Q 35: Quantum Information: Concepts and Methods V

Time: Wednesday 11:00–13:00 Location: K/HS1

Q 35.1 Wed 11:00 K/HS1

Minimal Experimental Multipartite Entanglement Detection — •Lukas Knips[1,2], Christian Schwemmer[1,2], Nico Klein[1,2], Marcin Wieśniak[3], and Harald Weinfurter[1,2] — [1]Department für Physik, LMU, D-80797 München — [2]MPI für Quantenoptik, D-85748 Garching — [3]Institute of Theoretical Physics and Astrophysics, University of Gdańsk, PL-80-952 Gdańsk, Poland

Certifying entanglement in a multipartite state is a demanding task. As a state of N qubits is parametrized by $4^N - 1$ real numbers, one may expect that the measurement complexity of generic entanglement detection is also exponential with N. However, in special cases we can design indicators for genuine multipartite quantum entanglement using measurements in only two settings. We describe the general method of deriving such criteria, which are based on a more general entanglement criterion [1] using correlation measurements. In the experiment we test two such non-linear witnesses, one constructed for four-qubit GHZ states, the other for Cluster states $|C_4\rangle$.

[1] P. Badziąg et al., *PRL* **100**, 140403 (2008).

Q 35.2 Wed 11:15 K/HS1

Joint measurability of generalized measurements implies classicality — •Roope Uola, Tobias Moroder, and Otfried Gühne — Naturwissenschaftlich-Technische Fakultät, Universität Siegen, Walter-Flex-Str. 3, 57068 Siegen, Germany

In this talk I will give an introduction to joint measurements of quantum observables and to steering of quantum states. Moreover, I will discuss the main result of the article "Joint measurability of generalized measurements implies classicality" (Phys. Rev. Lett. 113, 160403), which shows an equivalence between joint measurements and steering.

Q 35.3 Wed 11:30 K/HS1

Detecting the Range of Entanglement — •Sabine Wölk and Otfried Gühne — University of Siegen, Siegen, Germany

Entanglement is an important resource for quantum information. Investigation tools to investigate and certify entanglement are necessary to profit from entanglement. However, the evolution of quantum systems does not only depend on the amount of entanglement but also on how many particles are entangled and how far apart the entangled particles are. Especially for systems where addressing of single particles is not possible, investigation tools are missing.

In this talk we will introduce methods to investigate the range of entanglement with the help of global operators such as the Hamilton operator and the total spin. We will concentrate on the investigation of spin-chains described by the Heisenberg model with only nearest-neighbor coupling as well as next-nearest neighbor coupling. Such models are important to understand and explain magnetic phenomena in solid states such as phase transitions and spontaneous magnetization.

Q 35.4 Wed 11:45 K/HS1

Separable reduced states can imply genuine multiparticle entanglement. — •Nikolai Miklin, Tobias Moroder, and Otfried Gühne — University of Siegen, Siegen, Germany

The diversity of quantum states increases with the number of particles. However, most of the interesting examples of multiparticle entangled states are classes of pure states, while mixed states are less characterized. In the present talk, we describe a class of genuine multiparticle entangled mixed states with separable marginals, but where the entanglement could be detected by looking on correlations of these marginals only. First evidence for such states was recently reported by L. Chen et al. [Phys. Rev. A 90, 042314 (2014)], but we propose a more systematic approach of finding examples of such states using semidefinite programming. Our approach enables one to find examples of these states for more than three-qubit systems and can also be used, if not all marginals are known.

Q 35.5 Wed 12:00 K/HS1

Evaluation of convex roof entanglement measures — •Géza Tóth[1,2,3], Tobias Moroder[4], and Otfried Gühne[4] — [1]Theoretical Physics, University of the Basque Country UPV/EHU, E-48080 Bilbao, Spain — [2]IKERBASQUE, Basque Foundation for Science, E-48011 Bilbao, Spain — [3]Wigner Research Centre for Physics, H-1525 Budapest, Hungary — [4]Institut für Quantenoptik, Leibniz Universität Hannover, Welfengarten 1, D-30167 Hannover, Germany

We show a powerful method to compute entanglement measures based on convex roof constructions. In particular, our method is applicable to measures that, for pure states, can be written as low order polynomials of operator expectation values. We show how to compute the linear entropy of entanglement, the linear entanglement of assistance, and a bound on the dimension of the entanglement for bipartite systems. We discuss how to obtain the convex roof of the three-tangle for three-qubit states. We also show how to calculate the linear entropy of entanglement and the quantum Fisher information based on partial information or device independent information. We demonstrate the usefulness of our method by concrete examples

Q 35.6 Wed 12:15 K/HS1

Necessary and sufficient conditions for state-independent contextuality — •Costantino Budroni[1], Adan Cabello[2], and Matthias Kleinmann[3] — [1]Naturwissenschaftlich-Technische Fakultät, Universität Siegen, Walter-Flex-Str. 3, D-57068 Siegen, Germany — [2]Departamento de Física Aplicada II, Universidad de Sevilla, E-41012 Sevilla, Spain — [3]Department of Theoretical Physics, University of the Basque Country UPV/EHU, P.O. Box 644, E-48080 Bilbao, Spain

We review a recent proposal of necessary and sufficient conditions for state-independent contextuality (SIC) based on Linear Programming [1]. We show that such an approach fails to exclude many invalid scenarios, and thus it gives only necessary conditions.

We present a general solution of the problem, i.e., necessary and sufficient conditions for SIC, based on semidefinite programming, and discuss its relation with previous results. Moreover, we prove Yu and Oh's conjecture [2] on the simplest state-independent contextuality scenario

[1] R. Ramanathan and P. Horodecki, Phys. Rev. Lett. **112**, 040404 (2014).

[2] S. Yu and C. H. Oh, Phys. Rev. Lett. **108**, 030402 (2012).

Q 35.7 Wed 12:30 K/HS1

Quantum contextuality in d-dimensional systems — •Ali Asadian, Costantino Burdoni, Frank Steinhoff, and Otfried Guehne — Walter-Flex-Straße 3, Siegen, Germany

In a recent work, we proposed a new protocol for performing fundamental tests of quantum mechanics with massive objects. In this approach a single two-level system is used to probe the motion of a mechanical oscillator via multiple Ramsey interference measurements. This scheme enables the measurement of modular variables of macroscopic continuous variable systems and the correlations thereof. Furthermore, we present a general framework based on Weyl-Heisenberg groups for probing quantum contextuality in d-dimensional systems extending to the continuous limit. Experimental implementations of our analysis using the above-mentioned scheme are also discussed.

Q 35.8 Wed 12:45 K/HS1

Observables and the structure of entanglement for discrete and continuous-variable systems — •Kedar S. Ranade — Institut für Quantenphysik, Universität Ulm

The concept of entanglement as a resource in quantum information processing is related to the accessible observables in a physical system. This is manifested by the fact that in finite-dimensional systems the amount of entanglement may be changed arbitrarily by tailoring the observables [1]. Such concepts can be extended to continuous-variable systems, which are most conveniently described by Wigner functions [2]. Here we show that the amount of entanglement in continuous-variable systems can change with respect to various systems of observables and how this change can be understood. We also present some examples of how this may appear in physical situations.

[1] N. L. Harshman, K. S. Ranade, Phys. Rev. A **84** (2011), 012303

[2] N. Grimmer, Bachelor thesis (2014)