TT 59: Quantum Chaos (joint session DY/TT)

Time: Friday 11:30–13:00 Location: H37

TT 59.1 Fri 11:30 H37

Semiclassical foundation of universality in many-body quantum circuits — •Maximilian Kieler[1], Felix Fritzsch[2], and Arnd Bäcker[1] — [1]TU Dresden, Institut für Theoretische Physik, Dresden, Germany — [2]Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Straße 38, 01187 Dresden, Germany

For single particle systems the fundamental equivalence of quantum chaotic systems and random matrix theory is well-understood by means of semiclassical periodic orbit theory. We propose an extension to spatially local many-body systems by incorporating the concept of symmetry-breaking. Using this we show that random matrix behavior arises generically in quantum chaotic many-body systems in the form of a symmetry breaking of local time-translation symmetries. This general framework is applied to quantum circuits where an explicit correspondence to the random matrix result for the spectral form factor can be shown.

TT 59.2 Fri 11:45 H37

Distribution of resonance poles of chaotic scattering systems — •Jan Robert Schmidt, Florian Lorenz, and Roland Ketzmerick — TU Dresden, Institute of Theoretical Physics, Dresden, Germany

The distribution of resonance poles of chaotic scattering systems is investigated in the semiclassical limit at unprecedented small wavelengths. For the paradigmatic three-disk scattering system, we study the spectral gap towards the real axis, the fractal Weyl law, which counts the number of resonance poles, and the distribution of decay rates. These properties are compared to previous analytical results, e.g. from random matrix theory. In contrast to this system with full escape, systems with partial escape have significantly different properties. For the example of a dielectric cavity, we show that results from random matrix theory cannot explain the distribution of decay rates.

TT 59.3 Fri 12:00 H37

Solved after 60 years: Exact Derivation of the Ericson Transition in Quantum Chaotic Scattering — •Simon Köhnes and Thomas Guhr — University of Duisburg-Essen, Lotharstr. 1, 47048 Duisburg, Germany

Scattering experiments are the prime source of information on the quantum world. Scattering theory nowadays has numerous applications in various branches of physics and beyond, even including classical wave phenomena. We analyze chaotic scattering systems in the framework of Random Matrix Theory. The distribution of the scattering matrix elements is the key quantity. A strong sign of chaos in complex quantum systems is the Ericson regime of strongly overlapping resonances in which the cross sections exhibit random behavior. We apply the Supersymmetry Method. For the three Wigner-Dyson symmetry classes, we analytically calculate the transition to the Ericson regime, facilitating direct comparison with experimental results. In the course of doing so, we also gather new information on features of the underlying supersymmetric non-linear sigma model.

TT 59.4 Fri 12:15 H37

Chaotic Quantum Scattering: Exact Solutions for Systems with Spin — •Nils Gluth and Thomas Guhr — Universität Duisburg-Essen, Duisburg, Germany

Scattering experiments facilitate access to quantum systems. Scattering theory is needed to fully describe the involved experimental situations. Over the years, it became a powerful tool with applications to a large variety of different systems, such as for example compound nuclei, atoms, molecules, quantum graphs or even microwave networks and cavities. These systems are typically complex or in a broad sense chaotic, calling for statistical approaches, in particular Random Matrix Theory. Considerably extending our previous work, we calculate the distribution of scattering matrix elements and cross sections using Supersymmetry. We focus on the symplectic symmetry class which had not yet been solved, because a theoretical understanding is needed in view of recent experiments. We provide a comparison of our results with experimental data.

TT 59.5 Fri 12:30 H37

Phase-space representations and exceptional points of coupled polarized modes in cylindrical cavities — •Tom Rodemund[1], Shilong Li[2], Síle Nic Chormaic[3], and Martina Hentschel[1] — [1]Institute of Physics, Chemnitz University of Technology, Chemnitz, Germany — [2]College of Information Science and Electronic Engineering, Zhejiang University, Hangzhou, China — [3]Okinawa Institute of Science and Technology Graduate University, Okinawa, Japan

% Optical microcavities are often assumed to be two-dimensional (2D). This allows a convenient phase-space representation in 2D, where Poincaré surface of section for particle dynamics and the Husimi function for their wave counterpart are prominent methods. Here we extend the concept of Husimi functions for open systems [1] to three-dimensional (3D) optical microcavities of arbitrary shape. In particular we study deformed cylindrical cavities and illustrate their mode dynamics in terms of generalized Husimi functions.

The coupling between the two different polarizations (TE and TM) is a new feature in realistic 3D optical cavities that is not present in 2D. We find the interaction of polarized modes to be governed by a network of exceptional points that reflects the openness, or non-Hermiticity, of the system. The mode coupling is analyzed using the extended Husimi formalism that we find to be a comprehensive and useful way to represent the mode structure of 3D microcavities [2].

[1] Hentschel et al., Europhys. Lett. 62 636 (2003)
[2] Rodemund et al., to be submitted.

TT 59.6 Fri 12:45 H37

The classical Maldacena-Shenker-Standford bound — •Gerrit Caspari, Fabian Haneder, Juan-Diego Urbina, and Klaus Richter — University of Regensburg, Regensburg, Deutschland

The Maldacena-Shenker-Stanford (MSS) bound [1] is a condition on a system's quantum Lyapunov exponent, defined as half the growth rate of the regularised out-of-time-ordered correlator (OTOC), which states that said exponent is bounded by the system's temperature, with, e.g., black holes as characteristic systems saturating the bound.

From the perspective of classical chaos, this is surprising, since the classical Lyapunov exponent seems not to be bounded. We study chaotic quantum systems in a hyperbolic geometry with and without cusps and magnetic fields [2][3] via Selberg's Trace Formula (STF). Through this we derive bounds on the classical Lyapunov exponent from analyticity conditions in the trace formula and relate them to the MSS bound.

We report our progress in studying these bounds using the STF, which entails an investigation of the analyticity condition needed to prove the STF for the partition function of our systems and its relation to possible phase transitions.

[1] Maldacena, J., Shenker, S.H. & Stanford, J. High Energ. Phys. 2016, 106 (2016).
[2] Aurich, R., & Steiner, F. (1992)., Proceedings: Mathematical and Physical Sciences, 437(1901), 693-714
[3] Avron, J.E., Klein, M. & Pnueli, A., Phys. Rev. Lett. 69 (1992)