Q 50: Quantum Information (Concepts and Methods) IV

Time: Thursday 14:00–16:00 Location: S HS 001 Chemie

Invited Talk Q 50.1 Thu 14:00 S HS 001 Chemie
Quantum technologies enabled by dissipation — •Hendrik Weimer — Institut für Theoretische Physik, Leibniz Universität Hannover

I will present two examples where adding dissipation channels to a quantum-many body system allows to realize quantum devices that have substantial advantages compared to their purely coherent counterparts. First, I will show how a fundamental understanding of a dissipative phase transition [1] creates the possibility to build a quantum sensor with extraordinary properties [2]. As the second example, I will present a sympathetic cooling scheme for quantum simulators that allows for an efficient preparation of low-energy states of largely arbitrary Hamiltonians. These findings underline that dissipation in quantum systems is not always a nuisance, but is a powerful tool to enable future quantum technologies.

[1] H. Weimer, Phys. Rev. Lett. **114**, 040402 (2015).
[2] M. Raghunandan, J. Wrachtrup, H. Weimer, Phys. Rev. Lett. **120**, 150501 (2018).

Q 50.2 Thu 14:30 S HS 001 Chemie
Noisy quantum states and fidelity of measurement based quantum computation — •Mariami Gachechiladze and Otfried Gühne — University of Siegen

Measurement-based quantum computation (MBQC) is the model of a quantum computation, where a multipartite entangled resource state is prepared in advance and a computation is performed via local measurements on this state. Most conventionally cluster states, subclasses of graph states are used as resource states and then the corresponding MBQC protocols are derived. However, it is not fully understood what makes cluster states or some other specific states useful resources. In addition, very little in known for the cases when there is some noise presented in a resource state.

Given a multipartite entangled noisy quantum state as a resource state, we study its usefulness for MBQC. We connect entanglement properties of these quantum resource states with the optimal fidelities of quantum gates implemented in MBQC model. We characterize entanglement presented in the states, which give better fidelity than the optimal classical protocol would achieve.

Q 50.3 Thu 14:45 S HS 001 Chemie
Quantum steering of an open driven qubit — •Konstantin Beyer, Kimmo Luoma, and Walter Strunz — Technische Universität Dresden, Institut für Theoretische Physik, 01062 Dresden

We investigate quantum steering of an open qubit in the framework of collision models. The qubit and its environment form a bipartite system which is, in general, quantum correlated. Measuring the environment, therefore, yields information about the qubit system. Depending on the measurement scenarios used to observe the environment, the state of the system gets confined to different steering ensembles. This nonlocal phenomenon is known as quantum or EPR steering and can be demonstrated by the violation of a steering inequality.

In contrast to other approaches to open system dynamics, such as master equations, the environment is an inherent part of the collision model. Therefore, it becomes very obvious how the measurements affect the system state.

Q 50.4 Thu 15:00 S HS 001 Chemie
Von Neumann entropy from unitarity — Paul Boes[1], Jens Eisert[1], Rodrigo Gallego[1], Markus P. Mueller[2,3], and •Henrik Wilming[4] — [1]Dahlem Center for Complex Quantum Systems, Freie Universität Berlin, 14195 Berlin, Germany — [2]Institute for Quantum Optics and Quantum Information, Austrian Academy of Sciences, Boltzmanngasse 3, A-1090 Vienna, Austria — [3]Perimeter Institute for Theoretical Physics, Waterloo, ON N2L 2Y5, Canada — [4]Institute for Theoretical Physics, ETH Zurich, 8093 Zurich, Switzerland

The von Neumann entropy is a key quantity in quantum information theory. It quantifies the amount of quantum information contained in a state when many identical and independent i.i.d. copies are available. We provide a new operational characterization of the von Neumann entropy which neither requires an i.i.d. limit nor any explicit randomness. We do so by showing that the von Neumann entropy fully characterizes single-shot state transitions in unitary quantum mechanics, as long as one has access to a suitable ancillary system whose reduced state remains invariant in the transition and an environment which has the effect of dephasing in an arbitrary preferred basis. Furthermore we formulate and provide evidence for the *catalytic entropy conjecture*, which states that the above holds true even in the absence of a decohering environment. If true, it would prove an intimate connection between single-shot state transitions in unitary quantum mechanics and the von Neumann entropy. We also discuss implications of these insights to thermodynamics.

Q 50.5 Thu 15:15 S HS 001 Chemie
Entropic uncertainty relations from quantum designs — •Andreas Ketterer[1,2] and Otfried Gühne[2] — [1]Albert-Ludwigs Universität Freiburg, Freiburg, Germany — [2]Universität Siegen, Siegen, Germany

In recent years there has been a growing interest in entropic uncertainty relations among the quantum information community. This growth is not only due to conceptual reasons, but also to their important role as building blocks in quantum information protocols such as entanglement detection. In this talk we will show how to derive entropic uncertainty relations using the concept of quantum state designs. The key property of designs is that they are indistinguishable from truly random quantum processes as long as one is concerned with moments of some finite order. Exploiting this characteristic enables us to derive bounds on polynomial functions of measurement probabilities, which correspond to sums of generalized entropies.

Q 50.6 Thu 15:30 S HS 001 Chemie
Parametrization and optimization of Gaussian non-Markovian unravelings for open quantum dynamics — Nina Megier[1], Walter T. Strunz[1], Carlos Viviescas[2], and •Kimmo Luoma[1] — [1]Institut für Theoretische Physik, Technische Universität Dresden, D-01062,Dresden, Germany — [2]Departamento de Fisica, Universidad Nacional de Colombia, Carrera 30 No. 45-03, Bogota D.C., Colombia

We derive a family of Gaussian non-Markovian stochastic Schrödinger equations for the dynamics of open quantum systems. The different unravelings correspond to different choices of squeezed co- herent states, reflecting different measurement schemes on the environment. Consequently, we are able to give a single shot measurement interpretation for the stochastic states and microscopic ex- pressions for the noise correlations of the Gaussian process. By construction, the reduced dynamics of the open system does not depend on the squeezing parameters. They determine the non-Hermitian Gaussian correlation, a wide range of which are compatible with the Markov limit. We demonstrate the versatility of our results for quantum information tasks in the non-Markovian regime. In partic- ular, by optimizing the squeezing parameters, we can tailor unravelings for improving entanglement bounds or for environment-assisted entanglement protection.

Q 50.7 Thu 15:45 S HS 001 Chemie
Entanglement Generation in Nonreciprocal Systems — •Nils Buchholz[1], Saeed Khan[2], and Anja Metelmann[1] — [1]Dahlem Center for Complex Quantum Systems and Fachbereich Physik, Freie Universität Berlin, 14195 Berlin, Germany — [2]Department of Electrical Engineering, Princeton University, Princeton, NJ 08544, USA

The general desire to break the symmetry of reciprocity in engineered photonic structures has garnered an immense amount of recent interest, as nonreciprocity is fundamental for the design of optical devices which allow for unidirectional routing of photonic signals. Especially, nonreciprocal microwave-frequency devices are crucial to efforts at quantum-information processing with superconducting circuits.

However, although nonreciprocal concepts are realizable in quantum architectures, nonreciprocity itself holds up to the classical level and is not inherently quantum; the fundamental aspects of nonreciprocity in the quantum regime have yet to be fully investigated. A first question one might ask is, if a nonreciprocal, and therewith as well dissipative, system can generate entanglement between it's constituents? In this talk we will address this question and discuss under which conditions bi-bipartite system can generate entanglement.