Symposium Facets of many-body quantum chaos (SYQC)

jointly organised by
the Low Temperature (TT),
the Dynamics and Statistical Physics Division (DY), and
the Magnetism Division (MA)

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Many-body systems share the essential and surprising property that often simple effective descriptions emerge as a result of complex chaotic dynamics. Recent years have seen significant progress in the understanding of such complex dynamics in the quantum many-body context, both theoretically and experimentally, with impact onto areas as diverse as quantum gravity (via ADS/CFT dualities) or quantum information theory. It is the central goal of this Symposium to embody a broad spectrum of these recent developments with a particular focus on its cross-disciplinary aspects ranging from quantum statistical mechanics, atomic and condensed matter physics to high-energy physics.

Overview of Invited Talks and Sessions

(Lecture hall Audimax 2)

Invited Talks

SYQC 1.1	Tue	13:30–14:00	Audimax 2	**Holographic interpretation of SYK quantum chaos** — •Alexander Altland
SYQC 1.2	Tue	14:00–14:30	Audimax 2	**Non-Fermi liquids and the lattice** — •Sean Hartnoll
SYQC 1.3	Tue	14:30–15:00	Audimax 2	**Dual-unitary circuits: non-equilibrium dynamics and spectral statistics** — •Bruno Bertini
SYQC 1.4	Tue	15:15–15:45	Audimax 2	**Post-Ehrenfest many-body quantum interferences in ultracold atoms** — •Steven Tomsovic
SYQC 1.5	Tue	15:45–16:15	Audimax 2	**Dynamics in unitary and non-unitary quantum circuits** — •Vedika Khemani

Sessions

SYQC 1.1–1.5	Tue	13:30–16:15	Audimax 2	**Facets of many-body quantum chaos**

SYQC 1: Facets of many-body quantum chaos

Time: Tuesday 13:30–16:15 Location: Audimax 2

Invited Talk SYQC 1.1 Tue 13:30 Audimax 2

Holographic interpretation of SYK quantum chaos — •Alexander Altland — Institute for theoretical physics, University of Cologne, Germany

Since its introduction in 2015, the SYK model has been intensively researched, and at this point is the perhaps best understood model system of many body quantum chaos. However, when Kitaev first proposed the model, his motivation was to define the boundary theory of a two-to-one dimensional holographic correspondence. In this talk, we will address the question what the lessons learned about the SYK system in the past five years can teach us about the nature of candidate bulk theories. Looking at the problem through the lens of quantum chaos, we will argue that perturbative studies inspired by periodic orbit analysis go a long way, but not all, in identifying the gravitational bulk. The solution of the problem might lie in a symmetry breaking principle realized in all universality classes of quantum chaos, but not so far in the proposed bulk duals. We will suggest that this symmetry breaking must be present in bulk duals of chaotic boundary theories, and that the search for it might turn into a creative resource.

Invited Talk SYQC 1.2 Tue 14:00 Audimax 2

Non-Fermi liquids and the lattice — •Sean Hartnoll — Stanford University

Non-Fermi liquids are electronic systems with strong electronic interactions. For example, the electrons may be quantum critical. Therefore, the electrons are expected to thermalize quickly. However, heat must also be able to leave the electronic degrees of freedom – for example, this will happen by Joule heating upon applying a current. In a metal Joule heating goes via the lattice degrees of freedom. I will explain a new formalism for computing the timescales over which the electronic and lattice degrees of freedom thermalize each other in a non-Fermi liquid.

Invited Talk SYQC 1.3 Tue 14:30 Audimax 2

Dual-unitary circuits: non-equilibrium dynamics and spectral statistics — •Bruno Bertini — University of Oxford

I will discuss the quantum non-equilibrium dynamics and the spectral statistics of a recently introduced class of "statistically solvable" many-body quantum systems: the dual-unitary circuits. These systems furnish a minimal modelling of generic, locally interacting, many-body quantum systems. In particular, I will show that generic dual-unitary circuits display behaviours typically associated with many-body quantum chaos.

15 min. break

Invited Talk SYQC 1.4 Tue 15:15 Audimax 2

Post-Ehrenfest many-body quantum interferences in ultracold atoms — •Steven Tomsovic — Department of Physics and Astronomy, Washington State University, Pullman, WA USA

Far out-of-equilibrium many-body quantum dynamics in isolated systems necessarily generate interferences beyond an Ehrenfest time scale, where quantum and classical expectation values diverge. Ultracold atomic gases provide a promising setting to explore these phenomena. Theoretically speaking, the heavily-relied-upon truncated Wigner approximation leaves out these interferences. We develop a semiclassical theory of coherent state propagation for many-body bosonic systems, which properly incorporates such missing quantum effects. For mesoscopically populated Bose-Hubbard systems, it is shown that this theory captures post-Ehrenfest quantum interference phenomena very accurately, and contains relevant phase information to perform many-body spectroscopy with high precision.

Invited Talk SYQC 1.5 Tue 15:45 Audimax 2

Dynamics in unitary and non-unitary quantum circuits — •Vedika Khemani — Stanford University

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