Q 37: Quantum Information: Concepts and Methods VI

Time: Wednesday 14:30–16:30 Location: e214

Q 37.1 Wed 14:30 e214

Topological entanglement entropy and the Jones-Kosaki-Longo index — •Leander Fiedler[1] and Pieter Naaijkens[2,3] — [1]Institut für Theoretische Physik, Leibniz Universität Hannover, Germany — [2]Department of Mathematics, University of California, Davis, USA — [3]Institute for Quantum Computing, RWTH Aachen, Germany

In the thermodynamic limit of quantum spin systems with anyonic charge content a characteristic quantity is the Jones-Kosaki-Longo index. This index was derived from the algebraic properties of the theory and is equal to the quantum dimension of the anyonic model. We show how it relates to the topological entanglement entropy derived for finitely many particles and thereby provide an operational interpretation in terms of a data hiding task.

Q 37.2 Wed 14:45 e214

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]Naturwissenschaftlich-Technische Fakultät, Universität Siegen, Walter-Flex-Straße 3, 57068 Siegen, Germany, 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 and the convex roof of the three-tangle for three-qubit states, and several other useful quantities. Our method is based on showing that the quantities above can be defined as a result of an optimisation over the set of symmetric separable states. This implies that calculating certain entanglement measures based on convex roofs is essentially as difficult as identifying separable states in symmetric systems.

Q 37.3 Wed 15:00 e214

Upper bound for SL-invariant entanglement measures for mixed states of arbitrary rank — •Andreas Osterloh — Universität Duisburg-Essen, Lotharstr. 1, 47048 Duisburg, Germany.

I present an alternative algorithm to ref. [1], exploiting the knowledge obtained for the rank-two case. Whereas the known algorithm has an advantage of taking into consideration the whole range of the density matrix ρ, it on the other hand has the disadvantage of searching in a high-dimensional Hilbert space: imagine the states $|\psi_i\rangle$, where $E[|\psi_i\rangle]$ vanishes; the algorithm then calculates the distance to the baricenter of them as an upper bound of E, which comes with a disadvantage, of course.

Here, I only consider rank two states but calculate the upper bound obtained by the method presented in [2,3]. I discuss examples where the advantage of the new algorithm is obvious, but also highlight on the obvious disadvantage of only considering rank two parts of ρ.

[1] S. Rodriques, N. Datta, and P. Love, Phys. Rev. A **90**, 012340 (2014).

[2] R. Lohmayer, A. Osterloh, J. Siewert, and A. Uhlmann, Phys. Rev. Lett. **97**, 260502 (2006).

[3] A. Osterloh, J. Siewert, and A. Uhlmann, Phys. Rev. A **77**, 032310 (2008).

Q 37.4 Wed 15:15 e214

The nine ways of four qubit entanglement and their threetangle — •Andreas Osterloh — Universität Duisburg-Essen, Lotharstr. 1, 47048 Duisburg, Germany.

The mixed threetangle for the nine four qubit representant states found in Phys. Rev. A **65**, 052112 (2002) is calculated. The convex roof is found exactly in seven out of nine classes. In two classes an upper bound for the threetangle is found, where I have strong evidence that it is at least not far away from the convex roof. We compare our results with the findings of Phys. Rev. Lett. **113**, 110501 (2014).

Q 37.5 Wed 15:30 e214

Optimal detection of useful quantum entanglement with few expectation values — •Iagoba Apellaniz[1], Matthias Kleinmann[1], Otfried Ghüne[2], and Géza Tóth[1,3,4] — [1]Department of Theoretical Physics, University of the Basque Country, Bilbao, Spain — [2]Naturwissenschaftlich-Technische Fakultät, Universität Siegen, Siegen, Germany — [3]IKERBASQUE, Basque Foundation for Science, Bilbao, Spain — [4]Wigner Research Center for Physics, Hungarian Academy of Sciences, Budapest, Hungary.

In this work we show an optimal lower bound for the quantum Fisher information (qFI), $\mathcal{F}_Q[\varrho, J_z]$, for a given set of expectation values of the initial state, $\{w_i = \mathrm{tr}(\varrho \hat{\mathrm{W}}_\mathrm{i})\}_{\mathrm{i}=1}^{\mathrm{M}}$.

