DY 26: Poster - Quanten Systems

Time: Tuesday 18:15–21:00 Location: Poster C

DY 26.1 Tue 18:15 Poster C

What is the origin of power-law trapping in 4D maps? — •Steffen Lange[1], Arnd Bäcker[1,2], and Roland Ketzmerick[1,2] — [1]TU Dresden, Institut für Theoretische Physik, Dresden — [2]MPI für Physik komplexer Systeme, Dresden

While power-law trapping in 2D maps can be explained by a hierarchy of partial transport barriers, its origin in higher dimensional maps is still an open question. We study 4D symplectic maps with a regular region embedded in a large chaotic sea. Chaotic orbits are trapped in the vicinity of the regular region and show a power-law decay of trapping times. We search for the trapping mechanism by visualizing the trapped orbits in 3D phase-space slices [1] and by analyzing their time-dependent frequencies. While a hierarchy of regular regions similar to 2D maps is known to be present [2] and surprisingly also signatures of partial barriers are detected, these do not explain the observed trapping in 4D maps. Instead, a stochastic process including a drift along the resonance channels is conjectured to be the origin of the power-law trapping.

[1] M. Richter, S. Lange, A. Bäcker, and R. Ketzmerick, *Visualization and comparison of classical structures and quantum states of four-dimensional maps*, Phys. Rev. E **89**, 022902 (2014)

[2] S. Lange, M. Richter, F. Onken, A. Bäcker and R. Ketzmerick, *Global structure of regular tori in a generic 4D symplectic map*, Chaos **24**, 024409 (2014)

DY 26.2 Tue 18:15 Poster C

Phase-space structure of van der Waals dissociation — •Tom Schilling[1] and Arnd Bäcker[1,2] — [1]Institut für Theoretische Physik, TU Dresden, Dresden, Germany — [2]MPI für Physik komplexer Systeme, Dresden, Germany

An effective description of the dissociation of van der Waals complexes, such as He$-$I$_2$, can be obtained in terms of 4D symplectic maps. The escape dynamics is governed by a mixed phase space where in particular normally hyperbolic invariant manifolds are of importance. We use frequency space plots, escape time plots, and 3D phase-space slices [1] to visualize the dynamics. This allows for an understanding of the chaotic transport leading to dissociation.

[1] M. Richter, S. Lange, A. Bäcker, and R. Ketzmerick, *Visualization and comparison of classical structures and quantum states of four-dimensional maps*, Phys. Rev. E **89**, 022902 (2014)

DY 26.3 Tue 18:15 Poster C

Visualization of regular phase-space structures of the spatial circular restricted three-body problem — •Martin Langer[1] and Arnd Bäcker[1,2] — [1]TU Dresden, Institut für Theoretische Physik, Dresden, Germany — [2]MPI für Physik komplexer Systeme, Dresden, Germany

The spatial circular restricted three-body problem is a Hamiltonian system with three degrees of freedom, describing for example the dynamics of an astroid in the field of two heavy masses moving on circular orbits. By a Poincaré section this can be reduced to a 4D symplectic map. To visualize the dynamics in phase space, in particular around the Lagrangian triangular equilibria $\mathcal{L}_{4,5}$, we use the recently introduced 3D phase space slices [1]. We relate regular phase-space structures with those in frequency space and explain the organization of phase space using lower-dimensional tori.

[1] M. Richter, S. Lange, A. Bäcker, and R. Ketzmerick, *Visualization and comparison of classical structures and quantum states of four-dimensional maps*, Phys. Rev. E **89**, 022902 (2014)

DY 26.4 Tue 18:15 Poster C

Resonance–assisted tunneling in 4D symplectic maps — •Markus Firmbach[1], Felix Fritzsch[1], Arnd Bäcker[1,2], and Roland Ketzmerick[1,2] — [1]TU Dresden, Institut für Theoretische Physik, Dresden — [2]MPI für Physik komplexer Systeme, Dresden

Dynamical tunneling allows wave functions to penetrate into regions of phase space which are strictly separated by classical dynamics. Nonlinear resonances can enhance tunneling rates by several orders of magnitude due to resonance–assisted tunneling. While this is both qualitatively and quantitatively well understood for 2D systems, this is not the case for higher–dimensional systems. As a first step we introduce a class of 4D symplectic maps with just a single resonance and determine the tunneling rates numerically. In order to obtain a theoretical prediction we employ quantum perturbation theory and a suitable integrable approximation. We find good agreement with numerical data.

