Q 31: Quanteninformation: Konzepte und Methoden 4

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

Q 31.1 Tue 14:00 V7.01

Optimal generalized variance and quantum Fisher information — •Géza Tóth[2,3,4] and Dénes Petz[1] — [1]Theoretical Physics, The University of the Basque Country, E-48080 Bilbao, Spain — [2]IKERBASQUE, Basque Foundation for Science, E-48011 Bilbao, Spain — [3]Research Institute for Solid State Physics and Optics, H-1525 Budapest, Hungary — [4]Alfréd Rényi Institute of Mathematics, Reáltanoda utca 13-15, H-1051 Budapest, Hungary

We define the generalized variance based on requiring that (i) it equals the usual variance for pure states and (ii) it is concave. For a quantum system of any size, we show that the usual variance is the smallest generalized variance, which makes it optimal for using it in entanglement criteria based on uncertainty relations. Similarly, we define the generalized quantum Fisher information, replacing the requirement of concavity by convexity. For rank-2 density matrices, we show that the quantum Fisher information is the largest among generalized quantum Fisher informations. We relate our findings to the results of [D. Petz, J. Phys. A: Math. Gen. 35, 79 (2003); P. Gibilisco, F. Hiai and D. Petz, IEEE Trans. Inform. Theory 55, 439 (2009)].

Q 31.2 Tue 14:15 V7.01

Mapping the spatial distribution of entanglement in optical lattices — Emilio Alba[1], •Géza Tóth[2,3,4], and Juan José García-Ripoll[1] — [1]Instituto de Física Fundamental, CSIC, Calle Serrano 113b, Madrid E-28006, Spain — [2]Theoretical Physics, The University of the Basque Country, E-48080 Bilbao, Spain — [3]IKERBASQUE, Basque Foundation for Science, E-48011 Bilbao, Spain — [4]Research Institute for Solid State Physics and Optics, H-1525 Budapest, Hungary

We study the entangled states that can be generated using two species of atoms trapped in independently movable, two-dimensional optical lattices. We show that using two sets of measurements it is possible to measure a set of entanglement witness operators distributed over arbitrarily large regions of the lattice, and use these witnesses to produce two-dimensional plots of the entanglement content of these states. We also discuss the influence of noise on the states and on the witnesses, as well as connections to ongoing experiments.

[1] E. Alba, G. Tóth, and J.J. García-Ripoll, Phys. Rev. A 82, 062321 (2010).

Q 31.3 Tue 14:30 V7.01

How the dynamics of a continuous quantum field can be encoded by discrete ensembles — •Zoltan Kadar, Michael Keyl, and Zoltan Zimboras — Quantum Information Unit, ISI Foundation, Torino, Italy

Many spins can collectively couple to a continuous quantum field such that the ensemble approximate the state of the field well. Is this approximation also preserved during the time evolution? The answer largely depends on the state of the ensemble and is already challenging for quadratic Hamiltonians. The key is to use the appropriate collective quantities, the fluctuator operators (familiar from mean field theory) and the good limiting procedure. Important applications are light-matter interface experiments, which are used to implement a type of quantum memory.

Q 31.4 Tue 14:45 V7.01

Uncertainty relations and the Wehrl entropy — •Kedar S. Ranade and Wolfgang P. Schleich — Institut für Quantenphysik, Universität Ulm

In 1979, A. Wehrl introduced the concept of classical entropies of a quantum state and demonstrated several properties of these entropies. In this talk, we investigate generalisations of the Wehrl entropy with respect to quantum-mechanical uncertainty relations for systems with continuous variables. In important cases, the relevant quantities can be measured with standard techniques from quantum optics.

