Tübingen-Zürich Meeting in Mathematical Physics

University of Tübingen, Fachbereich Mathematik

4-5.07.2019

PROGRAM

Thursday 04.07 (Room N14)

14:00-14:50: Stefan Teufel (Tübingen)

Non-equilibrium almost-stationary states and linear response for gapped quantum systems

14:50-15:40: Giuseppe Genovese (UZH)

Periodic driving of one impurity in the XX chain: synchronisation at low frequencies

15:40-16:10: Coffee break

16:10-17:00: Christian Brennecke (Harvard)

Optimal Rate for Bose-Einstein Condensation in the Gross-Pitaevskii Regime

17:00-17:50: A. Shadi Tahvildar-Zadeh (Rutgers)

Classical and Quantum Laws of Motion for Singularities of Spacetime

19:00: Dinner at Gastätte Stern, Lange Gasse 4

Friday 05.07 (Room N15)

09:00-09:50: Giovanna Marcelli (Tübingen)

Non-equilibrium almost-stationary states and linear response for gapped non-interacting quantum systems

09:50-10:20: Coffee Break

10:20-11:10: Margherita Disertori (Bonn)

A supersymmetric transfer operator in 1D random band matrices.

11:10-12:00: Luca Fresta (UZH)

A hierarchical supersymmetric model for weakly disordered three-dimensional semimetals

12:00-13:30: Lunch break

13:30-14:20: Marco Falconi (Tübingen)

Microscopic Derivation of Point Interactions

14:20-15:10: Simone Rademacher (UZH)

Dynamics of the strongly coupled polaron

ABSTRACTS

Title: *Non-equilibrium almost-stationary states and linear response for gapped quantum systems* (S. Teufel)

Abstract: I will first review the problem of justifying linear response theory for gapped extended quantum systems and briefly discuss existing mathematical results. Then I will present a recent approach to the rigorous justification of linear (and higher order) response based on non-equilibrium almost-stationary states and an adiabatic theorem for time-dependent perturbations that close the spectral gap. My talk is based on [arXiv:1708.03581, CMP Online First] and an ongoing joint project with Giovanna Marcelli.

Title: *Periodic driving of one impurity in the XX chain: synchronisation at low frequencies* (G. Genovese)

Abstract: The topic of the talk will be the long time behaviour of the XX chain with a time-periodic transverse magnetic field acting on a single site. For high frequencies, in agreement to existing literature on similar problems, the state asymptotically synchronises with the forcing. It is possible to extend this result to low frequencies, for which much less is known, if the amplitude of the transverse field is small. However synchronisation can be proven only under a certain (neither severe nor quite natural) restriction on the forcing. A joint work with L. Corsi (Atlanta).

Title: *Optimal Rate for Bose-Einstein Condensation in the Gross-Pitaevskii Regime* (C. Brennecke)

Abstract: We consider systems of bosons trapped in a box, in the Gross-Pitaevskii regime. We show that low-energy states exhibit complete Bose-Einstein condensation with an optimal bound on the number of orthogonal excitations. This extends recent results obtained in our previous work, removing the assumption of small interaction potential. The talk is based on joint work with C. Boccato, S. Cenatiempo and B. Schlein.

Title: *Classical and Quantum Laws of Motion for Singularities of Spacetime* (A. Shadi Tahvildar-Zadeh)

Abstract: In this talk I report on recent developments towards a relativistic quantum-mechanical theory of motion for a fixed, finite number of electrons, photons, and their anti-particles, as well as its possible generalizations to other particles and interactions. I will briefly explain the necessary conditions under which worldlines of charged particles can be identified with timelike singularities of spacetime and/or classical fields permeating the spacetime, and show examples of classical as well as quantum theories of motion for them when these conditions are satisfied. I will then show how one can define a quantum-mechanical wave function for a single photon, and use that to obtain a Lorenz-covariant system of multi-time wave equations for an interacting two-body system in one space dimension, comprised of one electron and one photon. I will demonstrate that the corresponding initial-boundary-value problem is well-posed, and that both electron and photon trajectories exist globally for typical initial particle positions. I will conclude by presenting preliminary results of numerical experiments that illustrate Compton scattering in this context, as well as a possible new phenomenon: photon capture and release by the electron. This talk is a summary of joint work with Michael Kiessling, Matthias Lienert, Annegret Burtscher, and others.

