Abstracts Week 3

Speaker: Sarang Gopalakrishnan

Abstract: We explore the autocorrelation functions of "non-hydrodynamic" operators (e.g., the single-particle Green's function) at high temperature, under energy-conserving or charge-conserving quantum dynamics. These operators are strictly orthogonal to hydrodynamic modes, but are nevertheless indirectly affected by hydrodynamic fluctuations: in one or two dimensions, we show that their relaxation is subexponential at all temperatures. This subexponential decay is strictly a quantum-coherent effect, which is immediately destabilized by adding extrinsic noise. Our results imply that there are no well-defined Ruelle-Pollicott resonances in low-dimensional systems with charge conservation, even in sectors that are non-hydrodynamic. We develop a framework relating the dynamics of non-hydrodynamic operators to large deviations in classical hydrodynamics. E. McCulloch, J. A. Jacoby, C. von Keyserlingk, SG, Phys. Rev. Lett. 136, 190403 (2026) E. McCulloch, J. A. Jacoby, SG, arXiv:2604.27074

Speaker: Bruno Bertini

Abstract: In recent years, quantum circuits have emerged as useful effective models to understand generic quantum many-body dynamics, and as concrete platforms for quantum simulation. The most appealing feature of these systems is that, contrary to generic many-body systems in continuous time, the dynamics of quantum circuits are sometimes amenable to analytical treatment. In the talk I will present a fruitful route to achieve this goal based on imposing a duality symmetry between space and time. I will review how this symmetry allows to fully characterise interesting features of quantum many-body dynamics, such as entanglement spreading and operator growth, and examine its implications. I will then discuss how to systematically weaken this symmetry while retaining (some) solvability, and how an exchange of space and time can help characterising general aspects of quantum many-body dynamics.

Speaker: Tianci Zhou

Abstract: The influence matrices provide an alternative route to the classical simulation of quantum dynamics. These objects describe the effective bath seen by a finite subsystem and, since they retain information only on the local dynamics, they are expected to be easier to simulate than the full wavefunction. Recent work, however, has shown that the influence matrices carry strong temporal correlations even in maximally chaotic systems, which rules out their efficient representation. In this work, we demonstrate that one can nevertheless efficiently store the reduced transition matrix, the combination of influence matrices that directly determines local expectation values. We will first show that the truncation errors are controlled by the singular spectrum of this object, which naturally motivates a low-rank approximation. We then prove that, for chaotic dual-unitary circuits, the associated entropy grows at most logarithmically in time. Our conclusions follow from exact results for random dual-unitary circuits and are supported by numerical results for fixed instances of both dual-unitary circuits and generic circuits.

Speaker: Kavan Modi

Abstract: Chaotic systems are highly sensitive to a small perturbation, and are ubiquitous throughout biological sciences, physical sciences and even social sciences. Taking this as the underlying principle, we construct an operational notion for quantum chaos. Namely, we demand that the future state of a many-body, isolated quantum system is sensitive to past multitime operations on a small subpart of that system. By 'sensitive', we mean that the resultant states from two different perturbations cannot easily be transformed into each other. That is, the pertinent quantity is the complexity of the effect of the perturbation within the final state. From this intuitive metric, which we call the Butterfly Flutter Fidelity, we use the language of multitime quantum processes to identify a series of operational conditions on chaos, particularly the scaling of the spatiotemporal entanglement. Our criteria already contain routine notions and well-known diagnostics for quantum chaos. We then extend the criteria to include projected process ensembles, motivated by studies on deep thermalisation. Our results account for previous attempts to make sense of quantum chaos, such as the Peres-Loschmidt Echo, Dynamical Entropy, Tripartite Mutual Information, and Local-Operator Entanglement. Finally, we will present numerical results using the XXZ model and discuss how chaos leads to equilibration, Markovianisation, and thermalisation. Reference: N Dowling, K Modi, PRX Quantum 5, 010314 (2024)

Speaker: Robert Koenig

Abstract: This minicourse will introduce basic notions of quantum computing and quantum fault-tolerance. In Part I, I will discuss models of computation, noisy quantum circuits, quantum error-correcting codes, fault-tolerant gadgets, and the threshold theorem. In Part II, I will turn to the classical simulation of (noisy) quantum circuits and discuss how efficient simulations of quantum many-body dynamics can give insights into the fault-tolerance properties of quantum information-processing proposals.