DY 15 Quantum Chaos

Time: Monday 15:00–17:00 Room: SCH 251

DY 15.1 Mon 15:00 SCH 251

Fractal Classical Conductance Fluctuations — •Holger Hennig[1], Ragnar Fleischmann[1], and Lars Hufnagel[2] — [1]MPI for Dynamics and Self-Organization, Goettingen and Institute for Nonlinear Dynamics, University of Goettingen — [2]Kavli Institute for Theoretical Physics, University of California, Santa Barbara

The coherent conductance through mesoscopic structures is well known to show reproducible fluctuations with the variation of an external parameter (e.g. a magnetic field). These fluctuations are caused by interference effects and can be described semiclassically. In systems with mixed regular and chaotic classical dynamics *fractal* conductance curves are found [1]. Experiments that study the transition from coherent to incoherent transport showing a change of the fractal dimension with the coherence-length [2], however, seemed to contradict the semiclassical theory of the fractal scaling.
We show that there is no contradiction but that the classical dynamics itself already leads to fractal conductance curves explaining the experimental observations. Moreover, we predict fractal classical conductance fluctuations not only in systems with mixed phase space but in purely chaotic systems.
[1] R. Ketzmerick, Phys. Rev. B, 54, 10841
[2] A.P. Micolich et al., Phys. Rev. Lett., 87, 036802

DY 15.2 Mon 15:15 SCH 251

From irregular subthreshold oscillations to intermittent spiking: canard explosion for a chaotic attractor — •Michael Zaks, Xaver Sailer , and Lutz Schimansky-Geier — Institut für Physik, Humboldt-Universität zu Berlin, 12489 Berlin

In a deterministic model of a neuron with one fast and two slow variables, we observe the crisis of a chaotic attractor: a minute parameter variation causes the strong abrupt (albeit continuous) increase of the amplitude of irregular oscillations. In contrast to conventional types of attractor crises, this phenomenon owes to separation of characteristic timescales; it is related to the motion of the system in the phase space along the repelling part of the slow surface. In contrast to the conventional canard explosion, the transition is experienced not by a single limit cycle but by the attracting chaotic set. For the discussed model the crisis marks the transition from the state of chaotic subthreshold oscillations to the regime of intermittent chaotic spiking. Similar phenomena have been recovered in collective dynamics of large ensembles of globally coupled slow-fast stochastic oscillators.

DY 15.3 Mon 15:30 SCH 251

Microwave Billiards with broken Time Reversal Symmetry — •Florian Schäfer — TU Darmstadt, Institut für Kernphysik, Schlossgartenstrasse 9, 64289 Darmstadt

The effect of a broken time reversal symmetry on the principle of detailed balance has been studied in microwave resonators. This is the first time where resonance shapes of isolated and nearly degenerated resonances were analyzed with respect to their behaviour under time reversal. A model was developed to describe the violation of detailed balance in the nearly degenerated case and was successfully tested on the available data.

This work is supported by the DFG within SFB 634.

DY 15.4 Mon 15:45 SCH 251

Spectral properties of mushroom billiards — •Thomas Friedrich — Schlossgartenstraße 9, 64289 Darmstadt

In 2001 Bunimovich proposed a family of billiards shaped like mushrooms as a generalization of the well studied stadium billiard. The classical phase space of mushroom billiards is well separated into regular and chaotic regions with no KAM islands. We investigated the quantum properties of mushroom billiards experimentally using superconducting microwave cavities by measuring frequency spectra and wave functions. In the measured spectra a supershell structure was observed which, as could be shown, is due to the interference of short periodic orbits of comparable length. Their influences become also visible in the nearest neighbour distance distribution of resonance frequencies. We succeeded in separating the eigenmodes of the mushroom billiard into regular and chaotic modes following Poissonian and GOE statistics, respectively. With those subsets of modes dynamic tunneling between the two phase space regions was observed in terms of field distributions and frequency shifts. We thus found that the spectral properties of mushroom billiards are mainly governed by shell structures and dynamic tunneling.
This work has been supported by DFG within SFB 634.

DY 15.5 Mon 16:00 SCH 251

Vortex and anti-vortex correlations in open microwave billiards — •Ruven Höhmann, Ulrich Kuhl, Young-Hee Kim, Michael Barth, and Hans-Jürgen Stöckmann — Fachbereich Physik der Philipps-Universität Marburg

In quasi-two-dimensional microwave resonators there is a one-to-one correspondence between the Poynting vector and the probability current density in the corresponding quantum-mechanical system. This has been used to study the flow patterns through an open microwave billiard with particular emphasis to vortices and anti-vortices. Vortices correspond to nodal points of the complex wave function and anti-vortices to the hyperbolic points of the flow. Various pair correlation functions of vortices and anti-vortices, as well as distributions of nearest neighbor distances are investigated. The results are interpreted in terms of the random plane wave model [1,2].

[1] M. Berry, M. Dennis, Proc. R. Soc. Lond. A 456, 2059 (2000). [2] A. Saichev et al., Phys. Rev. E 64, 036222 (2001).

DY 15.6 Mon 16:15 SCH 251

Randomization of time-evolved wave-packets in chaotic quantum systems — •Nikolai Hlubek and Arnd Bäcker — Institut für Theoretische Physik, TU Dresden, 01062 Dresden

The time-evolution of initially localized wave-packets is studied for the case of quantum billiards with classically chaotic dynamics. For large times one expects that the wave-packet resembles a random wave. This implies that the intensity distribution is an exponential, which is confirmed by our results. In contrast to stationary states, we demonstrate that the spatial autocorrelation is different from the usual Bessel function behaviour. Of particular interest is the time-scale for which the randomization sets in. It turns out that this is much smaller than the Heisenberg time and we investigate its relation to the Ehrenfest time.

DY 15.7 Mon 16:30 SCH 251

Dynamical tunneling in a mixed phase space — •Lars Schilling, Arnd Bäcker, Roland Ketzmerick, and Steffen Löck — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany

The phase space of mixed systems consists of regular islands that are dynamically separated from the chaotic sea. Quantum mechanically these phase space regions are connected by dynamical tunneling. We derive a formula predicting dynamical tunneling rates of regular states to the chaotic sea. Agreement with numerics for kicked systems with resonance-free islands will be presented.

DY 15.8 Mon 16:45 SCH 251

Description of optical microresonators: When rays suffice — •Martina Hentschel — Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg — ATR Wave Engineering Laboratories, 2-2-2 Hikaridai, Kyoto 619-0228, Japan

Optical microresonators are interesting not only as model systems in the field of quantum chaos but also as components of future communication devices. This raises the question to what extent, based on the concept of ray-wave correspondence, the simple ray model can be deployed in application-oriented problems. It is well-known that for small size parameters (below approximately 500) semiclassical corrections, namely the Goos-Hänchen and Fresnel filtering effects, become important and potentially spoil ray model predictions. However, for large size parameters (above 1000, say) the ray model should suffice. The high capabililty of the ray model in this regime is confirmed and illustrated by various examples. We explain, for instance, a neat experiment in which a quadrupolar glass fiber showed a filter characteristics for specific setup geometries. Ray simulations reveal that this effect resulted from multiple beam interference that is possible in a limited parameter range around the conditions met in experiment.