Q 56: Quantum Optics III

Time: Thursday 14:00–16:00 Location: S Ex 04 E-Tech

Group Report Q 56.1 Thu 14:00 S Ex 04 E-Tech

Coupling and interference of individually trapped ions within two-dimensional arrays — Frederick Hackelberg, Philip Kiefer, Matthias Wittemer, Jan-Philip Schöder, Manuel Mielenz, •Daniel Rieländer, Ulrich Warring, and Tobias Schaetz — Physikalisches Insitut, Albert-Ludwigs-Universität Freiburg

Trapped ions are well suited for quantum simulations. We show coupling and interference between Mg-Ions, while traped in electromagnetic potetials and cooled optically to thier motional ground states. By using surface traps and appliying bias potetials to 30 control electrodes we can trap up to three ions in a equidistant triangular shape seperated by $40\mu m$ and control them individually. We show individual control of principal axes and secular frequencies, isolation between the individual traps as well as the coupling between individual ions. We will present planned experiments on phonen tunneling and spin-frustration in the triangular trap at realistic parameters and the related perspective for scaling larger 2D arrays.

Q 56.2 Thu 14:30 S Ex 04 E-Tech

Quantum witness of a damped qubit with generalized measurements — •Manuel Bojer[1], Alexander Friedenberger[1], and Eric Lutz[1,2] — [1]Department of Physics, Friedrich-Alexander-Universität Erlangen-Nürnberg, D-91058 Erlangen, Germany — [2]Institute for Theoretical Physics I, University of Stuttgart, D-70550 Stuttgart, Germany

We evaluate the quantum witness based on the no-signaling-in-time condition of a damped two-level system for nonselective generalized measurements of varying strength. We explicitly compute its dependence on the measurement strength for a generic example. We find a vanishing derivative for weak measurements and an infinite derivative in the limit of projective measurements. The quantum witness is hence mostly insensitive to the strength of the measurement in the weak measurement regime and displays a singular, extremely sensitive dependence for strong measurements. We finally relate this behavior to that of the measurement disturbance defined in terms of the fidelity between pre-measurement and post-measurement states.

Q 56.3 Thu 14:45 S Ex 04 E-Tech

Simulating open quantum systems using quantum Zeno dynamics — •Sabrina Patsch[1], Sabrina Maniscalco[2], and Christiane P. Koch[1] — [1]Theoretical Physics, University of Kassel, Germany — [2]Turku Centre for Quantum Physics, University of Turku, Finland

A watched quantum arrow does not move. This effect, referred to as the quantum Zeno effect, arises from a frequent measurement of a quantum system's state. In more general terms, the evolution of the quantum system can be confined to a subspace of the system's Hilbert space leading to quantum Zeno dynamics. Resulting from the measurement process, a source of dissipation is introduced into the systems dynamics. However, differently from a generic open quantum system, we can choose the strength of the dissipation by changing the parameters of the Zeno measurement.

We capitalise on the property of tunable dissipation to create a quantum simulator for open quantum systems and derive a Lindblad master equation to describe the evolution of the open system. Moreover, we extend the picture to enable also non-Markovian evolution. The considered quantum system are photons inside a cavity being subject to an indirect measurement using circular Rydberg atoms.

Q 56.4 Thu 15:00 S Ex 04 E-Tech

Revealing the nature of a non-equilibrium phase transition with quantum trajectories — •Valentin Link, Kimmo Luoma, and Walter T. Strunz — Technische Universität Dresden, 01069 Dresden, Germanyy

We consider a quantum master equation of Lindblad type, describing a collectively driven and damped ensemble of spins. Upon changing the drive strength, this model features a second order phase transition in the thermodynamic limit, in the sense that the steady state of the master equation undergoes a non-analytic change. The physical properties of both phases can be intuitively understood in a quantum trajectory picture. In fact, for this particular model, the quantum evolution can be mapped to classical noisy trajectories on a sphere. This helps to identify a spontaneously broken symmetry. In addition, the framework allows to account for finite size effects.

