DY 21: Quantum chaos II

Time: Thursday 10:15–13:00 Location: ZEU 255

DY 21.1 Thu 10:15 ZEU 255

The x-ray edge problem in integrable quantum dots — •Georg Röder and Martina Hentschel — Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Straße 38, 01187 Dresden, Germany

The x-ray edge problem in metals, which constitutes a well-studied many-body problem, is a classic problem in condensed matter physics. Here we address the question how the smallness and the individual properties of mesoscopic systems such as quantum dots affect the Fermi-edge singularities in the photo absorption signal. To this end, we follow a Fermi golden rule approach and model the localized core hole left behind upon the excitation of a core electron as a localized, or rank one, perturbation [K.Ohtaka and Y.Tanabe, RMP 62, 929 (1990)]. For the transition of a s core electron into a s-like quantum dot level (K-edge), we find the threshold absorption processes to be enhanced compared to the metallic case where typically a rounded K-edge is found as a consequence of Anderson orthogonality catastrophe. The enhancement is particularly strong when the core hole appears close to the (hard-wall) boundary of quantum dots of integrable (circular and rectangular) shape. This effect holds also for parabolic quantum dots that possess soft walls. An external magnetic field further increases the peaked photo absorption signal at the K-edge. We compare our findings to results for chaotic quantum dots obtained by random matrix theory [M.Hentschel, D.Ullmo and H.Baranger, PRL 93, 176807 (2004)].

DY 21.2 Thu 10:30 ZEU 255

The semiclassical continuity equation for open chaotic systems — •Jack Kuipers, Daniel Waltner, Martha Gutiérrez, and Klaus Richter — Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany

We consider the continuity equation for open chaotic quantum systems in the semiclassical limit, where the survival probability and the current density can be approximated by expressions involving classical trajectories. Performing an expansion based on correlated trajectories it is possible to show that the continuity equation, which links the survival probability to the current density, is satisfied within the semiclassical approximation to all orders. For this we develop recursion relation arguments which connect the trajectory structures involved for the survival probability, which travel from one point in the bulk to another, to those structures involved for the current density, which travel from the bulk to the lead.

arXiv:0811.2164

DY 21.3 Thu 10:45 ZEU 255

Quantum signatures of partial barriers in phase space — Arnd Bäcker, Roland Ketzmerick, and •Matthias Michler — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany

In generic Hamiltonian systems classical transport in the chaotic sea is limited by partial barriers, which allow a flux Φ given by the turnstile area. Quantum mechanically they are even more restrictive for Planck's constant $\hbar \gg \Phi$, while in the opposite case classical transport is recovered. This transition is qualitatively well understood, however, many quantitative questions are still open.

We construct a kicked system with a particularly simple phase-space structure, namely two chaotic regions separated by one dominant partial barrier. This enables us to investigate the properties of eigenfunctions under variation of the ratio $\hbar/\Phi$ and to search for a universal scaling.

DY 21.4 Thu 11:00 ZEU 255

A semiclassical approach to the ac conductance of quantum chaotic cavities — •Cyril Petitjean, Daniel Waltner, Jack Kuipers, Inanc Adagideli, and Klaus Richter — Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany

Due to progress in the control and manipulation of mesoscopic structures driven by high frequency periodic voltages, the ac regime has recently been experimentally investigated [1] and consequently theoretical interest in it has been renewed. We consider a quantum chaotic cavity that is coupled via (tunnel) barriers and gates to a macroscopic circuit which contains ac-sources. For the transparent barrier, our semiclassical techniques permit us to include the Ehrenfest time in the weak-localization correction to the screened conductance, previously obtained by random matrix theory [2]. Then by extending recent semiclassical theory in presence of tunnel barriers [3] to the ac-transport, we investigate the effect of dephasing on the relaxation resistance of a chaotic capacitor in the linear low frequency regime. This last investigation is in principle relevant to the recent measurements of the admittance at zero magnetic flux of a mesoscopic capacitor [1,4].

[1] J. Gabelli et al., Science **313**, 499 (2006).
[2] P.W. Brouwer and M. Büttiker, Europhys. Lett. **37**, 441 (1997).
[3] R.S. Whitney, Phys. Rev. **B, 75**, 235404 (2007).
[4] S. Nigg and M. Büttiker, Phys. Rev. **B 77**, 085312 (2008).

DY 21.5 Thu 11:15 ZEU 255

Power–Law Level–Statistics due to Dynamical Tunneling — Arnd Bäcker, Roland Ketzmerick, Steffen Löck, and •Normann Mertig — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Germany

We study level–spacing statistics for systems with a mixed phase space, where regular and chaotic regions coexist. Assuming statistical independence of the corresponding subspectra, spacings are described by the Berry–Robnik distribution. However due to dynamical tunneling, regular and chaotic states are coupled. This leads to small avoided crossings, which vary in size over many orders of magnitude, depending on the regular state involved. We demonstrate that this implies a power law of the level–spacing distribution for small spacings.

15 min.break.

