DY 26: Quantum Chaos I

Time: Thursday 9:30–12:00 Location: H47

Invited Talk DY 26.1 Thu 9:30 H47

Genuine quantum interference in interacting bosonic fields: The semiclassical propagator in Fock space — •Juan Diego Urbina[1], Thomas Engl[1], Arturo Arguelles[2,1], Julien Dujardin[2], Peter Schlagheck[2], and Klaus Richter[1] — [1]Institute for Theoretical Physics, University of Regensburg — [2]Department of Physics, University of Liege

We present a semiclassical theory of quantum interference effects in interacting bosonic fields. We make special emphasis on the difference between genuine quantum interference (due to the superposition principle in the many-body Hilbert space), and classical interference effects due to the wave character of the classical limit.

First, we discuss how the usual approaches to this problem are unable to provide the characteristic sum of oscilatory terms, each asociated with a solution of the classical equations of motion, required to semiclassically address interference effects. We show then how to solve this problems by a formal construction of the van Vleck-Gutzwiller propagator for bosonic fields as a sum over paths in the associated Fock space and we identify the classical limit as a Gross-Pitaevskii equation with boundary conditions and multiple solutions.

The theory predicts effects akin to weak localization to take place in Fock space, and in particular the enhancement of quantum probability of return due to interference between time-reversed paths there. We support our claims with extensive numerical calculations for a discrete version of an interacting bosonic field.

DY 26.2 Thu 10:00 H47

Universality in chaotic quantum transport: The concordance between random matrix and semiclassical theories — Gregory Berkolaiko[1] and •Jack Kuipers[2] — [1]Department of Mathematics, Texas A&M University, College Station, TX 77843-3368, USA — [2]Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany

Electronic transport through chaotic quantum dots exhibits universal, system independent, properties, consistent with random matrix theory. The quantum transport can also be rooted, via the semiclassical approximation, in sums over the classical scattering trajectories. Correlations between such trajectories can be organized diagrammatically and have been shown to yield universal answers for some observables. Here, we develop the general combinatorial treatment of the semiclassical diagrams, through a connection to factorizations of permutations. We show agreement between the semiclassical and random matrix approaches to the moments of the transmission eigenvalues. The result is valid for all moments to all orders of the expansion in inverse channel number for all three main symmetry classes (with and without time reversal symmetry and spin-orbit interaction) and extends to nonlinear statistics. This finally explains the applicability of random matrix theory to chaotic quantum transport in terms of the underlying dynamics as well as providing semiclassical access to the probability density of the transmission eigenvalues.

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DY 26.3 Thu 10:15 H47

Experimental resonance spectra and field distributions of a dielectric cube — •Marco Masi, Barbara Dietz, Maksim Miski-Oglu, and Achim Richter — Institut für Kernphysik, TU Darmstadt, 64289 Darmstadt, Germany

In the frame of a project which envisages to extend the experimental study from 2D to 3D dielectric microwave resonators, we present the measurement results for a 3D alumina cube resonator. The aim is the understanding of its spectral properties and its electromagnetic field distributions. These are different from those of a 2D flat dielectric microwave resonator since all polarizations have to be taken into account. Its resonance frequencies, the length spectrum of its corresponding classical periodic orbits, the wave vector distribution, the mode symmetry classes, and the polarization states are investigated. A central question is the existence of superscars in 3D resonant structures, and more generally the validity of semiclassical approximations in 3D resonant structures.

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15 min. break

DY 26.4 Thu 10:45 H47

Experimental observation of spectral gap in microwave n-disk systems — Sonja Barkhofen[1], •Tobias Weich[2], Alexander Potzuweit[1], Hans-Jürgen Stöckmann[1], Ulrich Kuhl[3], and Maciej Zworski[4] — [1]Fachbereich Physik, Philipps-Universität Marburg, Renthof 5,35032 Marburg, Germany — [2]Fachbereich Mathematik, Philipps-Universität Marburg, Hans-Meerwein-Straße,35032 Marburg, Germany — [3]Laboratoire de Physique de la Matière Condensée, CNRS UMR 7336, Université de NiceSophia-Antipolis, F-06108 Nice, France — [4]Department of Mathematics, University of California, Berkeley, California 94720, USA

We present experimental studies of the symmetry reduced 3-disk and 5-disk systems using a microwave setup. By extracting the complex resonances from the signal by means of the harmonic inversion we can access the width distribution. A spectral gap is observed for thick as well as for thin repellers, for thin repellers it is compared with the known topological pressure bounds. Furthermore the maxima of the distributions coincide in a large range with half of the classical escape rate.

DY 26.5 Thu 11:00 H47

Biased diffusion inside regular islands of randomly perturbed quantum maps — •Alexander Schnell[1] and Roland Ketzmerick[1,2] — [1]Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany — [2]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Straße 38, 01187 Dresden, Germany

We study quantum maps under random parametric perturbations. Similar to the corresponding classical case [1] we find biased diffusion of wave packets inside a regular island. We show that quantum mechanics leads to two additional effects: (i) Due to quantization the innermost states exhibit a different drift velocity and diffusion coefficient, which can be derived from a linearized model. This may enhance or reduce the survival probability in the regular island depending on the parity of the initial wave packet. (ii) Due to dynamical tunneling the escape from the regular island is further enhanced at large times.

[1] A. Kruscha, R. Ketzmerick, and H. Kantz, Phys. Rev. E **85**, 066210 (2012).

DY 26.6 Thu 11:15 H47

Edge states in a rectangular microwave Dirac billiard — •Maksym Miski-Oglu, Barbara Dietz, Christof Cuno, Tobias Klaus, Marco Masi, and Achim Richter — Institut für Kernphysik, Technische Universität Darmstadt, D-64289 Darmstadt, Germany

We present results on the experimental investigation of edge states in a superconducting microwave Dirac billiard. A rectangular microwave billiard is filled with metallic cylinders which form a photonic crystal with a triangular lattice. In the vicinity of a certain frequency, the so called Dirac frequency, the dispersion relation for electromagnetic waves in a photonic crystal is similar to that of a relativistic massless fermion and the Helmholtz equation reduces to the Dirac equation. The localized states, so called edge states, occur in the vicinity of the Dirac frequency. Their resonance frequencies are extracted from the measured transmission spectra and compared with predictons in the context of the semiclassical theory.

DY 26.7 Thu 11:30 H47

Quantum graphs with time dependent bond lengths — •Daniel Waltner and Uzy Smilansky — Department of Complex Systems, Weizmann Institute of Science, Rehovot, Israel

Usually a graph is considered to be built up by vertices connected by bonds with fixed lengths. In experimental realizations of graphs, for example by optical fiber networks, the bonds usually slightly change their lengths randomly caused e.g. by thermal fluctuations. We study perturbatively the effect of these fluctuations on the properties of graphs and discuss the experimental relevance.

DY 26.8 Thu 11:45 H47

Trapping of chaotic orbits in 4D maps — •Steffen Lange[1,2], Martin Richter[1], Arnd Bäcker[1,2], and Roland Ketzmerick[1,2]

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Generic Hamiltonian systems with more than two degrees of freedom lead to chaotic zones in phase space which are all interconnected by the Arnol'd web. We study 4D maps with a regular region embedded in a large chaotic sea, i.e. far away from the near-integrable regime. Chaotic orbits show a power-law decay of survival times. We find that the underlying mechanism is clearly different from trapping in 2D maps. Moreover, it is not related to the Arnol'd web. Instead, an anisotropic diffusion near the surface of the regular region is observed.