DY 23: Quantum chaos I

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

Invited Talk DY 23.1 Thu 9:30 MA 001

From the phase-space representation of optical microcavities to an improved ray dynamics — •Martina Hentschel — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Straße 38, D-01187 Dresden

Optical microcavities are open billiards for light in which electromagnetic waves can, however, be confined by total internal reflection at dielectric boundaries. These resonators enrich the class of model systems in the field of quantum chaos and are an ideal testing ground for the correspondence of ray and wave dynamics that, typically, is taken for granted. Using phase-space methods we show that this assumption has to be corrected towards the long-wavelength limit. We first generalize the concept of Husimi functions to dielectric interfaces where both the wave function and its derivative are non-zero. We then show that curved interfaces require a semiclassical correction of Fresnel's law due to an interference effect called Goos-Hänchen shift. It is accompanied by the so-called Fresnel filtering which, in turn, corrects Snell's law. These two contributions are especially important near the critical angle. They are of similar magnitude and correspond to ray displacements in independent phase-space directions. Implementing both effects into the ray model improves the agreement with wave optics by about one order of magnitude. We discuss the phase-space dynamics of light in this amended ray-optics picture and show that the Poincaré surface of section can be significantly modified.

Further reading: M. Hentschel *et al.*, Europhys. Lett. **62**, 636 (2003); H. Schomerus and M. Hentschel, Phys. Rev. Lett. **96**, 243903 (2006).

DY 23.2 Thu 10:00 MA 001

Semiclassical calculation for the survival probability — Daniel Waltner[1], •Martha Gutierrez[1], Klaus Richter[1], and Arseni Goussev[2] — [1]Institut für Theoretische Physik, Universität Regensburg, 93053 Regensburg — [2]Department of Mathematics, University of Bristol, Bristol

In open chaotic systems the classical decay rate is exponential in time, however it is well known that there are quantum corrections at time scales of the order of the Heisenberg time [1]. We calculate semiclassically the leading order correction to the survival probability of a wave packet inside an open chaotic quantum dot. In order to reproduce Random Matrix Theory predictions, we need to calculate, beyond the diagonal approximation, the contribution of a new type of loop - like diagramms, which until now did not have to be taken into account. We discuss implications of this result in the semiclassical approximation for the conductivity in linear response.

[1] K. Frahm, PRE 56, R6237, 1997.

DY 23.3 Thu 10:15 MA 001

Resonance widths in open microwave cavities studied by harmonic inversion — •Ulrich Kuhl[1], Ruven Höhmann[1], Jörg Main[2], and Hans-Jürgen Stöckmann[1] — [1]Fachbereich Physik, Philipps-Universität Marburg, Renthof 5, — [2]Institut für Theoretische Physik und Synergetik, Universität Stuttgart,

From the measurement of a reflection spectrum of an open microwave cavity the poles of the scattering matrix in the complex plane have been determined [1]. The resonances have been extracted by means of the harmonic inversion method [2]. By this it became possible to resolve the resonances in a regime where the line widths exceed the mean level spacing up to a factor of 10, a value inaccessible in experiments up to now. The obtained experimental distributions of line widths were found to be in good agreement with predictions from random matrix theory [3].

[1] arXiv:0711.1828v1
[2] J. Main, Phys. Rep. **316**, 233 (1999).
[3] H. J. Sommers, Y. V. Fyodorov, and M. Titov, J. Phys. A **32**, L77 (1999).

DY 23.4 Thu 10:30 MA 001

Conservation of energy in coherent backscattering of light — •Susanne Fiebig[1], Christof M. Aegerter[1], Wolfgang Bührer[1], Eric Akkermans[2], Gilles Montambaux[3], and Georg Maret[1] — [1]Universität Konstanz, Konstanz, Germany — [2]Technion Israel Institute of Technology, Haifa, Israel — [3]Universite Paris-Sud, Orsay, France

Although conservation of energy is fundamental in physics, its principles seem to be violated in the field of wave propagation in turbid media by the energy enhancement of the coherent backscattering cone. We present experimental data which show that the energy enhancement of the cone is balanced by an energy cutback at all scattering angles. Moreover, we give a theoretical description, which is in good agreement with these data. The additional terms needed to enforce energy conservation in this description result from an interference effect between incident and multiply scattered waves, which is reminiscent of the optical theorem in single scattering.

DY 23.5 Thu 10:45 MA 001

Emission through Chaotic Transports in Chaotic Microcavities — •Jeong-Bo Shim[1], Sang-Bum Lee[2], Soo Young Lee[2], Juhee Yang[2], Songky Moon[2], Sang Wook Kim[3], Jai-Hyung Lee[2], and Kyungwon An[2] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [2]School of Physics and Astronomy, Seoul National University, Seoul, Korea — [3]Department of Physics Education, Pusan National University, Busan, Korea

The idea of chaotic deformed microcavities has been suggested to make a directional emission with keeping the cavity-Q factor higher than conventional cavities. We realized the chaotic deformed microcavity with a liquid jet system, and analyzed the directional emission of it numerically and theoretically. In this work, we present a experimental and numerical evidence of the turnstile process which is realized in the double peak of the deformed microcavity emission. Interestingly, this characteristic emission is not consistently explained by the classical turnstile process in the whole regimes of a chaotic transition. Accordingly, we suggest the distinguished emission mechanism depending on the action transport in the classical phase space.

DY 23.6 Thu 11:00 MA 001

Algebraic fidelity decay for local perturbations — •Ruven Höhmann, Ulrich Kuhl, and Hans-Jürgen Stöckmann — Fachbereich Physik, Philipps-Universität Marburg, Renthof 5,

From a reflection measurement in a rectangular microwave billiard with an arrangement of randomly distributed scatterers the scattering fidelity was studied with the position of one of the scatterers as the perturbation parameter. Such perturbations have been termed "local" by us since the wave function is influenced only locally [1]. This is in contrast of previous studies of our group where the fidelity decay had been studied as a function of one billiard wall [2]. Using Berry's random plane wave conjecture, an analytic expression for the fidelity decay due to the shift of one scatterer has been obtained, yielding an algebraic 1/t decay for long times. A perfect agreement between experiment and theory has been obtained, including a predicted scaling behavior concerning the dependence of the fidelity decay on the shift distance. The only free parameter has been determined independently from the variance of the level velocities. From the spectrum the ordinary fidelity amplitude could be determined also, and was found to be in good agreement with the scattering fidelity.

[1] M. Barth, U. Kuhl, and H.-J. Stöckmann, Phys. Rev. Lett. **82**, 2026 (1999).
[2] R. Schäfer, H.-J. Stöckmann, T. Gorin, and T. H. Seligman, Phys. Rev. Lett. **95**, 184102 (2005).