DY 21.6 Thu 11:45 ZEU 255

Transport of Bose-Einstein condensates through two-dimensional billiard geometries — •Timo Hartmann, Michael Hartung, Juan-Diego Urbina, and Peter Schlagheck — Institute for Theoretical Physics, University of Regensburg, D-93040 Regensburg, Germany

The tremendous progress in the experimental techniques for Bose-Einstein condensates during the last decade lead to the realization of almost arbitrarily shaped confinement and waveguide geometries for interacting matter waves [1]. This opens new experimental possibilities for probing the transport of Bose-Einstein condensates through various mesoscopic structures. We numerically investigate the quasi-stationary propagation of a condensate through two dimensional cavities within the mean-field approximation of the condensate. Our calculations rely on a nonlinear Green function method that is based on the Gross-Pitaevskii equation. We study, on the one hand, resonant transport through nearly closed cavities, where the presence of the nonlinearity results in strong nontrivial distortions of the resonance peaks. On the other hand, we are investigating the transmission of the condensate through wide open cavities with chaotic classical dynamics. Here we focus on the question how the scenario of weak localization is modified by the presence of the atom-atom interaction [2].

[1] W. Guerin et al., Phys. Rev. Lett. **97**, 200402 (2006);V. Milner et al. Phys. Rev. Lett. **86**, 1514 (2001)
[2] M. Hartung et al., Phys. Rev. Lett. **101**, 020603 (2008).

DY 21.7 Thu 12:00 ZEU 255

Wavepacket dynamics in energy space of a chaotic trimeric Bose-Hubbard system — •Moritz Hiller[1], Tsampikos Kottos[2,3], and Theo Geisel[3] — [1]Fakultät für Physik, Albert-Ludwigs-Universität Freiburg, Germany — [2]Department of Physics, Wesleyan University, Middletown CT, USA — [3]Max-Planck-Insitut für Dynamik und Selbstorganisation, Göttingen, Germany

We study the energy redistribution of interacting bosons in a ring-shaped quantum trimer as the coupling strength between neighboring sites of the corresponding Bose-Hubbard Hamiltonian undergoes a sudden change δk. In the framework of (ultra-)cold atoms on optical lattices this perturbation corresponds to a modulation of the trapping potential. Our analysis is based on a three-fold approach combining linear response theory calculations as well as semiclassical and random matrix theory considerations. The δk-borders of applicability of each of these methods are identified by direct comparison with the exact quantum mechanical results. We find that while the variance of the evolving quantum distribution shows a remarkable quantum-classical correspondence (QCC) for all δk-values, other moments exhibit this QCC only in the non-perturbative δk-regime.

DY 21.8 Thu 12:15 ZEU 255

Underdamped quantum ratchets — •Sergey Denisov, Sigmund Kohler, and Peter Hänggi — Universitat Augsburg,Universitätsstrasse 1, D-86135 Augsburg, Germany

We investigate the quantum ratchet effect under the influence of weak dissipation which we treat within a Floquet-Markov master equation approach. A ratchet current emerges when all relevant symmetries are violated. Using time-reversal symmetric driving we predict a purely dissipation-induced quantum ratchet current. This directed quantum transport results from bath-induced superpositions of non-transporting Floquet states.

DY 21.9 Thu 12:30 ZEU 255

Microwave Floquet-systems — •Timur Tudorovskiy, Ulrich Kuhl, and Hans-Jürgen Stöckmann — Fachbereich Physik, Philipps-Universität Marburg, Renthof 5, D-35032 Marburg, Germany

We present a theory of a two-dimensional quantum billiard perturbed by a non-stationary point-like coupling. The theory is based on a generalization of the approach recently published in [1]. Among others it covers the case of the periodic perturbation, i.e. a Floquet system. This special type of a Floquet-system is of a particular interest, since it could be realized in microwave experiments. The theory describes a sideband-structure obtained from the reflection/transmission measurements with microwave billiards. To calculate the sideband-structure one has to solve a set of integral equations. Similar equations were obtained in the problem of electron detachment from an ionized atom [2]. The equations are simplified significantly when only a single isolated resonance is considered. For such a system the sideband-structure can be described by a first order differential equation. It shows the main features similar to those known from the solution of a one-dimensional Schrödinger equation with two focal points. We realized a microwave setup simulating the system with a single periodically perturbed resonance. We concluded that the experimentally obtained sideband structure shows all theoretically predicted peculiarities and can be successfully described by the presented theory.

[1] T. Tudorovskiy et al. J. Phys. A, 41 (2008) 275101

[2] Yu. N. Demkov and V. N. Ostrovskiy, Plenum Press, New York, 1988.

DY 21.10 Thu 12:45 ZEU 255

Exceptional Points in Microcavity Systems — •Jeong-Bo Shim[1], Sang-Bum Lee[2], Soo-Young Lee[2], Juhee Yang[2], Sonky Moon[2], Kyungwon An[2], Jai-Hyung Lee[2], Jungwan Ryu[3], and Sang Wook Kim[3] — [1]Max-Planck Institute for the Physics of Complex Systems, Nöthnitzer Strasse 38, D-01187, Dresden, Germany — [2]School of Physics and Astronomy, Seoul National University, Seoul, 151-742, Korea — [3]Department of Physics Education, Pusan National University, Busan, 609-735, Korea

A physical system with multiple interacting modes can generally show the level-repulsion in its spectrum by adjusting a system parameter. In the case that this system is opened, the openness may play a role of the additional parameter, thereby it may show a singular topological structure around the level-repulsion, which is so-called 'the exceptional point'. In terms of openness and coupling of modes, a chaotic deformed microcavity can be a good example to study about it. In this talk, we will discuss about the observation of the exceptional point in the microcavity spectrum and some relevant phenomena.