra $U_q\,[sl(2)]$. For the isotropic Heisenberg chain, coupled with strength Γ at the ends to boundary reservoirs polarized in different directions with twist angle ϑ, we calculate the exact magnetization profiles and magnetization currents in the nonequilibrium steady state of a chain N sites. For large N the in-plane steady-state magnetization profiles are harmonic functions with a frequency proportional to the twist angle ϑ. In-plane steady-state magnetization currents are subdiffusive and vanish like $1/\Gamma$ as the coupling increases, while the transverse current saturates to $2\vartheta/N$ when the coupling strength Γ is sufficiently large. For the anisotropic chain we find a current resonance at the specific values of the anisotropic interaction strength where the transverse current is independent of system size, even for non-integrable higher-spin chains.

16:05 ─ 16:20 Coffee Break

16:20 ─ 17:05 Sebastian Diehl (UoC)

From Micro- to Macrophysics in Driven Open Quantum Systems

Recent developments in diverse areas - ranging from cold atomic gases over light driven semiconductors to microcavity arrays - move systems into the focus, which are located on the interface of quantum optics, many-body physics and statistical mechanics. These "driven open quantum systems" share in common that coherent and driven-dissipative dynamics occur on an equal footing, creating genuine non-equilibrium scenarios without immediate counterpart in equilibrium condensed matter physics. A case in point are so-called exciton-polaritons in two spatial dimensions. We briefly explain the physical basis, their description, and how to detect the violation of thermal equilibrium conditions in the formalism. We then show that a paradigmatic hallmark of low-temperature equilibrium systems -- the presence of quasi-long range order, i.e. the algebraic decay of spatial correlation functions -- must be absent due to non-equilibrium conditions. This conclusion is drawn based on a connection to the problem of surface roughening.

17:15 Wine & Cheese