Q 49: Quanteninformation: Konzepte und Methoden 5

Time: Thursday 14:00–16:00 Location: V7.01

Q 49.1 Thu 14:00 V7.01

Local decoherence models and the robustness of multipartite quantum entanglement — •Mazhar Ali and Otfried Guehne — Naturwissenschaftlich-Technische Fakultaet, Universitaet Siegen, Walter-Flex-Straße 3, 57068 Siegen, Germany

We study the dynamics of multipartite quantum entanglement under various types of decoherence. In particular, we investigate the robustness of genuine multipartite entanglement of GHZ-type states by exposing each qubit to noise with different rates and also for different noise models. We also ask the question whether GHZ-states mixed with white noise can be dynamically converted to PPT-entangled states. We found that for all well known decoherence processes this is impossible but this possibility can not be ruled out for general processes which maps X-states to X-states. Finally, we compare the robustness of genuine entanglement of Cluster states and Dicke states with these results.

Q 49.2 Thu 14:15 V7.01

A dissipative quantum Church-Turing theorem — •Martin Kliesch[1], Thomas Barthel[1], Christian Gogolin[1], Michael Kastoryano[2], and Jens Eisert[1] — [1]Dahlem Center for Complex Quantum Systems, Freie Universität Berlin, Germany — [2]Niels Bohr Institute, University of Copenhagen, Denmark

We show that the time evolution of an open quantum system, described by a possibly time dependent Liouvillian, can be simulated by a unitary quantum circuit of a size scaling polynomially in the simulation time and the size of the system. An immediate consequence is that dissipative quantum computing is no more powerful than the unitary circuit model. Our result can be seen as a dissipative Church-Turing theorem, since it implies that under natural assumptions, such as weak coupling to an environment, the dynamics of an open quantum system can be simulated efficiently on a quantum computer. Formally, we introduce a Trotter decomposition for Liouvillian dynamics and give explicit error bounds. This constitutes a practical tool for numerical simulations, e.g., using matrix-product operators. We also demonstrate that most quantum states cannot be prepared efficiently.

Q 49.3 Thu 14:30 V7.01

Quasi-locality and efficient simulation of Markovian quantum dynamics — •Thomas Barthel[1,2] and Martin Kliesch[1,2] — [1]Dahlem Center für komplexe Quantensysteme, Freie Universität Berlin, 14195 Berlin — [2]Institut für Physik und Astronomie, Universität Potsdam, 14476 Potsdam

This presentation addresses open many-body systems governed by a time-dependent quantum master equation with short-range interactions. With a generalized Lieb-Robinson bound, we show that the evolution in this very generic framework is *quasi-local*, i.e., the evolution of observables can be approximated by implementing the dynamics only in a vicinity of the observables' support. The precision increases exponentially with the diameter of the considered subsystem. Hence, the time-evolution can be simulated on classical computers with a cost that is independent of the system size. Providing error bounds for Trotter decompositions, we conclude that the simulation on a quantum computer is additionally efficient in time. For experiments and simulations in the Schrödinger picture, the results can be used to rigorously bound finite-size effects. Reference: arXiv:1111.4210.

Q 49.4 Thu 14:45 V7.01

Thermalization under randomized local Hamiltonians — •Marcus Cramer — Institut für Theoretische Physik, Universität Ulm, Germany

Recently, there have been significant new insights concerning conditions under which closed systems equilibrate locally. The question if subsystems thermalize—if the equilibrium state is independent of the initial state—is however much harder to answer in general. Here, we consider a setting in which thermalization can be addressed: A quantum quench under a Hamiltonian whose spectrum is fixed and basis is drawn from the Haar measure. If the Fourier transform of the spectral density is small, almost all bases lead to local equilibration to the thermal state with infinite temperature. This allows us to show that, under almost all Hamiltonians that are unitarily equivalent to a local Hamiltonian, it takes an algebraically small time for subsystems to thermalize.