DY 26.5 Tue 18:15 Poster C

Distance dependence of fluctuations in mesoscopic transport: From branched flow to UCFs — •Kazuhiro Kubo and Martina Hentschel — Technische Universität Ilmenau, Institut für Physik, Ilmenau, Germany

We investigate the propagation of electrons starting from a quantum point contact-like source in a two dimensional random potential with spatial Gaussian correlation. We calculate the density of classical trajectories and find the well-known branching pattern near the source. However, we observe its gradual disappearance into a homogeneously fluctuating pattern at larger distances away from the source. This is accompanied by a continuous change in the trajectory-density probability distribution from lognormal-like to Gaussian-like, which is suggestive of change of the transport dynamics from ballistic to diffusive. We present the distribution of momenta, and confirm that, for shorter distances, a certain direction corresponding to the branched flow is properly preferred, while there is no such a direction at larger distances. Also, we show that the intensity distribution of each trajectory at a given distance can be obtained by correctly taking into account the distribution of travelling times to points at a certain distance from the source. These results are compared with those of the quasi one-dimensional (i.e. one of space coordinates is proportional to time) case to clarify the dependence on the degree of freedom.

DY 26.6 Tue 18:15 Poster C

Localization of Chaotic Resonance States due to a Partial Transport Barrier — •Martin Körber[1], Arnd Bäcker[1,2], and Roland Ketzmerick[1,2] — [1]TU Dresden, Institut für Theoretische Physik, Dresden — [2]MPI für Physik komplexer Systeme, Dresden

Chaotic eigenstates of quantum systems are known to localize on either side of a classical partial transport barrier if the flux connecting the two sides is quantum mechanically not resolved due to Heisenberg's uncertainty. Surprisingly, in open systems with escape chaotic resonance states can localize even if the flux is quantum mechanically resolved [1]. We explain this using the concept of conditionally invariant measures by introducing a new quantum mechanically relevant class of such fractal measures [2]. We numerically find quantum-to-classical correspondence for localization transitions depending on the openness of the system and on the decay rate of resonance states.

[1] Phys. Rev. Lett. **111**, 114102 (2013)

[2] Phys. Rev. Lett. (accepted); arXiv:1509.00665

DY 26.7 Tue 18:15 Poster C

Whispering Gallery Modes in Graphene Billiards — •Guido Natura — Institut für Physik, Technische Universität Ilmenau. 98693 Ilmenau

The development of optical resonators became essential for the improvements of optical devices such as filters, sensors or lasers. A promising application are microcavities, which allow the trapping of light by means of internal reflection. Here we are considering graphene Billiards where the resonator geometry is created by a radially increasing potential bias on a graphene surface and allows the trapping of carriers inside [1]. These are assumed to behave as relativistic fermions in a finite domain as in the Neutrino Berry-Mondragon-Billiards [2]. The objective of this work is the invesitigation of whispering gallery modes in graphene Billiards and the study of a possible ray-wave-correspondence in the relativistic case.

[1] Yue Zhao, Jonathan Wyrick, Fabian D. Natterer, Joaquin F. Rodriguez-Nieva, Cyprian Lewandowski, Kenji Watanabe, Takashi Taniguchi, Leonid S. Levitov, Nikolai B. Zhitenev, and Joseph A. Stroscio. Creating and probing electron whispering-gallery modes in graphene. *Science*, 348(6235):672-675, 2015.

