Q 59: Quantum Information (Concepts and Methods) V

Time: Friday 10:30–12:45 Location: S HS 001 Chemie

Q 59.1 Fri 10:30 S HS 001 Chemie

Relaxing Kochen Specker Inequalities — •Fabian Bernards, Otfried Gühne, and Matthias Kleinmann — Universität Siegen

When experimentally testing multiparticle quantum non-locality with Bell inequalities, one can distinguish between two types of tests: First, there are inequalities that only hold for fully local models, such as Mermin's inequality. Second, there are inequalities such as Svetlichny's inequality that also hold for hybrid models, i.e models that allow for non-classical correlations between some of the particles. In this way, Svetlichny's inequality is a Bell inequality that works with weaker assumptions than Mermin's inequality.

In the same spirit, we explore the possibility of finding an inequality to test contextuality while using fewer assumptions by not demanding measurement compatibility for all measurements within a measurement sequence.

Q 59.2 Fri 10:45 S HS 001 Chemie

Generalization of the Schmidt decomposition for bipartite systems — •Jens Siewert[1,2] and Christopher Eltschka[3] — [1]University of the Basque Country UPV/EHU, E-48080 Bilbao, Spain — [2]IKERBASQUE - Basque Foundation for Science, E-48013 Bilbao, Spain — [3]Institut für Theoretische Physik, Universität Regensburg, D-93053 Regensburg

There are few mathematical statements in the quantum information toolbox that are as powerful and of ubiquitous applicability as the Schmidt decomposition. In words, it states that any pure state of a finite-dimensional two-party Hilbert space can be written in terms of a basis whose vectors are tensor products of elements of two orthonormal local bases, and its coefficients with respect to this basis are real.

In this contribution we discuss a straightforward extension of the Schmidt decomposition that apparently is not widely known. It amounts to a simultaneous decomposition of two pure states into four inter-related local bases. The price to pay for the simultaneous decomposition is the orthogonality of the bases or/and real-valuedness of the cofficients.

Q 59.3 Fri 11:00 S HS 001 Chemie

Making geometric phases topological — Pedro Aguilar[1], Chryssomalis Chryssomalakos[1], Edgar Guzmán-González[1], Louis Hanotel[1], and •Eduardo Serrano-Ensástiga[1,2] — [1]Instituto de Ciencias Nucleares, Universidad Nacional Autónoma de México, CDMX, Mexico — [2]Institut für Theoretische Physik, Universität Tübingen, Tübingen, Germany

We show how special quantum spin states can be used to implement geometric phases with exceptional noise resilience under particular evolutions, which has possible applications to holonomic quantum computation. We discuss the abelian and non-abelian cases and describe how to find their respective special states using a generalization of the Majorana stellar representation.

Q 59.4 Fri 11:15 S HS 001 Chemie

Bounds on sector lengths in multi-qubit systems and their relation to entanglement, monogamy and representability — •Nikolai Wyderka and Otfried Gühne — Naturwissenschaftlich Technische Fakultät, Universität Siegen, Walter-Flex-Str. 3, D-57068 Siegen, Germany

In contrast to classical systems, one of the most intriguing features of multi-partite quantum systems is the fact that they may exhibit non-local correlations among multiple particles. However, in contrast to the above truism, the non-local correlations cannot be completely arbitrary as they underlie restrictions from quantum mechanics. A prominent example for these kind of restrictions, known as monogamy relations, is the Coffman-Kundu-Wootters-inequality, limiting the bipartite entanglement of one party in a three-partite state.

A powerful framework to study monogamy relations are sector lengths, a particular kind of quadratic LU-invariants of states that quantify, for different k, the amount of k-partite correlations in the state. We find new and tighter bounds on these sector lengths in multi-qubit states and highlight applications of these bounds to entanglement detection, the n-representability problem and find new monogamy relations.

Q 59.5 Fri 11:30 S HS 001 Chemie

Threetangle in the one-dimensional XY-model in integrability breaking magnetic field — •Jörg Neveling and Andreas Osterloh — Universität Duisburg-Essen, Lotharstrasse 1, 47057 Duisburg

We focused on the one-dimensional XY-model in a magnetic field that is not only in transverse direction but has also an in-plane orthogonal component. Therefore the model is beyond integrability. We analyze the behavior of the concurrence and the threetangle with growing in-plane component of the field. We furthermore emphasize on a fundamental simplification in calculations of the convex-roof in certain regimes and extend the threetangle in the exactly solved case of rank-two mixtures of W and GHZ state beyond the two pyramids in the Bloch sphere pointing in the direction of the two states.