Q 31.5 Tue 15:00 V7.01

Spin squeezing and entanglement in systems of spin-j particles — •Giuseppe Vitagliano[1], Philipp Hyllus[1], Iñigo Egusquiza[1], and Géza Tóth[1,2,3] — [1]Theoretical Physics, The University of the Basque Country, E-48080 Bilbao, Spain — [2]IKERBASQUE, Basque Foundation for Science, E-48011 Bilbao, Spain — [3]Research Institute for Solid State Physics and Optics, H-1525 Budapest, Hungary

We discuss the problem of finding inequalities useful to detect entanglement in systems of particles with a spin higher than $\frac{1}{2}$ [1]. We focus on uncertainty relations based on the knowledge of the first two moments of the total spin components J_i. We compare the various inequalities obtained from the point of view of their usefulness to detect entanglement by characterizing the experimental effort needed and by studying the states that violate them.

[1] G. Vitagliano, P. Hyllus, I.L. Egusquiza, and G. Tóth, Phys. Rev. Lett. 107, 240502 (2011).

Q 31.6 Tue 15:15 V7.01

Asymptotic Evolution of Quantum Markov Chains — •Jaroslav Novotny[1] and Gernot Alber[2] — [1]FNSPE, CTU in Prague, 115 19 Praha 1 - Stare Mesto, Czech Republic — [2]Institut für Angewandte Physik, Technische Universität Darmstadt, D-64289 Darmstadt, Germany

The iterated quantum operations, so called quantum Markov chains, play an important role in various branches of physics. They constitute basis for many discrete models capable to explore fundamental physical problems, such as the approach to thermal equilibrium, or the asymptotic dynamics of macroscopic physical systems far from thermal equilibrium. On the other hand, in the more applied area of quantum technology they also describe general characteristic properties of quantum networks or they can desribe different quantum protocols in the presence of decoherence.

A particularly, an interesting aspect of these quantum Markov chains is their asymptotic dynamics and its characteristic features. We demonstrate there is always a vector subspace (typically low-dimensional) of so-called attractors on which the resulting superoperator governing the iterative time evolution of quantum states can be diagonalized and in which the asymptotic quantum dynamics takes place. As the main result interesting algebraic relations are presented for this set of attractors which allow to specify their dual basis and to determine them in a convenient way. Based on this general theory we show some generalizations concerning the theory of fixed points or asymptotic evolution of random quantum operations.

Q 31.7 Tue 15:30 V7.01

Equilibration and thermalization in closed quantum systems — •Christian Gogolin, Arnau Riera, and Jens Eisert — Dahlem Center for Complex Quantum Systems, Freie Universitat Berlin, 14195 Berlin, Germany

Why and how do closed macroscopic systems equilibrate and thermalize? How can we justify the methods of thermodynamics and statistical mechanics from the microscopic theory of quantum mechanics? How can one prepare thermal states in quantum simulators? Which mechanisms lead to the emergence of classical, statistical behavior and decoherence? We show how methods from quantum information theory can help to attack such questions, which are fundamental on the one hand, but which have recently gained new relevance in the light of experiments with ultra cold atoms and ions in optical latices.

Q 31.8 Tue 15:45 V7.01

Optimal teleportation with a noisy source — •Bruno G. Taketani[1,3], Fernando de Melo[2,3], and Ruynet L. de Matos Filho[1] — [1]Instituto de Física, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil — [2]Instituut voor Theoretische Fysica, Katholieke Universiteit Leuven, Leuven, Belgie — [3]Physikalisches Institut der Albert-Ludwigs-Universität, Freiburg, Deutschland

In this work we discuss the role of decoherence in quantum information protocols. Particularly, we study quantum teleportation in the realistic situation where not only the transmission channel is imperfect, but also the preparation of the state to be teleported. The optimal protocol to be applied in this situation is found and we show that taking into account the input state noise leads to sizable gains in teleportation fidelity. It is then evident that sources of noise in the input state preparation must be taken into consideration in order to maximize the teleportation fidelity. The optimization of the protocol can be defined for specific experimental realizations and accessible operations, giving a trade-off between protocol quality and experiment complexity.