Title: *Non-equilibrium almost-stationary states and linear response for gapped non-interacting quantum systems* (G. Marcelli)

Abstract: We construct explicitly a non-equilibrium almost-stationary state (NEASS) at zero temperature for gapped infinitely extended quantum systems within the one-particle approximation. A gapped Hamiltonian, which is not necessarily periodic, is perturbed by switching on adiabatically in time a constant electric field of intensity $\varepsilon \ll 1$, modelled by a linear potential. It is expected that the initial Fermi projection evolves adiabatically into NEASS, once the perturbation, which closes immediately the spectral gap of the unperturbed Hamiltonian, is turned on. We provide formulas for linear and higher order response coefficients, including the conductivity tensor, assuming the validity of NEASS method. We follow the strategy implemented in [arXiv:1708.03581, CMP (2019)], but for both discrete and continuum models. Two new technical difficulties occur: to establish the trace class property and to deal with domain issues of some relevant unbounded operators (e.g. the do-

main of the perturbed Hamiltonian does depend on time). This talk is based on an ongoing joint project with S. Teufel.

Title: *A supersymmetric transfer operator in 1D random band matrices.* (M. Disertori)

Abstract: Transfer matrix approach proved to be a a powerful tool to study one dimensional or quasi 1d statistical mechanical models. Transfer operator kernels arising in the context of quantum diffusion and the supersymmetric approach display bosonic and fermionic components. For such kernels, the presence of fermion-boson symmetries allows to drastically simplify the problem. I will review some results in the case of random band matrices.

This is joint work with Sasha Sodin and Martin Lohmann.

Title: *A hierarchical supersymmetric model for weakly disordered three-dimensional semimetals* (L. Fresta)

Abstract: An important open problem in quantum mechanics is to prove that three-dimensional lattice Schrödinger operators with extensive disorder exhibit a localization/delocalization transition as a function of the disorder strengh. We studied a hierarchical supersymmetric lattice model for Weyl semimetals with weak Anderson-type disorder. In the talk I will present a theorem about the algebraic decay of the disorder-averaged two-point correlation function, compatible with delocalization. Our method is based on a rigorous implementation of the renormalization group, reminiscent of the Gawedzki-Kupiainen block spin transformations. The main technical novelty is the multi-scale analysis of massless Gaussian convolutions with purely imaginary covariances via stationary phase expansions. Joint work with G. Antinucci and M. Porta.

Title: *Microscopic Derivation of Point Interactions* (M. Falconi)

Abstract: In this talk I will report on a joint work with R. Carlone, M. Correggi, and M. Olivieri concerning the derivation of time-dependent point interactions. Starting from the microscopic polaron model, describing the interaction of an electron with a phonon field, we consider the effective action of the latter on the electron, in the quasi-classical limit. For suitable configurations of the quantum field, such effective action is indeed described by a time-dependent point interaction. As a byproduct, since time-dependent point interactions present complete ionization, we also prove that there are configurations of the phonon field

that can induce polaron ionization.

Title: *Dynamics of the strongly coupled polaron* (S. Rademacher)

Abstract: We study the time evolution of the strongly coupled polaron described by the Fröhlich Hamiltonian with large coupling constant α. We show that the time evolution of a particular class of Pekar product states is well approximated by the Landau-Pekar equations for times short compared to α^2. This is achieved by proving an adiabatic theorem for the Landau-Pekar equations. This is joint work with Nikolai Leopold, Robert Seiringer and Benjamin Schlein.