DY 29: Poster: Quantum Dynamics and Many-body Systems

Time: Wednesday 15:00–18:00 Location: P4

DY 29.1 Wed 15:00 P4

Prethermalization in Open Quantum Systems — •Saptarshi Saha[1] and Rangeet Bhattacharyya[2] — [1]Institute of Theoretical Physics, Technical University of Berlin Hardenbergstr. 36, Sekr. EW 7-1, 10623 Berlin, Germany. — [2]Department of Physical Sciences, Indian Institute of Science Education and Research Kolkata, Mohanpur-741246, West Bengal, India

A nearly-integrable isolated quantum many-body system reaches a quasi-stationary prethermal state before a late thermalization. Here, we revisit a particular example in the settings of an open quantum system (OQS). We consider a collection of non-interacting atoms coupled to a spatially correlated bosonic bath characterized by a bath correlation length. Our result implies that the integrability of the system depends on such a correlation length. If this length is much larger than the distance between the atoms, such a system behaves as a nearly-integrable OQS. We study the properties of the emerging prethermal state for this case, i.e. the state's lifetime, the extensive number of existing quasi-conserved quantities, the emergence of the generalized Gibbs state, and the scaling of von Neumann entropy, etc. We find that for the prethermal state, the maximum growth of entropy is logarithmic with the number of atoms, whereas such growth is linear for the final steady state, which is the Gibbs state in this case.

DY 29.2 Wed 15:00 P4

Quantum Fluctuations Approach to Many-Body Systems for Weak and Strong Coupling — •Erik Schroedter, Jan-Philip Joost, Tim Kalsberger, and Michael Bonitz — CAU, Kiel, Germany

The theoretical description of correlated quantum many-body systems out of equilibrium is a significant challenge across many areas, including condensed matter, ultracold atoms, and dense plasmas. Standard approaches used for their description include the formalisms of reduced density matrices (RDM) and nonequilibrium Green functions (NEGF). However, all approaches suited for the description of nonequilibrium systems are limited in their applicability due to their accuracy or numerical scaling. Here, we present an alternative approach based on fluctuations of field operator products and their correlation functions[1,2]. It is closely related to NEGF and RDM theory and offers an alternative approach to the GW and T-matrix approximations while exhibiting interesting complementary features, such as the capability to simulate many-body effects using stochastic methods[3]. This significantly reduces numerical complexity while preserving accuracy and allows for the description of both weakly and strongly coupled systems. Additionally, this improves numerical stability and allows for direct access to spectral two-particle quantities, such as the density response function or dynamic structure factor.

[1] E. Schroedter, et al., Cond. Matt. Phys. 25, 23401 (2022)
[2] E. Schroedter, and M. Bonitz, CTPP 202400015 (2024)
[3] E. Schroedter, et al., Phys. Rev. B 108, 205109 (2023)

DY 29.3 Wed 15:00 P4

Dynamics of topological defects in non-equilibrium magnon condensates — •Alexander Wowchik and Achim Rosch — Institut für Theoretische Physik, Universität zu Köln, 50937 Cologne, Germany

It has been demonstrated in the past that thin Yttrium Iron Garnet (YIG) films exhibit condensation of magnons in two degenerate minima of the band structure when driven with microwave radiation in the presence of an external magnetic field.

This creates a non-equilibrium many-body system at room temperature, which provides a framework to study the dynamics of self-propelling units that violate the conservation of energy, analogous to models of active matter.

We examine the behaviour of a single topological vortex defect in the magnon condensate after explicitly breaking the spatial inversion symmetry that restricts the dynamics of the ideal system. This is motivated by an asymmetric configuration in the typical experimental setup.

The study is performed by solving the driven-dissipative Gross-Pitaevskii equation for the emergent condensate degrees of freedom. It is derived from the semi-classical limit of an effective U(1) x O(2) symmetric Keldysh field theory.

The results are compared to micromagnetic simulations of the underlying ferromagnetic spin-Hamiltonian.

DY 29.4 Wed 15:00 P4

Wiedemann-Franz law violation domain for graphene and nonrelativistic systems — •Thandar Zaw Win, Cho Win Aung, Gaurav Khandal, and Sabyasachi Ghosh — Department of Physics, Indian Institute of Technology Bhilai, Kutelabhata, Durg 491002, India

Systematic and comparative research on Lorenz ratios for graphene and nonrelativistic systems has been studied to identify their Wiedemann-Franz law violation domain. Fermi energy and tem- perature are the main governing parameters for deciding the values of the Lorenz ratio, which is basically thermal conductivity divided by electrical conductivity times temperature times Lorenz number. Metals as three-dimensional nonrelativistic electron gas locate at higher Fermi energy by temperature domain, where Lorenz ratio remains one. Hence, they obey the Wiedemann-Franz law. By creating higher doping in a two-dimensional graphene system, one can again reach a higher Fermi energy by temperature domain and get a constant Lorenz ratio. For both graphene and nonrelativistic systems, the Lorenz ratio goes below one if we go lower Fermi energy by temperature domain, which is possible for the graphene system by decreasing the doping concentration. Experimentally observed greater than one Lorenz ratio in this lower Fermi energy by temperature domain or Dirac fluid domain indicates that non-fluid expressions of Lorenz ratio should be replaced by fluid-type expressions. We have noticed a divergent trend of Lorenz ratio in the Dirac fluid domain using its fluid-type expression, and it matches with the trend of experimental data.