Q 59.6 Fri 11:45 S HS 001 Chemie

Generalized W-state of four qubits with exclusively threetangle — Sebastian Gartzke and •Andreas Osterloh — Universität Duisburg-Essen, Lotharstrasse 1, 47057 Duisburg

We single out a class of states possessing only threetangle but distributed all over four qubits. This is a three-site analogue of states from the W-class, which only possess globally distributed pairwise entanglement as measured by the concurrence. We perform an analysis for four qubits, showing that such a state indeed exists. To this end we analyze specific states of four qubits that are not convexly balanced as for SL invariant families of entanglement, but only affinely balanced. For these states all possible SL-invariants vanish, hence they are part of the SL null-cone. Instead, they will possess at least a certain unitary invariant. As an interesting byproduct it is demonstrated that the exact convex roof is reached in the rank-two case of a homogeneous polynomial SL-invariant measure of entanglement of degree $2m$, if there is a state which corresponds to a maximally m-fold degenerate solution in the zero-polytope that can be combined with the convexified minimal characteristic curve to give a decomposition of the density matrix. If more than one such state does exist in the zero polytope, a minimization must be performed. A better lower bound than the lowest convexified characteristic curve is obtained if no decomposition of the mixed state is obtained in this way.

Q 59.7 Fri 12:00 S HS 001 Chemie

Cooperative efficiency boost for quantum heat engines — David Gelbwaser-Klimovsky[1], Wassilij Kopylov[2], and •Gernot Schaller[2] — [1]Department of Chemistry and Chemical Biology, Harvard University, Cambridge, USA — [2]Institut für Theoretische Physik, Technische Universität Berlin, D-10623 Berlin, Germany

The power and efficiency of many-body single-stroke heat engines can be boosted by performing cooperative non-adiabatic operations in contrast to the commonly used adiabatic implementations. The key property relies on the fact that non-adiabaticity allows for cooperative effects, that can use the thermodynamic resources only present in the collective non-passive state of a many-body system. In particular, we discuss an analytic formula for the efficiency of a quantum Otto cycle, which increases with the number of copies used and reaches a many-body bound, which we discuss analytically.

[1] D. Gelbwaser-Klimovsky, W.Kopylov, and G. Schaller, *Cooperative efficiency boost for quantum heat engines*, arXiv:1809.02564.

Q 59.8 Fri 12:15 S HS 001 Chemie

Heat transport in a two-qubit collision model — •Daniel Heineken, Konstantin Beyer, Kimmo Luoma, and Walter T. Strunz — Technische Universität Dresden, Dresden, Germany

We investigate a collision model for a two-qubit system coupled to two thermal baths at different temperatures consisting of qubits in thermal states. Each environment couples to one of the system's qubits.

We analyse the steady state of the system's evolution for Markovian dynamics in which the system interacts with new, uncorrelated environmental qubits in each collision step. As expected, the heat flow between the two baths depends on the coupling strength between the system's qubits and the baths as well as on the temperature difference and shows a behaviour which agrees with our classical intuition. We find a parameter region where the steady state is entangled.

We modify the collision model by taking into account the effects

of the earlier collisions between the system and environmental qubits. The impact of these memory effects on the steady state is considered. We find that heat flow as well as steady state entanglement are affected by the non-Markovian environments.

Q 59.9 Fri 12:30 S HS 001 Chemie

Quantum simulation of low dimensional Floquet systems — •Simon Strnad, Filip Wudarski, and Andreas Buchleitner — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg

Floquet theory allows for an accurate, non-perturbative treatment of a large class of physical scenarios with explicit time dependence, with applications, e.g., in light-matter interaction, mesoscopic and open quantum systems. Since Floquet theory relies on the time periodicity of the Hamiltonian ($H(t) = H(t+T)$), it represents a natural link between autonomous problems and those with non-periodic time dependence.

Given recent progress in the simulation of autonomous quantum systems on quantum computing platforms, we extend these approaches to Floquet problems. We demonstrate how to map the low dimensional unitary Floquet evolution on a set of easily implementable gates, and discuss potential limitations of the accuracy, which arise from hardware restrictions.