DY 20: Quantum chaos I

Time: Wednesday 14:00–15:30 Location: H2

Invited Talk DY 20.1 Wed 14:00 H2

Semiclassical approach to universality in quantum chaos — Stefan Heusler[1], •Sebastian Müller[2], Alexander Altland[3], Petr Braun[1,4], and Fritz Haake[1] — [1]Fachbereich Physik, Universität Duisburg-Essen, 47048 Duisburg, Germany — [2]Cavendish Laboratory, University of Cambridge, Cambridge CB30HE, UK — [3]Institut für Theoretische Physik, Zülpicher Str 77, 50937 Köln, Germany — [4]Institute of Physics, Saint-Petersburg University, 198504 Saint-Petersburg, Russia

According to the so-called Bohigas-Giannoni-Schmit conjecture the quantum spectra of classically chaotic systems display universal fluctuations. We explain this universality using periodic-orbit theory. To do so, we work with a generating function whose semiclassical limit is determined by quadruplets of sets of periodic orbits. We show that the interference between the contributions of these orbits gives rise to universal spectral correlations, agreeing with the predictions of random-matrix theory. In contrast to previous work the present approach yields both the non-oscillatory and the oscillatory parts of the universal spectral correlator. In particular, a semiclassical understanding of (the different possible degrees of) level repulsion is thus reached.

[1] S. Heusler, S. Müller, A. Altland, P. Braun, and F. Haake, `nlin.CD/0610053`, accepted for publication in Phys. Rev. Lett. (2007).

DY 20.2 Wed 14:30 H2

Statistical theory of irregular eigenfunctions: a semiclassical approach — •Juan Diego Urbina and Klaus Richter — Institute for Theoretical Physics, Regensburg University, 93040 Regensburg, Germany

The spatial fluctuations of quantum wavefunctions in systems with chaotic classical dynamics or in the presence of disorder, show a remarkable universality.

In clean chaotic systems, such universality is encoded in Berry's Random Wave Model (RWM)[1] while the exact theory of wavefunction statistics in disordered systems has been conjectured to describe not only the diffusive, but also the clean, ballistic case [2] by the so-called Ballistic Sigma Model (BSM). In particular, the BSM seems not to be compatible with the Gaussian distribution for the wavefunction's amplitude typical of the RWM.

However, the results of the BSM can indeed be derived by means of a natural generalization of Berry's conjecture, keeping the wavefunction's distribution strictly Gaussian [3]. The key point is the consistent use of the diagonal approximation in order to eliminate oscillatory contributions neglected by the BSM.

In this contribution, we present the three basic ingredients of this generalization, namely, how to incorporate arbitrary boundaries into the Random Wave Model, the semiclassical approximation for the averages, and the diagonal approximation providing the link with the results for disordered systems.

[1] M. V. Berry *J. Phys. A: Math. Gen.* **10**, 2083 (1977).
[2] A. D. Mirlin *Phys. Rep.* **326**, 259 (2000).
[3] J. D. Urbina and K. Richter *Phys. Rev. Lett.* **97**, 214101 (2006).

DY 20.3 Wed 14:45 H2

Nodal domains in open microwave systems — •Ulrich Kuhl, Ruven Höhmann, and Hans-Jürgen Stöckmann — AG Quantenchaos, Fachbereich Physik, Philipps-Universität Marburg, Renthof 5, D-35032 Marburg, Germany

Nodal domains in the wavefunctions ψ of closed systems have been proposed as a tool to discriminate between regular and chaotic systems [1], and interpreted for chaotic systems in terms of percolation models [2]. The theoretical predictions have been verified experimentally in a closed microwave billiard [3]. In open systems ψ is complex and has no longer nodal lines but nodal points. Still one can define nodal domains for real part ψ_R and imaginary part ψ_I of ψ. They show the same behavior as wavefunctions in closed billiards. In addition we investigate the variation of the number of nodal domains and the signed area correlation by changing the global phase φ_g according to $\psi_R + i\psi_I = e^{i\varphi_g}(\psi'_R + i\psi'_I)$. This variation can be qualitatively, and the signed area correlation quantitatively explained in terms of the phase rigidity characterizing the openness of the billiard [4].

[1] G. Blum, S. Gnutzmann, and U. Smilansky, Phys. Rev. Lett. 88, 114101 (2002).
[2] E. Bogomolny and C. Schmit, Phys. Rev. Lett. 88, 114102 (2002).
[3] N. Savytskyy, O. Hul, and L. Sirko, Phys. Rev. E 70, 056209 (2004).
[4] Y.-H. Kim, U. Kuhl, H.-J. Stöckmann, and P. W. Brouwer, Phys. Rev. Lett. 94, 036804 (2005)

DY 20.4 Wed 15:00 H2

Nodal Domains Statistics in the Barrier Billiard — •Maksim Miski-Oglu — 64291-Darmstadt, Schlossgartenstr.9, Institut für Kernphysik

Using the experimentally obtained wave functions of the barrier billiard we analyse the properties of the nodal domains of its wave functions. The total number of nodal domains, rescaled number of the inner nodal domains and the nodal domains area distribution are analyzed. We found that the mean value of the rescaled number of the inner nodal domains shows a clear deviation from the value predicted by the percolation like model, however the nodal domain area distribution agrees well with the prediction of the percolation theory.

DY 20.5 Wed 15:15 H2

Spectrum, wave functions and effective index of refraction of a circular dielectric billiard — •Stefan Bittner, Barbara Dietz-Pilatus, Thomas Friedrich, Maksim Miski-Oglu, Pedro Oria Iriarte, Achim Richter, and Florian Schäfer — Institut für Kernphysik, Schloßgartenstraße 9, 64289 Darmstadt

The goal of the presented work is to investigate the correctness and precision of effective index of refraction calculations for open dielectric resonators. For this purpose, the spectrum and wave functions of circular dielectric billiards in different geometries were measured with high resolution and the corresponding quantum numbers identified. The general structure of the spectrum and resonance frequencies were compared to the calculations. General agreement was found, but also a high dependence on geometric parameters and perturbations, motivating further investigations and precision measurements.