DY 2: Quantum Chaos

Time: Tuesday 10:00–12:15 Location: H6

Invited Talk DY 2.1 Tue 10:00 H6

Local Versus Global Two-Photon Interference in Quantum Networks — •Sonja Barkhofen[1], Thomas Nitsche[1], Syamsundar De[1], Evan Meyer-Scott[1], Johannes Tiedau[1], Jan Sperling[1], Aurél Gábris[2,3], Igor Jex[2], and Christine Silberhorn[1] — [1]Applied Physics, University of Paderborn, Warburger Strasse 100, 33098 Paderborn, Germany — [2]Department of Physics, Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague, Brehová 7, 115 19 Praha 1-Stare Mesto, Czech Republic — [3]Wigner Research Centre for Physics, Konkoly-Thege M. út 29-33, H-1121 Budapest, Hungary

We devise an approach to characterizing the intricate interplay between classical and quantum interference of two-photon states in a network, which comprises multiple time-bin modes. By controlling the phases of delocalized single photons, we manipulate the global mode structure, resulting in distinct two- photon interference phenomena for time-bin resolved (local) and time-bucket (global) coincidence detection. This coherent control over the photons' mode structure allows for synthesizing two-photon interference patterns, where local measurements yield standard Hong-Ou-Mandel dips while the global two-photon visibility is governed by the overlap of the delocalized single-photon states. Thus, our experiment introduces a method for engineering distributed quantum interferences in networks.

DY 2.2 Tue 10:30 H6

Interplay between coherent and incoherent decay processes in chaotic systems: the role of quantum interference — •Camilo Alfonso Moreno Jaimes and Juan-Diego Urbina — Regensburg University, Regensburg, Germany

The population decay due to a small opening in an otherwise closed cavity supporting chaotic classical dynamics displays a quantum correction on top of the classical exponential form, a pure manifestation of quantum coherence that acquires a universal form and can be explained by path interference. Being coherent, such enhancement is prone to decoherence effects due to the coupling of the system to an external environment. We study this interplay between incoherent and coherent quantum corrections to decay by evaluating, within a Caldeira-Leggett scenario, off-diagonal contributions to the decoherence functional coming from pairs of correlated classical paths in the time regime where dissipative effects are neglected and decoherence does not affect the classical dynamics, but quantum interference must be accounted for. We find that the competing effects of interference and decoherence lead to a universal nonmonotonic form for the survival probability depending only on the coupling strength and macroscopic parameters of the cavity.

DY 2.3 Tue 10:45 H6

Geometry of complex instability in four-dimensional symplectic maps — •Jonas Stöber and Arnd Bäcker — TU Dresden, Institut für Theoretische Physik

In four-dimensional symplectic maps complex instability of periodic orbits is possible, which cannot occur for the two-dimensional case. We investigate the transition from stable to complex unstable dynamics of a fixed point under parameter variation. The change in the geometry of regular structures is visualized using three-dimensional phase-space slices and in frequency space using the example of two coupled standard maps. The chaotic dynamics is studied using escape time plots and two-dimensional invariant manifolds associated with the complex unstable fixed point. Based on a normal-form description, we investigate the underlying transport mechanism by visualizing the escape paths and the long-time confinement in the surrounding of the complex unstable fixed point.

15 min. break.

DY 2.4 Tue 11:15 H6

Chaos induced by interface produces universal Hong-Ou-Mandel correlations in topological insulators — •Andreas Bereczuk, Juan Diego Urbina, Cosimo Gorini, and Klaus Richter — Institut of Theoretical Physics, University Regensburg, Germany

The celebrated Hong-Ou-Mandel (HOM) effect [1] is a known coherent manifestation of the indistinguishable-distinguishable transition that is experimentally accessible through measurements of the transmission probability for two-body fermionic states propagating through a quantum point contact in electron quantum optics [2]. As shown in [3, 4], universal HOM correlations are visible by substituting the quantum point contact by a chaotic cavity in a mesoscopic regime [3] where universal correlations of the scattering matrix entries at different energies enter. We present here a numerical analysis of this correlators for a HOM setup with normal cavities playing the role of complex beam splitters and edge states of a topologiocal insulator instead of waveguides. Our main observation is the emergence of universal HOM correlations in this setup where chaotic dynamics is driven by the high reflectivity due to mode mismatch at the interfaces.

