Q 58: Quantum information: Concepts and methods IV

Time: Friday 10:30–12:15 Location: Kinosaal

Q 58.1 Fri 10:30 Kinosaal

Dynamical decoupling with stochastic unitary pulses — •József Zsolt Bernád, Holger Frydrych, and Gernot Alber — Institut für Angewandte Physik, Technische Universität Darmstadt, D-64289 Germany

Dynamical decoupling is a powerful method to increase coherence times of quantum states by applying regular controlled unitary pulses to a quantum system. We propose a stochastic model to describe imperfections in the applied pulses and discuss the impact of this kind of error on different decoupling schemes. In the limit of continuous control we derive a stochastic evolution for the density matrix. In the context of this modified time evolution we discuss the possibilities of protecting the time evolution of a subsystem against the rest of the system. In the case of finite dimensional Hilbert spaces we derive an inequality, which quantifies the relationship between the number of pulses and the effectiveness of the decoupling procedure. We demonstrate our model for both finite and countably infinite dimensional Hilbert spaces and relate to ongoing experimental works.

Q 58.2 Fri 10:45 Kinosaal

Witnessing Entanglement with Random Measurements — •Jochen Szangolies, Hermann Kampermann, and Dagmar Bruss — Institut für Theoretische Physik III, Heinrich-Heine-Universität Düsseldorf, Universitätsstraße 1, D-40225 Düsseldorf

Characterizing entanglement in an unknown quantum state is, in general, a difficult problem. We investigate the possibility of utilizing randomly oriented measurements for the construction of entanglement witnesses. To this end, we carry out numerical simulations quantifying the probability of successfully distinguishing between entangled and separable states. Furthermore, we optimize the witnesses and study the relation between the detectability of a given state and its total amount of entanglement.

Q 58.3 Fri 11:00 Kinosaal

A Partial Derandomization of PhaseLift using Spherical Designs — David Gross[1], Felix Krahmer[2], and •Richard Kueng[1] — [1]Physikalisches Institut, Universität Freiburg, Deutschland — [2]Institut für Numerische und Angewandte Mathematik, Universität Göttingen, Deutschland

The problem of retrieving phase information from amplitudes alone (equivalently: recovering a signal from quadratic measurements) has appeared in many scientific disciplines over the last century.

PhaseLift is a recently introduced algorithm for that task which is computationally efficient, numerically stable, and comes with rigorous performance guarantees. PhaseLift is optimal in the sense that the number of amplitude measurements required for phase reconstruction scales linearly with the dimension of the signal. However, it specifically demands Haar-random measurement vectors — a limitation that restricts practical utility and obscures the specific properties of measurement ensembles that enable phase retrieval.

Here we present a partial derandomization of PhaseLift that only requires sampling from t-designs. Such configurations have been studied extensively in quantum information and are known to serve as a general-purpose tool for de-randomization. Following this philosophy, we prove reconstruction guarantees for a number of measurements that depends on the degree t of the design.

This work is another instance of a fruitful application of quantum information ideas to the mathematical study of data analysis problems.

Q 58.4 Fri 11:15 Kinosaal

Entanglement resources of noisy cluster states — Zhi-Hua Chen[1], Jing-Ling Chen[2], Christopher Eltschka[3], Marcus Huber[4], Zhi-Hao Ma[5], and •Jens Siewert[6] — [1]Zhejiang University of Technology, Hangzhou, P.R. China, and National University of Singapore — [2]Nankai University, Tianjin, P.R. China — [3]University of Regensburg, Germany — [4]Universitá Autónoma de Barcelona, and ICFO Barcelona, Spain — [5]Shanghai Jiaotong University, Shanghai, P.R. China — [6]University of the Basque Country, Bilbao, and Ikerbasque Foundation, Bilbao, Spain

We pose the question of a mathematical characterization for the diverse entanglement resources of multipartite quantum states in the case of linear (and also more general) cluster states. We quantitatively investigate the persistence of these resources for linear clusters of a few qubits under the addition of white noise. We hypothesize what the actual resource for measurement-based quantum computation (MBQC) might be, and we prove that it vanishes at significantly lower noise levels than genuine multipartite entanglement (GME). Technically, we introduce new criteria for GME detection and for the assessment of the MBQC resource.

Q 58.5 Fri 11:30 Kinosaal

Randomized Graph States and their Entanglement Properties — •Jun-Yi Wu[1], Matteo Rossi[2], Hermann Kampermann[1], Leong Chuan Kwek[3], Chiara Macchiavello[2], and Dagmar Bruss[1] — [1]Institut für Theoretische Physik III, Heinrich-Heine-Universität Düsseldorf, D-40225 Düsseldorf, Germany — [2]Dipartimento di Fisica and INFN-Sezione di Pavia, via Bassi 6, 27100 Pavia, Italy — [3]Centre for Quantum Technologies, National University of Singapore, 3 Science Drive 2, Singapore 117543, Singapore

Graph states are a resource for measurement based quantum computation. We consider the situation that the graph state edges are generated by noisy controlled-Z gates, which work ideally with probability p, and operate as the identity map with probability $(1-p)$. The total state after such a generation procedure is a convex combination of subgraph states. We call such mixtures randomized graph states. The randomized graph state obtained from a fully connected graph is the quantum counterpart of a classical random graph. In this work we study the properties of such randomized graph states. We show that randomized graph states are not maximally connected and less persistent than the ideal graph states ($p = 1$). We show that for randomness p greater than a certain critical value p_c, a randomized graph state is genuine multipartite entangled. An upper bound on the critical value p_c can be obtained with the help of a witness operator.

Q 58.6 Fri 11:45 Kinosaal

Locality of temperature — •Martin Kliesch, Christian Gogolin, Michael J. Kastoryano, Arnau Riera, and Jens Eisert — Freie Universität Berlin

This work is concerned with thermal quantum states of Hamiltonians on spin and fermionic lattice systems with short range interactions. We provide results leading to a local definition of temperature, which has been an open problem in the context of nanoscale systems. Technically, we derive a truncation formula for thermal states. The truncation error is exactly given by a generalized covariance. For this covariance we prove exponential clustering of correlations above a universal critical temperature. The proof builds on a percolation argument originally used to approximate thermal states by matrix-product operators. As a corollary we obtain that above a the critical temperature, thermal states are stable against distant Hamiltonian perturbations and we obtain a model independent upper bound on critical temperatures, such as the Curie temperature. Moreover, our results imply that above the critical temperature local expectation values can be approximated efficiently in the error and the system size.

Q 58.7 Fri 12:00 Kinosaal

Entropic approach to quantum correlations — •Rafael Chaves, Lukas Luft, and David Gross — Institute for Physics, University of Freiburg, Rheinstrasse 10, D-79104 Freiburg, Germany

Nonlocality is arguably one of the most fundamental and counterintuitive aspects of quantum theory. Nonlocal correlations could, however, be even more nonlocal than quantum theory allows, while still complying with basic physical principles such as no-signaling. So why is quantum mechanics not as nonlocal as it could be?

Information Causality is an information-theoretic principle that has been introduced aiming to solve that question. It basically states that if Alice communicates m bits to Bob, the total information access that Bob gains to her data is not greater than m.

In this work we show that Information Causality naturally follows from the entropic framework to non-locality. For instance, Information Causality defines the only non-trivial facet of the entropic cone of classical correlations. This result suggests that the entropic approach could be useful as an automatized machinery to derive information-theoretic principle for quantum correlations.