DY 24: Quantum Chaos II

Time: Thursday 11:30–13:15 Location: MA 001

DY 24.1 Thu 11:30 MA 001

Localization of modes in a dielectric square resonator — •Stefan Bittner[1], Barbara Dietz[1], Jochen Isensee[1], Maksim Miski-Oglu[1], Achim Richter[1,2], and Christopher Ripp[1] — [1]Institut für Kernphysik Darmstadt — [2]ECT* Trento

The correspondence between ray and wave dynamics in dielectric cavities is of high interest due to their applications as microlasers or sensors, and they are used to study the signatures of chaos in open wave-dynamical systems. We present microwave experiments with a dielectric square resonator made of alumina. The frequency spectrum and field distributions were measured and analyzed. Unlike the closed square cavity, the dielectric square resonator is not an integrable system. The field distributions, however, show scarlike patterns and are localised on families of certain classical trajectories. We use a simple model based on the classical ray-dynamics to describe them and obtain good agreement for almost all modes. The work presented in this talk was supported by the DFG within SFB 634.

DY 24.2 Thu 11:45 MA 001

Periodically driven microwave systems - theory and experimental realization — •Stefan Gehler[1], Ulrich Kuhl[1,2], Hans-Jürgen Stöckmann[1], and Timur Tudorovskiy[3] — [1]Fachbereich Physik, Philipps-Universität Marburg, Renthof 5, D-35032 Marburg, Germany — [2]LPMC, CNRS UMR 6622, Université de Nice Sophia-Antipolis, 06108 Nice, France — [3]Radboud Universiteit, IMM, Heyendaalsweg 135, 6525AJ Nijmegen, Netherlands

A theoretical description and an experimental realization of a periodically perturbed (Floquet) microwave system will be presented. In previous works perturbations of cavities by stationary antennas had been theoretically studied [1] and experimentally verified [2].

This work has now been extended to antennas with a time dependent coupling between antenna and cavity. For an isolated single perturbed resonance the description showed up to be similar to the description of a resonant circuit with a time dependent capacitance. For the experimental realization we developed a resonator with a small inductivity and resistance. Using a varicap as a capacitor the resonance frequency can be changed periodically. A microwave field was driven with a frequency close to the resonator resonance frequency leading to complicated sideband structures. The different obtained sideband structures could be explained perfectly well by the present theory.

[1] T. Tudorovskiy, R. Höhmann, U. Kuhl, and H.-J. Stöckmann, J. Phys. A 41, 275101, 2008.
[2] T. Tudorovskiy, U. Kuhl, and H.-J. Stöckmann, J. Phys. A 44, 135101 (2011).

DY 24.3 Thu 12:00 MA 001

Emission directionality switching for chaotic dielectric cavities — Alexander Eberspächer[1], Jeong-Bo Shim[1], •Jan Wiersig[1], Hui Cao[2], Brandon Redding[2], Qinghai Song[3], and Li Ge[4] — [1]Institut für Theoretische Physik, Otto-von-Guericke-Universität Magdeburg — [2]Department of Applied Physics, Yale University — [3]Harbin Institute of Technology — [4]Princton University

The far-field emission directionality for ultra-small dielectric microcavities is discussed. For deformed microcavity systems, we found that tiny changes in boundary deformations—much smaller than the wavelength—can have drastic effects on the emission directionality of individual modes. Even though one expects that this change cannot be resolved by the optical modes, the far-field can switch directionality. We characterise the emission in terms of tunneling and demonstrate that the changes in boundary deformation induce considerable differences in the dynamical status of the systems under investigation. Then, the relation of dynamical status and emission will be discussed.