[1] C. K. Hong, Z. Y. Ou and L. Mandel, Phys. Rev. Lett. 59, 2044 (1987)
[2] E. Bocquillon et al., Annalen der Physik 526, 1 (2014)
[3] J. D. Urbina et al., Phys. Rev. Lett. 116, 100401 (2016)
[4] A. Bereczuk et al., Phys. Rev. E 103, 052209 (2021)

DY 2.5 Tue 11:30 H6

Dirac fermion optics and directed emission from single- and bilayer graphene cavities — •Jule Katharina Schrepfer[1], Szu-Chao Chen[2], Ming-Hao Liu[2], Klaus Richter[3], and Martina Hentschel[4] — [1]Technische Universität Ilmenau, 98693 Ilmenau, Germany — [2]National Cheng Kung University, Tainan 70101, Taiwan — [3]Universität Regensburg, 93040 Regensburg, Germany — [4]Technische Universität Chemnitz, 09107 Chemnitz, Germany

High-mobility graphene hosting massless charge carriers with linear dispersion provides a promising platform for electron optics phenomena. Inspired by the physics of dielectric optical micro-cavities where the photon emission characteristics can be efficiently tuned via the cavity shape, we study corresponding mechanisms for trapped Dirac fermionic resonant states in deformed micro-disk graphene billiards and directed emission from those. In such graphene devices a backgatevoltage provides an additional tunable parameter to mimic different effective refractive indices and thereby the corresponding Fresnel laws at the boundaries. Moreover, cavities based on single-layer and double-layer graphene exhibit Klein- and anti-Klein tunneling. Moreover,we find a variety of different emission characteristics depending on the position of the source where charge carriers are fed into the cavites. Combining quantum mechanical simulations with optical ray tracing and a corresponding phase-space analysis, we demonstrate strong confinement of the emitted charge carriers in the mid field of single-layer graphene systems and can relate this to a lensing effect. For bilayer graphene, trapping of the resonant states is more efficient.

DY 2.6 Tue 11:45 H6

Optical microcavities in a ray picture with phase information — •Lukas Seemann — TU Chemnitz

Ray-wave correspondence has proven a useful tool to describe various aspects of optical microcavities, for example the far-field emission of deformed microdisk resonators. However, for more complicated settings such as coupled microcavities, interference effects will become important [1]. To this end we expand the ray description by the phase information and include the phase collected by the light ray along its trajectory [2] into the model. We explore the chances as well as possible limitations of this approach in various examples and investigate to what extent a ray model with phase information can deepen ray-wave correspondence.

[1] J. Kreismann, J. Kim, M. Bosch, M. Hein, S. Sinzinger, and M. Hentschel, Super-directional light emission and emission reversal from micro cavity arrays, Phys. Rev. Res. 1, 033171(1-5) (2019).
[2] M. Hentschel and M. Vojta, Multiple beam interference in a quadrupolar glass fiber, Opt. Lett. 26, 1764-1766 (2001).

DY 2.7 Tue 12:00 H6

Emergent fractal phase in energy stratified random models — •Anton Kutlin and Ivan Khaymovich — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Straße 38, 01187-Dresden, Germany

We study the effects of partial correlations in kinetic hopping terms of long-range disordered random matrix models on their localization

properties. We consider a set of models interpolating between fully-localized Richardson's model and the celebrated Rosenzweig-Porter model (with implemented translation-invariant symmetry). In order to do this, we propose the energy-stratified spectral structure of the hopping term, allowing one to gradually decrease the range of correlations. We show both analytically and numerically that any deviation from the completely correlated case leads to the emergent non-ergodic delocalization in the system unlike the predictions of localization of cooperative shielding. In order to describe the models with correlated kinetic terms, we develop the generalization of the Dyson Brownian motion and cavity approaches basing on stochastic matrix process with independent rank-one matrix increments and examine its applicability to the above set of models