DY 29.5 Wed 15:00 P4

Anisotropic Dicke model in the presence of periodic and quasiperiodic drive — •Pragna Das[1], Devendra Singh Bhakuni[2], Lea F. Santos[3], and Auditya Sharma[4] — [1]Department of Theoretical Physics, J. Stefan Institute, SI-1000 Ljubljana, Slovenia — [2]The Abdus Salam International Centre for Theoretical Physics (ICTP), Strada Costiera 11, 34151 Trieste, Italy — [3]Department of Physics, University of Connecticut, Storrs, Connecticut 06269, USA — [4]Indian Institute of Science Education and Research, Bhopal 462066, India

We analyze the anisotropic Dicke model in the presence of a periodic drive and under a quasiperiodic drive. We show that under a quasiperiodic Fibonacci (Thue-Morse) drive, the system features a prethermal plateau that increases as an exponential (stretched exponential) with the driving frequency before heating to an infinite-temperature state. In contrast, when the model is periodically driven, the dynamics reaches a plateau that is not followed by heating. In either case, the plateau value depends on the energy of the initial state and on the parameters of the undriven Hamiltonian. Surprisingly, this value does not always approach the infinitetemperature state monotonically as the frequency of the periodic drive decreases. We also show how the drive modifies the quantum critical point and discuss open questions associated with the analysis of level statistics at intermediate frequencies.

DY 29.6 Wed 15:00 P4

Enhancing quantum metric using periodic driving — •Dhruv Tiwari, Roderich Moessner, and Johannes S. Hofmann — Max Planck Institute for Physics of Complex Systems, Nöthnitzer Str., 01187, Dresden

The advent of periodically driven systems has revolutionized modern condensed matter physics by offering two transformative opportunities. First, they allow the realization of nonequilibrium analogs of well-established equilibrium phases under highly tunable conditions. Second, they facilitate the emergence of novel phases with no equilibrium counterparts. In this work, we focus on the former, leveraging the tunable parameters of periodically driven systems to enhance the quantum metric in flat-band systems. The quantum metric, a fundamental geometric property of the band structure, plays a critical role in the formation of superconductivity in flat-band systems with attaractive density interactions. Here, we present preliminary results demonstrating how the interplay between periodic driving and elec-

tron correlations can amplify the quantum metric, leading to enhanced physical properties compared to the equilibrium case. These findings pave the way for designing engineered quantum states and exploring the interplay of nonequilibrium dynamics and strong correlations in flat-band systems.

DY 29.7 Wed 15:00 P4

Phase-space correlations of resonances in chaotic scattering systems — •Florian Lorenz and Roland Ketzmerick — TU Dresden, Institute of Theoretical Physics, Dresden, Germany

Chaotic eigenfunctions in closed quantum systems show strong phase-space correlations along classical trajectories [1]. These correlations extend across the whole system size and persist in the semiclassical limit [1]. We here expand this analysis to open quantum maps and scattering systems, in particular the kicked rotor and a dielectric cavity. To this end, we generalize a time-dependent correlator suggested in [1] to the case of an open system using left- and right resonance states. For quantum maps we find similar results as for closed systems. For the dielectric cavity the correlations propagate as wave fronts through the system.

[1] H. Schanz, Phase-Space Correlations of Chaotic Eigenstates, Phys. Rev. Lett. **94**, 134101 (2005).

DY 29.8 Wed 15:00 P4

Generalizing Quantum Question Equalities: Measurement Order Effects in Cognitive Decision-Making — •Michael Schnabel — Vanderbilt University, Nashville, TN (USA)

The quantum question (QQ) equality, formulated by Wang and Busemeyer [1] provides a non-parametric prediction for the pairwise probabilities of binary questions represented by two non-commutative observables A and B and their associated projection operators P_A and P_B. The QQ equality has played a significant role in the development of the quantum cognition research program as it enabled testing whether the order effects observed in a representative dataset of questionnaires could be represented as quantum interference within a quantum probability framework, providing compelling evidence [2]. Here, I formulate QQ equalities that extend beyond pairwise comparisons and binary outcomes, accommodating situations with $N \geq 3$ questions under the assumption that measurements are represented by idempotent projection operators. These results may be applicable to low-dimensional discrete quantum systems, such as qubits and qtrits, and potentially provide a generalizable framework for understanding order effects in cognitive decision-making across various domains of questionnaire design and experimental psychology. [1] Wang and Busemeyer. *Top.Cogn.Sci.,* 5(4), (2013). [2] Wang, Solloway, Shiffrin, and Busemeyer.*PNAS,* 111(26), (2014).

DY 29.9 Wed 15:00 P4

Subordination approach for derivation of generalized quantum models in non-relativistic and relativistic cases — •Irina Petreska[1], Trifce Sandev[1,2,3], and Alexander Iomin[4,5] — [1]Ss. Cyril and Methodius University in Skopje, Macedonia — [2]Macedonian Academy of Sciences and Arts, Skopje, Macedonia — [3]Korea University, Seoul, Korea — [4]Solid State Institute, Technion, Haifa, Israel — [5]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

The generalized Schrödinger equation and the generalized Klein-Gordon equation are derived by applying the subordination approach to conventional quantum mechanics. The special cases of the fractional Schrödinger equation and the fractional Klein-Gordon equation are adequately introduced. Additionally, the subordination approach is also applied to derive the special case of the generalized Dirac equation for spin 1/2 particles and the directions for future research are discussed. It is evident that according to the subordination approach, the time fractional derivatives in quantum mechanics, including the relativistic one, can be related to the Lévy stable processes in time.

[1] T. Sandev, I. Petreska, A. Iomin, From standard to generalized Schrödinger and Klein-Gordon equations: Subordination approach, *submitted* (2024).