[2] M. V. Berry and R. J. Mondragon. Neutrino billiards: Time-reversal symmetry-breaking without magnetic fields. *Proceedings of the Royal Society of London A: Mathematical, Physical and Engineering Sciences*, 412(1842):53-74, 1987.

DY 26.8 Tue 18:15 Poster C

Semiclassical Theory for Interacting Many-Body Scattering of Bosons Through Mesoscopic Chaotic Cavities — •Josef Michl, Fabian Stöger, Juan-Diego Urbina, and Klaus Richter — Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg, Germany

We report our progress in constructing a theory for mesoscopic scattering of identical particles through open chaotic cavities suitable for studying the interplay between three physical effects: universality of single-particle transport, many-body correlations due to quantum indistinguishability, and the presence of interparticle interactions.

Already at the level of non-interacting particles, indistinguishability alone produces non-trivial combinations of single-particle scattering matrices in the transport of many particles through mesoscopic chaotic cavities, which result in a mesoscopic version of the Hong-Ou-Mandel effect known from quantum optics[1]. Going beyond non-interacting systems, the study of interaction effects requires a proper choice of the underlying single-particle basis for the Fock space. We show, that in the basis of chaotic single-particle scattering states, the many-body Hamiltonian takes a universal form, which is ready to be used within a non-perturbative semiclassical approach based on solutions of mean-field equations, similar to that for Bose-Hubbard systems[2]. We present analytical and numerical results at the level of the diagonal approximation and discuss how to go beyond.

[1] Hong, C. K., Ou, Z. Y., Mandel, L., PRL 18, 2044 (1987)
[2] Engl, T. et al., PRL 112, 140403 (2014)

DY 26.9 Tue 18:15 Poster C

Stationary waves on nonlinear quantum graphs — Sven Gnutzmann[1] and •Daniel Waltner[2] — [1]School of Mathematical Sciences, University of Nottingham, Nottingham NG7 2RD, UK — [2]Fakultät für Physik, Universität Duisburg-Essen, Lotharstraße 1, 47048 Duisburg, Germany

We present a general framework for solving the stationary nonlinear Schrödinger equation (NLSE) on a network of one-dimensional wires modelled by a metric graph with suitable matching conditions at the vertices. For the cubic NLSE the solutions are given by Jacobi elliptic functions. For sufficiently small amplitudes we use canonical perturbation theory that allows to extract the leading nonlinear corrections over large distances. Simple closed and scattering graphs serve as examples.

DY 26.10 Tue 18:15 Poster C

Nonthermal Fixed Points and Superfluid Turbulence in Ultracold Bose Gases — Halil Cakir[1], Stefanie Czischek[1], •Markus Karl[1,2], Eike Nicklas[1], Thomas Gasenzer[1,2], and Markus K. Oberthaler[1] — [1]Kirchhoff-Institut für Physik, Ruprecht-Karls-Universität Heidelberg, Im Neuenheimer Feld 227, 69120 Heidelberg — [2]Institut für Theoretische Physik, Ruprecht-Karls-Universität Heidelberg, Philosophenweg 16, 69120 Heidelberg

Ultracold quantum gases provide various means to probe universal many-body dynamics far from equilibrium. Here, we focus on the non-linear dynamical evolution induced in an ultra cold Bose gas by a sudden initial parameter quench. Considering one- or multi-component (spin) systems, various types of spatial and wavenumber- space patterns emerge, being characterized by universal scaling functions associated with non-thermal fixed points. Such fixed points can be observed in existing experiments and are closely related to quantum turbulence usually discussed in systems of more than one spatial dimension. While these situations are associated with quenches to a symmetry-broken state, quenches within the symmetric phase offer a way to probe the properties of universal dynamics similar to those near a quantum critical point in equilibrium. Scaling properties have been found which indicate the importance of pre-thermalisation temperatures long before dephasing has occurred in the nearly gapless system. We discuss the theoretical results in the light of and illustrated by recent experimental measurements.

