DY 25: Quantum chaos II

Time: Thursday 9:30–11:00 Location: H2

Invited Talk DY 25.1 Thu 9:30 H2

Surprises in the time-evolution of wave-packets — •Arnd Bäcker — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany

Hamiltonian systems show a large variety of dynamical behaviour ranging from integrable over mixed to fully chaotic dynamics. Quantum mechanically this is reflected in the properties of eigenfunctions and eigenvalue statistics. In this talk the quantum-to-classical correspondence is investigated using the time evolution of wave-packets. While classical and quantum dynamics coincide at short times, the question is what happens at larger times? For fully chaotic systems one expects that an initially localized wave-packet becomes random for sufficiently long times. It is shown that this randomization time-scale is surprisingly large. For systems with a mixed phase space it turns out that a wave-packet, initially placed in the chaotic sea, may ignore the classical phase space boundaries and that the randomized wave-packet substantially floods into the region of the regular island. This is explained in terms of the eigenstates [1] and with a random matrix model. One interesting application are rough nano-wires in a magnetic field where surprisingly large localization lengths can be understood by this flooding process [2].

[1] A. Bäcker, R. Ketzmerick, and A. Monastra, Phys. Rev. Lett. **94** 054102 (2005).

[2] J. Feist, A. Bäcker, R. Ketzmerick, S. Rotter, B. Huckestein, and J. Burgdörfer, Phys. Rev. Lett. **97** 116804 (2006).

DY 25.2 Thu 10:00 H2

Chaotic billiards: Loschmidt echo decay due to local deformations of boundaries — •Arseni Goussev and Klaus Richter — Institute for Theoretical Physics, University of Regensburg, Germany

We study the stability of the quantum dynamics against perturbations of the Hamiltonian in systems that are chaotic in the classical limit. For this purpose, we address the time dependence of the Loschmidt echo (LE), also known as fidelity, for semiclassical wave packets in two-dimensional chaotic billiards. The LE is the overlap between two wave functions that are obtained in the course of time evolution of the same initial quantum state under two different Hamiltonians. We investigate, analytically and numerically, the time decay of the LE for the case that the difference between the two Hamiltonians, i.e. the Hamiltonian perturbation, is due to a local deformation of the billiard's boundary. We find the LE to decay exponentially in time, with the rate equal to the classical escape rate from an open billiard obtained from the original one by removing the deformation-affected region of its boundary. This result provides an appealing connection between the quantum fidelity in the regime of strong Hamiltonian perturbations and properties of the chaotic dynamics of the underlying classical system.

DY 25.3 Thu 10:15 H2

Fidelity Decay in chaotischen Quantensystemen — •Heinerich Kohler — Institut für theoretische Physik, Philosophenweg 19, Universität Heidelberg, 69120 Heidelberg

Fidelity is defined as the modulus square of the overlap integral of an initial wave function which is propagated in time by a Hamiltonian H_0 with the same initial wave function which is propagated by a slightly modified Hamiltonian $H_0 + \delta V$. The surprisingly complex time behaviour of fidelity is described and calculated within the framework of Random Matrix Theory. Non perturbative phenomena like the freeze of fidelity on a high plateau and for long times as well as a revival at Heisenberg time are found. There exists an interesting relation to parametric level correlations. The universality of this relation will be discussed.

DY 25.4 Thu 10:30 H2

Survival probability of an open circular microwave resonator — Stefan Bittner, Barbara Dietz-Pilatus, Thomas Friedrich, Maksim Miski-Oglu, •Pedro Oria Iriarte, Achim Richter, and Florian Schäfer — Institut für Kernphysik, Schloßgartenstraße 9, 64289 Darmstadt

An experimental study of an open circular quantum billiard simulated by a flat microwave cavity is presented. A piece of absorber material placed on the boundary simulates a hole and opens the system. The survival probability is determined and compared to its classical counterpart obtained by a numerical simulation. It is connected to the famous Riemann hypothesis in the limit of a small opening. This connection might be accessible in further experiments.

DY 25.5 Thu 10:45 H2

Leaking Billiards — •Jan Nagler, Moritz Krieger, Marco Linke, Johannes Schönke, and Jan Wiersig — Institut für Theoretische Physik, Universität Bremen, Otto-Hahn-Allee, 28334 Bremen

Billiards are idealizations for systems where particles or waves are confined to cavities, or to other homogeneous regions. In billiard systems a point particle moves freely except for specular reflections from rigid walls. However, billiard walls are not always completely reflective and measurements inside can also open the billiard. Since boundary openings have been studied extensively in the literature, we rather model leakages inside the billiard. In particular, we investigate the classical dynamics of a leakage for a continuous family of billiard systems, that is, the stadium-lemon-billiard family. With a single parameter the geometry of the billiard can be tuned from stadium (being fully hyperbolic) over circle (integrable) to the lemon-shaped billiard (mixed chaotic). For the stadium billiard we found an algebraically decaying mean escape time with the linear size ϵ of the leakage $\langle n_{\mathrm{esc}} \rangle \sim \epsilon^{-1}$ together which an exponential decay of the survival probability distribution. The finding is nearly independent of the position and size of the leakage, as long as the leakage is much smaller than the system size. Due to the mixed phase space for lemon billiards, the mean escape time depends both on the position and geometry of the leakage. For systems where quasi-regular motion dominates, we found a linear dependence of the mean escape time, $\langle n_{\mathrm{esc}} \rangle \sim 1 - \epsilon$ which we refer to as *flooding law.* Our findings are helpful in understanding dynamics of leaking Hamiltonian systems.