DY 23: Quantum Chaos I

Time: Thursday 9:30–11:15 Location: MA 001

DY 23.1 Thu 9:30 MA 001

New Scattering Mechanism in Rough Boundary Nanowires — •Otto Dietz[1,2], Ulrich Kuhl[1], Hans-Jürgen Stöckmann[1,3], Nykolay M Makarov[4], and Felix M Izrailev[4] — [1]FB Physik, Uni Marburg, Germany — [2]Institute of Physics, Humboldt-Universität zu Berlin, Germany — [3]LPMC, Université de Nice Sophia-Antipolis, France — [4]Universidad Autónoma de Puebla, Mexico

Rough boundaries strongly influence the conductance of nanowires. The theoretical description of this influence constitutes an open problem across different fields, from silicon nanowires to graphene nanoribbons.

A recently proposed theory tackles this problem, but is restricted to ensembles of nanowires [1]. To overcome this restriction, we show experimentally that this theory is directly applicable to single nanowires. Now the conductance of a single wire can be calculated analytically from its boundary profile, and vice versa.

This is the first experimental test of the theory. We confirm the surprising prediction of a new scattering mechanism in nanowires. The theory is tested in microwave waveguides with rough walls. Because of the strict analogy between the 2d Schrödinger equation and the Helmholtz equation, the results can be directly applied to electron transport. The advantage of microwave techniques is that - in contrast to real nanowires - the boundary roughness is both known and controllable.

[1] M. Rendón et. al. Phys. Rev. B 75, 205404 (2007)

DY 23.2 Thu 9:45 MA 001

Complex paths for regular-to-chaotic tunneling rates — Arnd Bäcker[1,2], Roland Ketzmerick[1,2], Steffen Löck[1], •Normann Mertig[1,2], and Akira Shudo[3,2] — [1]Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden — [2]MPI für Physik komplexer Systeme, 01187 Dresden — [3]Department of Physics, Tokyo Metropolitan University, Minami-Osawa, Hachioji, Tokyo 192-0397, Japan

In generic Hamiltonian systems tori of regular motion are dynamically separated from regions of chaotic motion in phase space. Quantum mechanically these phase-space regions are coupled by dynamical tunneling. Based on complex paths, we present a semiclassical prediction of dynamical tunneling rates from regular tori to the chaotic region. This prediction is in excellent agreement with numerically determined tunneling rates of the standard map.

DY 23.3 Thu 10:00 MA 001

Weak (anti-)localization of Bose-Einstein condensates in two-dimensional chaotic cavities — •Timo Hartmann[1], Josef Michl[1], Juan Diego Urbina[1], Cyril Petitjean[2], Thomas Wellens[3], Klaus Richter[1], and Peter Schlagheck[4] — [1]University of Regensburg, Germany — [2]SPSMS-INAC-CEA, Grenoble, France — [3]University of Freiburg, Germany — [4]Université de Liège, Belgium

The possibility to create arbitrarily shaped confinement potentials for cold atoms [1] makes it feasible to study coherent transport of Bose-Einstein condensates through various mesoscopic structures. Previous theoretical studies have focused on the question how coherent backscattering in disordered potentials is modified by the presence of the atom-atom interaction [2]. We now study the analogous scenario of weak localization in ballistic billiard geometries which exhibit chaotic classical dynamics. To this end we investigate the quasi-stationary propagation of a condensate through such structures within the mean-field approximation. The transmission is studied as a function of an artifical magnetic gauge field [3] and of the nonlinearity within the Gross-Pitaevskii equation. Numerical simulations reveal a (partial) inversion of the weak-localization signature with increasing nonlinearity. This effect is analyzed using a diagrammatic perturbation theory based on semiclassical methods.

[1] K. Henderson et al., New J. Phys. **11**, 043030(2009)
[2] M. Hartung et al., Phys. Rev. Lett. **101**, 020603 (2008)
[3] J. Dalibard et al., Rev. Mod. Phys. Colloquium, accepted (2011)

DY 23.4 Thu 10:15 MA 001

Fractal Weyl Law in Systems with a Mixed Phase Space? — Arnd Bäcker[1,2], Roland Ketzmerick[1,2], •Martin Körber[1], and Matthias Michler[1] — [1]Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany — [2]MPI für Physik komplexer Systeme, 01187 Dresden, Germany

A characteristic feature of open systems is the escape of classical orbits and the decay of quantum states. In ergodic systems the number of long-lived states obeys a fractal Weyl law, where the exponent is associated to the fractal dimension of the repeller. In generic Hamiltonian systems with a mixed phase space, where regular and chaotic motion coexist, the structure of the repeller and its quantum implications are open questions.

In such systems the transport in the chaotic sea is governed by the hierarchy of partial barriers. We design a controllable model system which captures this property. Classically, we analyze the impact on the repeller. Quantum mechanically, we investigate the interplay between the location of eigenstates in the hierarchy and their decay rates in order to clarify the impact on the fractal Weyl law.

DY 23.5 Thu 10:30 MA 001

The semiclassical many body density of states: Progress in the treatment of the smooth part — •Quirin Hummel, Juan Diego Urbina, Jack Kuipers, and Klaus Richter — Universität Regensburg, Germany

For single particle billiard systems, the smooth part of the density of states (DOS) in a semiclassical approximation is known as the Weyl expansion. We study a corresponding expansion for the smooth part of the many body DOS in systems of identical particles. We show that the treatment of exchange symmetry already has a strong effect. As an extension we present progress in including additional effects like physical boundaries. The possibility of including short range interactions among particles is discussed.

DY 23.6 Thu 10:45 MA 001

Resummation of the spectral determinant: the interpretation in terms of orbits — •Daniel Waltner[1], Gregor Tanner[2], and Klaus Richter[1] — [1]Institut I - Theoretische Physik, Universität Regensburg, Universitätsstraße 31, D-93053 Regensburg — [2]School of Mathematical Sciences, University of Nottingham, University Park, Nottingham, NG7 2RD, UK

Calculating spectra based on semiclassical expressions with periodic-orbit sums faces divergence problems in chaotic systems: The number of orbits and thus also the contributions increase exponentially with their length. Based on unitarity, expressions containing finite sums over orbits could be derived for the spectral determinant. However, the underlying orbit correlations that could justify such a resummation procedure remained unclear in this context. Here we want to explain the pseudo-orbit correlations leading to finite pseudo-orbit sums considering graphs with chaotic dynamics.

DY 23.7 Thu 11:00 MA 001

Eigenmodes in the long-time behavior of a coupled spin system measured with NMR — •Benno Meier, Jonas Kohlrautz, and Jürgen Haase — University of Leipzig, Faculty of Physics and Earth Science, Linnéstrasse 5, 04103 Leipzig, Germany

The many body quantum dynamics of coupled spins $I = 1/2$ on an otherwise isolated cubic lattice are studied with nuclear magnetic resonance (NMR). By measuring the free induction decay (FID) of ^{19}F spins in CaF_2 across six orders of magnitude, unique insight into its long-time behavior is obtained. While the recently reported experimental evidence for universal long-time behavior of the form of an exponentially decaying cosine is confirmed experimentally for FID and solid echo experiments, it is possible for the first time to extract a second universal decay mode from the FIDs long-time behavior with comparable frequency but twice as fast a decay rate. The observed response is in agreement with recently published theoretical works and further supports the notion of eigenvalues in chaotic many-body quantum systems.