DY 24.4 Thu 12:15 MA 001

Spectral properties of rectangular microwave Dirac billiard — •Maksym Miski-Oglu[1], Stefan Bittner[1], Barbara Dietz[1], and Achim Richter[2] — [1]Institut für Kernphysik, Technische Universität Darmstadt, D-64289 Darmstadt, Germany — [2]ECT*, Villa Tambosi, I-38123 Villazzano (Trento), Italy

A spectrum of a superconducting flat microwave Dirac billiard has been measured. The microwave billiard is filled with metallic cylinders which form a photonic crystal with a triangular lattice. In the vicinity of a certain frequency, called the Dirac frequency, the dispersion relation for electromagnetic waves in a photonic crystal is similar to that of a relativistic massless fermion and is described by the Dirac equation. The measurement with a superconducting Dirac billiard allows to obtain experimentally the complete spectrum of eigenvalues and to investigate therewith the level statistics of the corresponding relativistic Dirac billiard. Furthermore the length spectrum of the classical periodic orbits has been extracted from the spectrum of eigenvalues and compared to semiclassical predictions.

This work has been supported within the DFG grant SFB634.

DY 24.5 Thu 12:30 MA 001

From chaotic phase space to structured far fields: A ray study of optical microcavities — •Daniel Kotik and Martina Hentschel — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Straße 83, 01187 Dresden

Optical microcavities have received continuous interest both as model systems for quantum chaos in open systems and as promising nanophotonic devices. The openness of the system originates from the violation of total internal reflection at the dielectric boundary for rays with an angle of incidence smaller than the critical angle. These rays leave the cavity and contribute to the far-field pattern of the microresonator, a property that crucially determines the application potential of the device. There exists an intimate relation between the resonator's unstable manifold and its emission properties that has been known now for some time. Here we present a systematic study on how the far field depends on the details of the ray simulations (choice of initial conditions, number of reflections/trajectory length considered) and on the resonator parameters (geometry, refractive index). Our objective is to investigate under what conditions the far field possesses the same invariant properties as the unstable manifold and to establish the corresponding optimal settings for reliable ray simulations.

DY 24.6 Thu 12:45 MA 001

Varying boundary conditions for dielectric microcavities — •Jörg Götte and Martina Hentschel — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden

Circle and semicircle billiards with mixed (Robin) boundary conditions, for which the mixing parameter varies along the boundaries, are singular, if the boundary contains a D point, at which the boundary condition is purely Dirichlet. The spectrum of the Laplace operator for such a billiard is no longer discrete and the energy levels form a continuous spectrum.

A versatile physical realisation to test the predictions of dynamical billiards are dielectric microvavities, and it is possible to design microcavities with varying boundary conditions by embedding a microresonator within a gradient index medium. However, the boundary condition for such a system are dielectric rather than mixed, and it is therefore interesting to see, if similar predictions can be made for an open, dielectric system, for which the exterior of the cavity has to be taken into account. In our work we determine the spectrum of energy levels of a dielectric microcavity with varying boundary conditions and test the system for integrability.

DY 24.7 Thu 13:00 MA 001

Complex dynamics in two-electron quantum dots — •Sebastian Schröter[1], Paul-Antoine Hervieux[2], Giovanni Manfredi[2], Johannes Eiglsperger[3], Moritz Schönwetter[1,4], and Javier Madroñero[1] — [1]TU München — [2]CNRS, IPCMS Strasbourg — [3]Universität Regensburg — [4]MPI PKS, Dresden

To characterise the degree of chaoticity in a quantum system a variety of measures have been established in the literature. A detailed analysis of various spectral properties combined with investigations of the classical analogue and semiclassical properties of a planar anharmonic two-electron quantum dot enables us to classify this system in the regime of weak quantum chaos. The core of our quantum analysis is an *ab initio* approach for planar two-electron quantum dots including full Coulomb interaction. The quantum dot is approximated by an harmonic potential with an additional quartic perturbation introducing irregularity in the system. Via the strength of the quartic potential the transition between regular and choatic dynamics can be tuned. Our model is experimentally accessible and impacts on relevant properties of coherence in many-body systems [1] can be addressed within our *ab initio* approach.

[1] G. Manfredi, P.-A. Hervieux, New J. Phys. **11** (2009), 013050. – Phys. Rev. Lett. **100** (2008), 050405. – Phys. Rev. Lett. **97** (2006), 190404.