DY 27: Quantum chaos II

Time: Thursday 14:30–17:00 Location: MA 004

DY 27.1 Thu 14:30 MA 004

Occupation probabilities of Floquet states in driven systems with a mixed phase space — Roland Ketzmerick and •Waltraut Wustmann — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany

We investigate time-periodic driven systems with regular and chaotic Floquet states weakly coupled to a heat bath. The stationary occupation probabilities of the two types of states turn out to follow fundamentally different distributions. Chaotic states have almost equal probabilities irrespective of their time-averaged energy. Regular states show Boltzmann-like probabilities proportional to $\exp(-E_n^*/kT^*)$ as in time-independent systems. In contrast, however, an effective temperature T^* appears that can be derived analytically and effective energies E_n^* that have to be determined from properties of the classical regular island they are localized on.

DY 27.2 Thu 14:45 MA 004

Modifications of the phase space structure of optical microcavities due to the Goos-Hänchen shift — •Julia Unterhinninghofen[1], Jan Wiersig[1], and Martina Hentschel[2] — [1]Institut für theoretische Physik, Universität Bremen, Postfach 330 440, 28334 Bremen — [2]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden

Optical microcavities have important applications in various different fields of physics [1]. In the quantum chaos community microdisk cavities with deformed cross-sectional shape attracted considerable attention since they can be used to study the ray-wave correspondence in open systems in direct comparison to experiments [2,3]. As recent experimental progress allows for smaller and smaller cavities, wave corrections to the ray dynamics become highly relevant. We theoretically study the influence of the most important correction, the Goos-Hänchen shift [4], on the phase space structure of optical microcavities. We find an interesting relation to scarlike modes near avoided resonance crossings [5].

[1] K. J. Vahala, Nature **424**, 839 (2003). [2] J. U. Nöckel and A. D. Stone, Nature **385**, 45 (1997). [3] C. Gmachl *et al.*, Science **280**, 1556 (1998). [4] H. Schomerus and M. Hentschel, Phys. Rev. Lett. **96**, 243903 (2006). [5] J. Wiersig, Phys. Rev. Lett. **97**, 253901 (2006).

DY 27.3 Thu 15:00 MA 004

Dynamical tunneling rates in billiards — Arnd Bäcker, Roland Ketzmerick, and •Steffen Löck — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany

In systems with a mixed phase space regular islands are dynamically separated from the chaotic sea, while quantum mechanically these phase space regions are connected by dynamical tunneling. We present an approach using a fictitious integrable system which predicts dynamical tunneling rates from regular states to the chaotic sea in billiards. A comparison with numerical results, for e.g. the mushroom billiard and the annular billiard, shows excellent agreement.

DY 27.4 Thu 15:15 MA 004

Dynamical Husimi functions at dielectric interfaces of lasing cavities — •Tae Yoon Kwon and Martina Hentschel — MPIPKS, Dresden, Germany

We generalize the concept of Husimi functions to active optical microresonators by introducing dynamical Husimi functions at the interfaces of dielectric laser cavity systems. To this end we solve the spatio-temporal laser cavity equations, so-called Schrödinger-Bloch model, and deduce generalized, time-dependent Husimi functions. These functions give insight into the dynamics of the lasing modes in phase-space that conveniently complements the information derived from the time-dependence of the modes in configuration space. We apply these functions to characterize the near and far field optical properties of various two-dimensional microcavity systems.

DY 27.5 Thu 15:30 MA 004

Two-point correlations of spectral determinants — •Daniel Waltner[1], Stefan Heusler[2], Juan-Diego Urbina[1], and Klaus Richter[1] — [1]Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg — [2]Universität Münster

We consider the correlator of two spectral determinants using semiclassical methods. While in the unitary case the diagonal approximation reproduces the leading order contribution from Random Matrix Theory (RMT) [1], we show that semiclassical loop contributions are not consistent with RMT [2]. A complementary analysis based on a field theoretical approach shows that the additional terms occurring in semiclassics are cancelled in field theory by so-called curvature effects. We attempt to find a semiclassical interpretation of such effects.

[1] J. P. Keating, S. Müller, Proc. R. Soc. **463**, 3241
[2] D. Waltner et. al., *in preparation*

DY 27.6 Thu 15:45 MA 004

Doorway based model for superscars in the barrier billiard — Sven Aberg[1], Thomas Guhr[2], •Maksim Miski-Oglu[3], and Achim Richter[3] — [1]Matematisk Fysik, LTH, Lunds Universitet, Lund, Sweden — [2]Fachbereich Physik, Universität Duisburg–Essen, Duisburg, Germany — [3]Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, Germany

Superscars in a pseudointegrable barrier billiard serve as a paradigm for strength function phenomena in different quantum systems ranging from atoms to nuclei. Superscarring state are spatially localized in a channel of a family of classical periodic orbitis and have a simple structure. Their strength is spread over many other nonsuperscarring states in the billiard, i.e. it acts as a so called doorway state. We analyze the observed spreading for four different superscar families appplying random matrix theory. We design a doorway based model for superscarred wave functions. With this model we investigated the spatial correlations of the experimentally obtained billiard wave functions and their nodal domains statistics. The results for different bservables are consistent.

