Q 34: Quanteninformation: Konzepte IV

Zeit: Mittwoch 14:00–15:45 Raum: VMP 6 HS-D

Q 34.1 Mi 14:00 VMP 6 HS-D

Classification of qubit entanglement: $SL(2)$ versus $SU(2)$ invariance — •Andreas Osterloh — Institut für theoretische Physik, Leibniz Universität Hannover, Appelstrasse 2, 30167 Hannover.

The role of $SU(2)$ invariants for the classification of multiparty entanglement is discussed and exemplified for the Kempe invariant I_5 of pure three-qubit states. It is found to being an independent invariant only in presence of both W-type entanglement and threetangle. In this case, constant I_5 admits for a wide range of both threetangle and concurrences. Furthermore, the present analysis indicates that an $SL^{\otimes 3}$ orbit of states with equal tangles but continuously varying I_5 must exist. This means that I_5 provides no information on the entanglement in the system in addition to that contained in the tangles (concurrences and threetangle) themselves. Together with the numerical evidence that I_5 is an entanglement monotone this implies that $SU(2)$ invariance or the monotone property are too weak requirements for the characterization and quantification of entanglement for systems of three qubits, and that $SL(2,\mathbb{C})$ invariance is required. This conclusion can be extended to general multipartite systems (including higher local dimension) because the entanglement classes of three-qubit systems appear as subclasses.

Q 34.2 Mi 14:15 VMP 6 HS-D

Entanglement and permutational symmetry — •Géza Tóth[1,2,3] and Otfried Gühne[4,5] — [1]Física Teórica, Universidad del País Vasco, Apdo. 644, E-48080 Bilbao — [2]Ikerbasque-Basque Foundation for Science, E-48011 Bilbao — [3]Research Institute for Solid State Physics and Optics, Hungarian Academy of Sciences, H-1525 Budapest — [4]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, A-6020 Innsbruck — [5]Institut für Theoretische Physik, Universität Innsbruck, A-6020 Innsbruck

We study entanglement and separability for permutationally symmetric quantum states. We show that for bipartite symmetric systems the most relevant entanglement criteria coincide. However, we provide a method to generate examples of bound entangled states in symmetric systems, for the bipartite and the multipartite case. These states shed some new light on the nature of bound entanglement.

Q 34.3 Mi 14:30 VMP 6 HS-D

Entanglement properties of Werner-like three-qubit states — •Christopher Eltschka and Jens Siewert — Institut für theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany

We analyse the entanglement properties of the Werner-like three-qubit states of the form $\rho(p) = p\,|\mathrm{GHZ}\rangle\langle\mathrm{GHZ}| + (1-p)\rho_{\mathrm{mixed}}$, where $|\mathrm{GHZ}\rangle = (|000\rangle + |111\rangle)/\sqrt{2}$ is the three-qubit GHZ state, and ρ_{mixed} is the completely mixed three-qubit state. Using geometrical considerations in the space of density matrices, we estimate the maximal value of p for which the three-tangle vanishes, i.e. the maximal p for which $\rho(p)$ describes a W-class state. We give an optimal decomposition for that state, and from that try to derive an optimal GHZ\W witness.

Q 34.4 Mi 14:45 VMP 6 HS-D

Non-local structure, adjoint orbits, and efficient implementations of unitary transformations in three-qubit systems — •Robert Zeier — Department Chemie, Technische Universität München, Lichtenbergstrasse 4, 85747 Garching, Germany

We analyze the non-local structure of unitary transformations in three-qubit systems. Computing integral cohomology groups we gain insight into the algebraic structure of cosets with respect to local operations. We employ this information in our analysis of adjoint orbits. We discuss applications to efficient implementations of unitary transformations.

Q 34.5 Mi 15:00 VMP 6 HS-D

Characterizing entanglement with geometric entanglement witnesses — •Philipp Krammer — Fakultät für Physik, Universität Wien, A-1090 Vienna, Austria — Institut für Theoretische Physik III, Heinrich-Heine-Universität Düsseldorf, D-40225 Düsseldorf, Germany

A challenge in quantum information theory is the detection of entangled states on a finite dimensional Hilbert space. Useful tools for this purpose are entanglement witnesses; they provide a geometrically intuitive method to detect entanglement.

We show how to detect entangled, bound entangled, and separable bipartite quantum states of arbitrary dimension and mixedness using geometric entanglement witnesses. These witnesses are constructed using properties of the Hilbert-Schmidt geometry and can be shifted along parameterized lines. The involved conditions are simplified using Bloch decompositions of operators and states. As an example we determine the three different types of states for a family of two-qutrit states that is part of the “magic simplex”, i.e. the set of Bell-state mixtures of arbitrary dimension.

Q 34.6 Mi 15:15 VMP 6 HS-D

On polynomial invariants of multipartite qubit systems — •Andreas Osterloh[1] and Dragomir Ž. Djokovic[2] — [1]Institut für theoretische Physik, Leibniz Universität Hannover, Appelstrasse 2, 30167 Hannover, Germany. — [2]Department of Pure Mathematics, University of Waterloo, Waterloo, Ontario, N2L 3G1, Canada.

It is a recent observation that entanglement classification for qubits is closely related to local $SL(2,\mathbb{C})$-invariants including the invariance under qubit permutations, which has been termed SL^* invariance. In order to single out the SL^* invariants, we analyze the $SL(2,\mathbb{C})$-invariants of four resp. five qubits and decompose them into irreducible modules for the symmetric group S_4 resp. S_5 of qubit permutations. A classifying set of measures of genuine multipartite entanglement is given by the ideal of the algebra of SL^*-invariants vanishing on arbitrary product states. We find that low degree homogeneous components of this ideal can be constructed in full by using the approach using local invariant operators. Our analysis highlights an intimate connection between this latter procedure and the standard methods to create invariants, such as the Ω-process. As the degrees of invariants increase, the comb based method proves to be particularly efficient.

Q 34.7 Mi 15:30 VMP 6 HS-D

Dynamical Control of Entanglement — •Felix Platzer, Florian Mintert, and Andreas Buchleitner — Albert-Ludwigs-Universität Freiburg, Germany

We study the possibility to control entanglement dynamics with the help of coherent driving. Based on algebraic approximations to multipartite generalizations of the concurrence C [1,2], we analytically find local control Hamiltonians that maximize time derivatives of C. With this approach we investigate optimal ways of preparing highly entangled multi-partite states for various types of interactions, both in closed systems and in the presence of dissipation and decoherence.

[1] F. Mintert and A. Buchleitner, Phys. Rev. Lett. **98**, 140505 (2007)
[2] L. Aolita, A. Buchleitner and F. Mintert, Phys. Rev. A **78**, 022308 (2008)