Q 13: Quantum information: Concepts and methods I

Time: Monday 14:00–16:00 Location: E 214

Q 13.1 Mon 14:00 E 214

Effective theories from missing information — •Cedric Beny and Tobias Osborne — Leibniz Universität Hannover

Our ability to probe the real worlds is always limited by experimental constraints such as the precision of our instruments, or our inability to fully control a system's environment. It is remarkable that the resulting imperfect data nevertheless contains strong regularities which can be understood in terms of effective laws.

I will present recent results towards the development of systematic methods to define such effective theories using tools from quantum information theory. In particular, I will examine decoherence and renormalization as phenomena giving rise to a classical effective field theory from a quantum theory.

Q 13.2 Mon 14:15 E 214

Bell inequalities from variable elimination methods — •Costantino Budroni[1] and Adan Cabello[2] — [1]Naturwissenschaftlich-Technische Fakultät, Universität Siegen, D-57068 Siegen,Germany — [2]Departamento de Física Aplicada II, Universidad de Sevilla, E-41012 Sevilla, Spain

Complete sets of tight Bell inequalities are necessary and sufficient conditions for the existence of local hidden variable models describing a given measurement scenario. They are facets of Pitowsky's correlation polytope and are usually obtained from its extreme points by solving the hull problem. While there are algorithms that find all the facets of a given correlation polytope, the time required to compute them grows exponentially as the number of settings increases. This method has therefore been applied only to simple cases with a reduced number of settings.

In this talk an alternative method based on a combination of algebraic results on extensions of measures and variable elimination methods, e.g., the Fourier-Motzkin method, will be presented. Non-trivial cases where our method overcomes some of the computational difficulties associated with the hull problem will be discussed.

Q 13.3 Mon 14:30 E 214

Non-linear genuine multiparty entanglement witness and its application to graph states — •Junyi Wu[1], Hermann Kampermann[1], Dagmar Bruss[1], Claude Klockl[2], and Marcus Huber[3] — [1]Institute for Theoretical Physics III, Heinrich-Heine-University Dusseldorf, D-40225 Dusseldorf, Germany — [2]University of Vienna, Faculty of Mathematics, Nordbergstrae 15, 1090 Wien, Austria — [3]University of Bristol, Department of Mathematics, Bristol, BS8 1TW, U.K.

In [1] we introduced a general non-linear witness by lower bounding a genuine multipartite entanglement (GME) measure. The witness is experimentally efficient to implement since only a few off-diagonal and diagonal density operator elements are needed. However, its detection capabilities are basis dependent. Because it is not straightforward to construct an optimal non-linear GME-witness for a given target state, we develop techniques to construct an optimal non-linear GME-witness, and investigate its application to graph states with noise.

[1] Jun-Yi Wu, Hermann Kampermann, Dagmar Bruß, Claude Klockl, and Marcus Huber. Phys. Rev. A, 86:022319, Aug 2012.

Q 13.4 Mon 14:45 E 214

Extremal properties of the variance and the quantum Fisher information — •Géza Tóth[1,2,3] and Dénes Petz[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]Alfréd Rényi Institute of Mathematics, Reáltanoda utca 13-15, H-1051 Budapest, Hungary

We show that the variance is its own concave roof. For rank-2 density matrices and operators with zero diagonal elements in the eigenbasis of the density matrix, we show analytically that the quantum Fisher information is 4 times the convex roof of the variance. Strong numerical evidence suggests that the quantum Fisher information is very close to the convex roof even for operators with nonzero diagonal elements or density matrices with a rank larger than 2. Hence, we conjecture that the quantum Fisher information is 4 times the convex roof of the variance even for the general case.

Q 13.5 Mon 15:00 E 214

Quantitative two-qutrit entanglement — Christopher Eltschka[1] and •Jens Siewert[2,3] — [1]Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany — [2]Departamento de Química Física, Universidad del País Vasco UPV/EHU, 48080 Bilbao, Spain — [3]IKERBASQUE, Basque Foundation for Science, 48011 Bilbao, Spain

We introduce the new concept of axisymmetric bipartite states. For $d \times d$-dimensional systems these states form a two-parameter family of nontrivial mixed states that include the isotropic states. We present exact quantitative results for class-specific entanglement as well as for the negativity and I-concurrence of two-qutrit axisymmetric states. These results have interesting applications such as for quantitative witnesses [1] of class-specific entanglement in arbitrary two-qutrit states and as device-independent witness for the number of entangled dimensions.

[1] C. Eltschka and J. Siewert, Sci. Rep. **2**, 942 (2012).

Q 13.6 Mon 15:15 E 214

Wick's theorem for matrix product states — •Robert Hübener[1], Andrea Mari[1,2,3], and Jens Eisert[1] — [1]Freie Universität Berlin — [2]Universität Potsdam — [3]Consiglio Nazionale delle Ricerche Pisa

Matrix product states and their continuous analogues are variational classes of states that capture quantum many-body systems or quantum fields with low entanglement; they are at the basis of the density-matrix renormalization group method and continuous variants thereof. In this talk we show that, generically, N-point functions of arbitrary operators in discrete and continuous translation invariant matrix product states are completely characterized by the corresponding two- and three-point functions. Aside from having important consequences for the structure of correlations in quantum states with low entanglement, this result provides a new way of reconstructing unknown states from correlation measurements e.g. for one-dimensional continuous systems of cold atoms. We argue that such a relation of correlation functions may help in devising perturbative approaches to interacting theories.

Q 13.7 Mon 15:30 E 214

Multiparticle negativity - a computable entanglement monotone for mixed states — •Martin Hofmann, Tobias Moroder, and Otfried Gühne — Naturwissenschaftlich-Technische Fakultät, Universität Siegen, Walter-Flex-Straße 3, 57068 Siegen, Germany

The detection of genuine multiparticle entanglement in composite systems of three or more particles is a challenging task and many results known so far, can be applied to pure states only.

One way to detect entanglement of multiparticle mixed states is given in [1]. The main idea of the authors is to try to decompose a mixed state into a convex combination of PPT states. If this can not be done for the state in question, then it is clearly genuine multiparticle entangled and there exists an entanglement witness detecting the state. This idea then finally leads to a computable entanglement monotone, which is based on semidefinite programing.

In our work we analytically investigate monogamy relations for this entanglement monotone. Additionally, we relate the monotone to a mixed state convex roof of the negativity.

[1] B. Jungnitsch *et al.*, Phys. Rev. Lett. **106**, 190502 (2011)

Q 13.8 Mon 15:45 E 214

SL-invariant measures in higher local dimensions — •Andreas Osterloh — Theoretische Physik (AG Schützhold), Universität Duisburg-Essen, Lotharstrasse 1, 47048 Duisburg, Germany.

We write the SL-invariant operator, the determinant, in terms of antilinear expectation values of the local $SL(d,\mathbb{C})$, thereby extending the mechanism for qubits to qudits. We outline the method on spin 1, and spin 3/2 explicitely, and generalize the method to higher spin. There is an odd-even discrepancy: whereas for half odd integer spin a situation similar to that observed in qubits is observed, for integer spin the outcome is an asymmetric invariant of doubled polynomial degree. The corresponding conditions for genuinely entangled spins carry over directly from the qubit case.