DY 27.7 Thu 16:00 MA 004

Level Density of a Fermi Gas: Average Growth and Fluctuations — •Roccia Jerome[1] and Leboeuf Patricio[2] — [1]Institut für Theoretische Physik, Universität Regensburg D-93040 Regensburg, Germany — [2]Laboratoire de Physique Théorique et Modèles Statistiques bâtiment 100 Université Paris-Sud centre scientifique d'Orsay 15 rue Georges Clémenceau 91405 Orsay cedex, France

We investigate the many-body level density ρ_{MB} for fermions. We establish its behavior as a function of the temperature and the number of particules. We propose a semiclassical expression of ρ_{MB} for two types of particules with an angular momentum. It is decomposed into a smooth part coming from the saddle point method plus corrective terms due to the expansion of the number of partitions for two types of particles and an oscillating part coming from the fluctuations of the single-particle level density. Our model is validated by a numerical study. For the case of the atomic nucleus, the oscillating part of ρ_{MB} is controled by a temperature factor which depends on the chaotic or integrable nature of the system and depends on the fluctuation of the ground state energy. This leads to consider in more detail this last quantity. For an isolated system, we give the general expression of the mean value for fixed potentials. We treat the self-bound system case through the example of the three dimensional harmonic oscillator (3DHO).

DY 27.8 Thu 16:15 MA 004

Friedel oscillations in microwave billiards — Arnd Bäcker[1], •Thomas Friedrich[2], Maksim Miski-Oglu[2], Achim Richter[2], and Steven L. Tomsovic[3] — [1]Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany — [2]Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany — [3]Dept. of Physics, Washington State University, Pullman, WA

Oscillations of the electronic wave function in the neighborhood of defect atoms or potential steps in metallic surfaces (so-called Friedel oscillations) are known for a long time. Scanning tunnelling microscopy brought up breathtaking pictures such as the well known quantum corrals where this phenomenon is visualized. We investigate the properties of Friedel oscillations in the experiment using two flat microwave billiards, the mushroom billiard with mixed dynamics and a pseudointegrable barrier billiard. The average of the field distributions of eigen-

modes below the Fermi energy exhibits oscillations close to the boundary. We compare them with predictions of the random plane wave model. Taking into account the structure of the classical phase space, we find a good agreement.

DY 27.9 Thu 16:30 MA 004

Orthogonality catastrophe in mesoscopic systems: A quantum chaos perspective — •Georg Röder and Martina Hentschel — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

We study the response of integrable and chaotic mesoscopic systems to a sudden, localized perturbation caused, e.g., by an x-ray exciting a core electron into the conduction band. Anderson orthogonality catastrophe (AOC) refers to the disappearance of the overlap of the many-particle ground states before and after the perturbation is applied in the thermodynamic limit. In contrast, a finite number of particles causes AOC to be incomplete with a broad distribution of AOC overlaps originating from mesoscopic fluctuations, in particular those that occur close to the Fermi energy. We consider two integrable ballistic quantum dots (rectangle and disc with hard walls) subject to a rank-one perturbation and compare the results with those obtained for generic chaotic systems. We find that the distributions of AOC overlaps differ, especially in the presence of a magnetic field. Level degeneracies present in integrable systems lead to additional peaks in the AOC distribution that shift the average overlap to smaller values. Furthermore, we apply these results to study Fermi edge singularities in the photo-absorption spectra of mesoscopic systems and show that their signature can qualitatively deviate from metallic (bulk-like) systems.

DY 27.10 Thu 16:45 MA 004

Dephasing in quantum chaotic transport (semiclassical approach) — Robert S. Whitney[1], Philippe Jacquod[2], and •Cyril Petitjean[3,4] — [1]Institut Laue-Langevin, Grenoble, France — [2]Physics Department, University of Arizona, Tucson, USA — [3]Département de Physique Théorique, Genève, Switzerland — [4]Institut für Theoretische Physik, Universität Regensburg, Regensburg, Germany

Electronic systems in the mesoscopic regime are ideal testing-grounds for investigating the quantum-to-classical transition. Quantum coherence conservation in these systems is usually determined by the ratio of the dephasing time τ_ϕ to some relevant classical time scale.

We investigate the effect of dephasing on quantum transport through a two-terminal chaotic dot in the deep semiclassical limit. The decoherence originating from: an external quantum chaotic environment, a classical noise, a voltage probe. We find an exponential suppression of weak-localization $\propto \exp[-\tilde{\tau}/\tau_\phi]$ in addition to the universal algebraic suppression of weak localization. The parameter $\tilde{\tau}$ depends strongly on the source of dephasing. For a voltage probe, is of order the Ehrenfest time. In contrast, for a chaotic environment or a classical noise, where is related to the correlation length of the coupling/noise potential. We show also that the Fano factor is unaffected by decoherence. We connect these results to earlier works on dephasing due to electron-electron interactions, and numerically confirm our findings.

[1] Petitjean, Jacquod, Whitney, JETP Letters **86**, 736 (2007),
[2] Whitney, Jacquod ,Petitjean, arXiv:0710.5137v1