DY 26.11 Tue 18:15 Poster C

Self-localization of Bose-Einstein condensates in leaking optical lattices — •Johannes Kruse and Ragnar Fleischmann — Max Planck Institute for Dynamics and Self-Organization, 37073 Göttingen, Germany

Mean field and beyond mean field model calculations of Bose-Einstein condensates trapped in optical lattices have shown that initially homogeneous condensates can evolve into self-trapped, strongly localized states in the presence of weak boundary dissipation, a phenomenon called self-localization. A phase transition from extended to localized states has been observed when the effective nonlinearity exceeds a critical threshold Λ^b_{eff}.
We investigate the phase transition to self-localization in the mean field approximation of the discrete nonlinear Schrödinger equation. Earlier, based on the concept of the Peierls-Nabarro barrier an analytical upper bound for Λ^b_{eff} as a function of the system size had been found. We now propose and numerically verify an analytical lower bound for Λ^b_{eff}, linking it to the phenomenon of Anderson localization. Moreover we quantitatively characterize the properties of the nonlinear localized solutions, so called *discrete breathers*, directly after the phase transition. The results strongly suggest that in the thermodynamic limit the average shape of the solutions at the transition approaches a fixed limiting profile located in the center of the lattice.

DY 26.12 Tue 18:15 Poster C

DMRG simulations of relaxation dynamics of interacting electrons in a disordered quantum wire — •Felix Weiner[1], Peter Schmitteckert[2], and Ferdinand Evers[1] — [1]Institut I - Theoretische Physik, Universität Regensburg — [2]Institut für Theoretische Physik IV, Heinrich-Heine-Universität Düsseldorf

We study high temperature relaxation dynamics of electrons with short range interaction in a disordered quantum wire. Such systems are believed to exhibit many-body localisation, which has attracted considerable attention in recent thereotical investigations. Our simulations are performed by means of time-dependent density matrix renormalization group (DMRG) with the standard extension to mixed state evolution via purification. Accessible time scales in this approach are known to be limited by the fast growth of entanglement with time. Nevertheless, we are able to demonstrate results for time traces that are converged in a systematic way for a given disorder realisation. Charge relaxation is investigated via a wave-packet propagation. Besides the variance also higher moments of the distribution are investigated because one would expect a non-Gaussian broadening. The goal of the project is to obtain, eventually, the time evolution of the entire (non-Gaussian) distribution function in the localised and delocalised phase.

DY 26.13 Tue 18:15 Poster C

Thermalization in Two Uncoupled Wires of Interacting Luttinger Liquids — •Sebastian Huber[1,2,3], Michael Buchhold[2,3] und Sebastian Diehl[2,3] — [1]Physics Department, Ludwig-Maximilians-Universität München, 80333 Munich, Germany — [2]Institute of Theoretical Physics, Technische Universität Dresden, 01069 Dresden, Germany — [3]Institute of Theoretical Physics, University of Innsbruck, A-6020 Innsbruck, Austria

Coherently splitting a one-dimensional Bose gas provides an attractive, experimentally established platform to investigate thermalization dynamics. After the split, the two wires are in a strongly entangled non-equilibrium state with equal longitudinal phase profiles. The dynamics is generated by interactions within the two uncoupled Luttinger Liquids.

In order to find signatures of thermalization and to calculate the non-equilibrium dynamics of this system, we derive the kinetic equations for the time dependent normal and anomalous phonon densities in a Keldysh framework. We determine the spatial expansion of the relative phase correlation function numerically at each time step, which is experimentally detectable by means of matter-wave interferometry.

The time evolution of the relative phase correlation function has two distinct regimes: At early times the system evolves to a prethermal state characterized by a light-cone behaviour and described by a GGE state. However, the presence of phonon scattering induces late time dynamics, during which the relative phase correlation function shows clear signatures of thermalization.