It is well known that a complete state tomography of an increasing number of particles becomes unfeasible. Therefore, different simplifying techniques have been developed recently in order to evaluate the qFI based on few expectation values of the initial state [1,2].

We apply our method to the results of various multi-particle quantum states prepared in experiments with photons and trapped ions. We also verify with our method the saturability of the archetypical lower bound for spin squeezed states [3].

[1] Z. Zang and L. M. Duan, New J. Phys. **16** 103037, (2014).

[2] F. Fröwis *et al.*, arxiv: 1509.0333, (2015).

[3] L. Pezzé and A. Smerzi, Phys. Rev. Lett. **102** 100401, (2009).

Q 37.6 Wed 15:45 e214

Quantifying entanglement of two-qutrit states with positive partial transpose — Christopher Eltschka[1], •Gaél Sentís[2], and Jens Siewert[2,3] — [1]University of Regensburg, Regensburg, Germany — [2]University of the Basque Country UPV/EHU, Bilbao, Spain — [3]Ikerbasque, Basque Foundation for Science

A bipartite system with local dimensions $d \geqq 3$ may be in an entangled state albeit its partially transposed density matrix has only nonnegative eigenvalues. Such PPT-entangled states constitute a subject of continued interest in quantum information since, e.g., no singlet entanglement can be distilled from them. As PPT-entangled states in general are highly mixed the quantification of their entanglement in terms of established entanglement measures has remained an open question. In this contribution we present a family of highly symmetric two-qutrit states which contains regions with PPT entanglement. We discuss the possibility of exact quantification of the entanglement by using concurrence-based entanglement monotones.

Q 37.7 Wed 16:00 e214

Anticoherence and entanglement of spin states — •John Martin[1], Dorian Baguette[1], François Damanet[1], Thierry Bastin[1], and Olivier Giraud[2] — [1]Institut de Physique Nucléaire, Atomique et de Spectroscopie, Université de Liège, 4000 Liège, Belgium — [2]LPTMS, CNRS, Univ. Paris-Sud, Université Paris-Saclay, 91405 Orsay, France

We investigate multiqubit permutation-symmetric states with maximally mixed reduced density matrices in the symmetric subspace [1]. Such states can be viewed as particular spin states, namely anticoherent spin states [2]. Using the Majorana representation of spin states in terms of points on the unit sphere [3], we analyze the consequences of degeneracies of the Majorana points and of a point-group symmetry in their arrangement on the existence of anticoherent spin states. We provide different characterizations of anticoherence and establish a link between point symmetries, anticoherence, and SLOCC classes [4]. We consider in detail the case of small numbers of qubits and solve the 4-qubit case completely by identifying and characterizing all 4-qubit anticoherent states.

[1] D. Baguette, T. Bastin, and J. Martin, Phys. Rev. A **90**, 032314 (2014); O. Giraud *et al.*, Phys. Rev. Lett. **114**, 080401 (2015); D. Baguette *et al.*, Phys. Rev. A **92**, 052333 (2015).

[2] J. Zimba, Electron. J. Theor. Phys. **3**, 143 (2006).

[3] E. Majorana, Nuovo Cimento **9**, 43 (1932).

[4] SLOCC classes : Classes of states equivalent through stochastic local operations with classical communication.

Q 37.8 Wed 16:15 e214

Proving multipartite entanglement from separable marginals — •Marius Paraschiv, Nikolai Miklin, Tobias Moroder, and Otfried Gühne — Universität Siegen Department Physik Emmy-Noether-Campus Walter-Flex-Straße 3 57068 Siegen Germany

We address here the question of whether or not global entanglement of a quantum state can be inferred from local properties. Specifically, we are interested in genuinely entangled multipartite states whose two-body marginals are separable. Due to the fact that any biseparable state is also a PPT mixture, we can focus only on the class of fully decomposable entanglement witnesses. This type of witness is positive for all PPT mixtures. The problem thus formulated naturally falls within the field of semidefinite programming (SDP). By running an iteration over two different SDPs, one for the global quantum state with PPT two-body marginals, the other for the witness, fully decomposable and restricted to two-body interactions, we have found states that obey the above requirements for up to 6 qubits. We present an analytical construction of such states for an arbitrary number of particles.