Q 56.5 Thu 15:15 S Ex 04 E-Tech

Driven dissipative quantum dynamics in spin coherent state representation — •Konrad Merkel, Valentin Link, and Kimmo Luoma — Technische Universität Dresden, 01069 Dresden, GERMANY

Driven dissipative many body quantum systems are becoming experimentally available but they are demanding to analyze theoretically due to large system size and lack of detailed balance. Typical model systems consist of large numbers of spins coupled to an environment, effectively modeled by a Gorini-Kossakowski-Sudarshan-Lindblad (GKSL) master equation. We investigate the dynamics of such an open quantum system in phase space utilizing spin coherent states. In this representation the complexity of the problem becomes independent of the system size. Moreover, we are able to find parameter regions, where the GKSL master equation is mapped to a proper Fokker-Planck equation with positive diffusion. The problem can then be solved efficiently using stochastic differential equations.

Q 56.6 Thu 15:30 S Ex 04 E-Tech

Universal relaxation dynamics in a disordered Heisenberg spin system — •Titus Franz[1], Adrien Signoles[1,2], Renato Ferracini Alves[1], Martin Gärttner[3], Shannon Whitlock[1,4], Gerhard Zürn[1], and Matthias Weidemüller[1,5] — [1]Physikalisches Institut, Universität Heidelberg, Heidelberg, Germany. — [2]Institut d'Optique, Palaiseau, France — [3]Kirchhof Institut für Physik, Universität Heidelberg, Heidelberg, Germany — [4]IPCMS and ISIS, University of Strasbourg and CNRS, Strasbourg, France — [5]Shanghai Branch, University of Science and Technology of China, Shanghai 201315, China

The macroscopic nature of many-body systems is drastically changed by the presence of disorder in the medium which induces new phases of matter like Spin glasses or Localization. Using a frozen gas of Rydberg atoms, we study how the interplay between quantum fluctuations and disorder changes the far-from equilibrium dynamics of an isolated Heisenberg XXZ spin system. In this work, we can attribute fully coherent dynamics and a drastic deviation from mean-field predictions to the quantum nature of the system, while disorder leads to a non-exponential relaxation of the magnetization towards a randomized state. We found that the system is characterized by a stretched exponential function with a universal stretched exponent of 0.4, independent of the strength of interactions and disorder. This might indicate that slow dynamics described by stretched exponential decay is a generic feature of disordered quantum spin systems hinting towards a unifying effective theory description.

Q 56.7 Thu 15:45 S Ex 04 E-Tech

Localization in spin chains with facilitation constraints and disordered interactions [1] — •Maike Ostmann[1,2], Matteo Marcuzzi[1,2], Juan P. Garrahan[1,2], and Igor Lesanovsky[1,2] — [1]School of Physics and Astronomy, The University of Nottingham, Nottingham, NG7 2RD, United Kingdom — [2]Centre for the Theoretical Physics and Mathematics of Quantum Non-equilibrium Systems, The University of Nottingham

Quantum many-body systems with kinetic constraints exhibit intriguing relaxation dynamics. Recent experimental progress in the field of cold atomic gases offers a handle for probing collective behavior of such systems, in particular for understanding the interplay between constraints and disorder. We explore a spin chain with facilitation kinetic constraints — by which an initial excitation can "seed" the nucleation of an excitation cluster — together with disorder that originates from spin-spin interactions [2,3]. The specific model we study, which is realized in a natural fashion in Rydberg quantum simulators, maps onto an XX-chain with non-local disorder. We characterize the localization properties and find signatures of a crossover between a delocalized and a localized phase. Our study demonstrates a need to consider situations that differ from the standard settings for MBL of local on-site disorder and clean interactions) in order to study possible localization in constrained systems realizable in experiments [3].

[1] M. Ostmann et al., arXiv 1811.01667 (2018), [2] M. Ostmann et al., arXiv 1802.00379 (2018), [3] M. Marcuzzi et al., Phys. Rev. Lett 118, 063606 (2017)