Q 49.5 Thu 15:00 V7.01

Entanglement dynamics in local many-sided noisy channels — •Michael Siomau and Ali Kamli — Department of Physics, Jazan University, Saudi Arabia

We study entanglement dynamics of pure three- and four-qubit Greenberger-Horne-Zeilinger-type entangled states when one, two or three (four) qubits being subjected simultaneously to general local noise. Employing a lower bound for three-qubit concurrence as an entanglement measure, we show that for some many-sided noisy channels the entanglement dynamics can be completely described by the evolution of the entangled states in single-sided channels.

Q 49.6 Thu 15:15 V7.01

Behavior of Quantum Correlations under Local Noise — •Alexander Streltsov, Hermann Kampermann, and Dagmar Bruss — Heinrich-Heine-Universität Düsseldorf, Institut für Theoretische Physik III, D-40225 Düsseldorf, Germany

We characterize the behavior of quantum correlations under the influence of local noisy channels. Intuition suggests that such noise should be detrimental for quantumness. When considering qubit systems, we show for which channels this is indeed the case: The amount of quantum correlations can only decrease under the action of unital channels. However, nonunital channels (e.g., such as dissipation) can create quantum correlations for some initially classical states. Furthermore, for higher-dimensional systems even unital channels may increase the amount of quantum correlations. Thus, counterintuitively, local decoherence can generate quantum correlations.

Q 49.7 Thu 15:30 V7.01

Characterization of highly efficient up-conversion from 1550 nm to 532 nm — •Christoph Baune[1], Christina E. Vollmer[1], Aiko Samblowski[1], Jaromír Fiurášek[2], and Roman Schnabel[1] — [1]Institut für Gravitationsphysik, Leibniz Universität Hannover and Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Callinstr. 38, 30167 Hannover, Germany — [2]Department of Optics, Palacký University, 17. listopadu 50, 77200 Olomouc, Czech Republic

Highly efficient up-conversion processes play an important role in quantum metrology and quantum information. Under specific conditions the quantum state of the up-converted field is maintained [1] as long as the conversion efficiency is sufficiently large. We report on the efficient conversion of a weak signal field at 1550 nm into a 532 nm field utilizing a strong 810 nm pump field in a doubly resonant optical parametric oscillator. A method for the accurate determination of the efficiency of the sum frequency generation process is presented. Both the conversion efficiency and the signal field depletion are determined simultaneously. With the help of numerical simulations both methods were combined yielding rather small error bars. A conversion efficiency of (84.4 ± 1.5) % was achieved which seems applicable to convert continuous wave squeezed vacuum states from 1550 nm to 532 nm.

[1] Kumar, P. (1990). Quantum frequency conversion. Optics letters, 15(24), 1476-8.

Q 49.8 Thu 15:45 V7.01

Probability amplitudes of two-level atoms beyond the rotating wave approximation: Quantization of Rabi frequency — •Armen Hayrapetyan[1,2] and Stephan Fritzsche[3,4] — [1]Physikalisches Institut, Universität Heidelberg, D-69120 Heidelberg, Germany — [2]Max-Planck-Institut für Kernphysik, Postfach 103980, D-69029 Heidelberg, Germany — [3]Department of Physics, P.O. Box 3000, Fin-90014 University of Oulu, Finland — [4]GSI Helmholtzzentrum für Schwerionenforschung, D-64291 Darmstadt, Germany

The interaction of a two-level atom with a linearly polarized electromagnetic field is examined within the framework of semi-classical theory. Using an invariant approach to the Schrödinger equation, analytical solutions for the probability amplitudes of the atomic states are obtained beyond the typical rotating wave approximation. These solutions are constructed in close resemblance to relativistic quantum theory by making use of the invariant phase of radiation field. In particular, the population inversion is analyzed for the two-level atom

both, within and beyond dipole approximations. It is shown, moreover, that a "quantization" of the Rabi frequency occurs, i.e. a discretization of this coupling strength, when one proceeds beyond rotating wave approximation.