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ABSTRACTS – POSTER SESSION

Presented in alphabetical order

Borhan Ahmadi, University of Gdańsk, Poland

Charging Quantum Batteries by an Incoherent Source

Abstract: The transfer of energy from a coherent source to a quantum battery holds significant technological importance. However, perhaps even more crucial is the ability to transfer energy from an incoherent source to a quantum battery and store it in a coherent state. In this study, we propose a novel approach to accomplish this task. Our method involves utilizing two-level fermions as the fundamental units of the quantum battery, collectively interacting with a shared reservoir. Through analytical analysis, we demonstrate that non-zero coherent energy can indeed be transferred to the battery. Furthermore, by increasing the number of battery cells, we establish that energy storage in a fully coherent state within the battery becomes achievable. Intriguingly, our analysis reveals that the charging power of the battery experiences enhancement with an increase in the temperature of the shared reservoir.

Michał Banacki, Faculty of Mathematics, Physics and Informatics, University of Gdańsk, Poland

On steering in the C*-algebraic framework

Abstract: We discuss a scenario of bipartite steering with local subsystems of the parties modeled by certain operator algebras. In particular, we formalize the notion of quantum assemblages in a commuting observables paradigm and focus on equivalent descriptions of such objects providing a systematic analysis of previously scattered approaches. We provide necessary and sufficient conditions for the equivalence of quantum commuting and tensor models that is stable under extensions of the trusted subsystem by arbitrary finite-dimensional ancillae. As a result, for the first time, we show the existence of Tsirelson's gap for steering in the case of two measurement settings. Finally, we provide no-go results concerning the possibility of post-quantum steering in this most general bipartite paradigm and discuss related corollaries concerning free probability and operator system approach.

Bihalan Bhattacharya, Nicolaus Copernicus University in Toruń, Poland

A class of Schwarz qubit maps with diagonal unitary and orthogonal symmetries

Abstract: In this presentation I shall discuss on complete characterization of a class of qubit maps with diagonal unitary and orthogonal symmetries in terms of necessary and sufficient conditions for positivity, operator Schwarz inequality, and complete positivity. Generalizing the structure to non-unital case Schwarz condition will be analysed. I shall also present a case study on characterization of Pauli maps which leads to the generalization of seminal Fujiwara-Algoet conditions for Pauli quantum channels.

Marta Bielińska, ICTQT, University of Gdańsk, Poland

Superluminal signalling and chaos in nonlinear quantum dynamics

Rafał Bistroń, Marcin Rudziński, Jagiellonian University in Kraków, Poland

Error accumulation in Quantum Volume circuit

Abstract: The Quantum Volume test is one of the most widely used benchmarks for modern quantum computers. In our work, we considered the accumulation of errors inherent to the circuit used in the Quantum Volume test, specifically imperfect implementations of 2-qubit gates and permutations of qubits. By analyzing fidelity in relation to the circuit size and the noise intensity, we established general behaviour as well as bounds for those types of errors, dependent only on the dimensionality of quantum computer architecture.

Wojciech Bruzda, Centre for Theoretical Physics, Polish Academy of Sciences, Poland

Perfect Tensors and Multipartite Entanglement

Abstract: We define the notion of a perfect tensor and explain its relevance in quantum information theory, especially in description of multipartite quantum entanglement. The existence of such objects in Hilbert space of arbitrary dimension is currently investigated from theoretical and practical point of view. We present a solution to the particular case of four parties with six degrees of freedom each, which contains additional features simplifying its experimental realization.

Anubhav Chaturvedi, Gdańsk University of Technology, Poland

Extending loophole-free nonlocal correlations to arbitrarily large distances

Abstract: One of the most striking features of quantum theory is that it allows distant observers to share correlations that resist local hidden variable (classical) explanations, a phenomenon referred to as Bell nonlocality. Besides their foundational relevance, the nonlocal correlations enable distant observers to accomplish classically inconceivable information processing and cryptographic feats such as unconditionally secure device-independent key distribution schemes. However, the distances over which nonlocal correlations can be realized in state-of-the-art Bell experiments remain severely limited owing to the high threshold efficiencies of the detectors and the fragility of the nonlocal correlations to experimental noise. Instead of looking for quantum strategies with marginally lower threshold requirements, we exploit the properties of loophole-free nonlocal correlations, which are experimentally attainable today, albeit at short distances, to extend them over arbitrarily large distances. Specifically, we consider Bell experiments wherein the spatially separated parties randomly choose the location of their measurement devices in addition to their measurement settings. We demonstrate that when devices close to the source are perfect and witness extremal loophole-free nonlocal correlations, such correlations can be extended to devices placed arbitrarily far from the source, with almost-zero detection efficiency and visibility. To accommodate imperfections close to the source, we demonstrate a specific analytical tradeoff: the higher the loophole-free nonlocality close to the source, the lower the threshold requirements away from the source. We utilize this analytical tradeoff paired with optimal quantum strategies to estimate the critical requirements of a measurement device placed away from the source and formulate a versatile numerical method applicable to generic network scenarios.

Paweł Cieśliński, Faculty of Mathematics, Physics and Informatics University of Gdańsk, Poland

Unmasking the Polygamous Nature of Quantum Nonlocality

Abstract: Quantum mechanics imposes limits on the statistics of certain observables. Perhaps the most famous example is the uncertainty principle. Similar trade-offs also exist for the simultaneous violation of multiple Bell inequalities. In the simplest case of three observers, it has been shown that violating one Bell inequality precludes the violation of any other inequality, a property called monogamy of Bell violations. Forms of Bell monogamy have been linked to the no-signalling

principle and the inability of simultaneous violations of all inequalities is regarded as their fundamental property. We show that the Bell monogamy does not hold universally and that in fact the only monogamous situation exists only for three observers. Consequently, the nature of quantum nonlocality is truly polygamous. We present a systematic methodology for identifying quantum states and tight Bell inequalities that do not obey the monogamy principle for any number of more than three observers. The identified polygamous inequalities are experimentally violated by the measurement of Bell-type correlations using six-photon Dicke states and may be exploited for quantum cryptography as well as simultaneous self-testing of multiple nodes in a quantum network.

Arpan Das, University of Warsaw, Poland

Universal time scalings of sensitivity in Markovian quantum metrology

Abstract: Assuming a Markovian time evolution of a quantum sensing system, we provide a general characterization of the optimal sensitivity scalings with time, under the most general quantum control protocols. We allow the estimated parameter to influence both the Hamiltonian as well as the dissipative part of the quantum master equation. We focus on the asymptotic-time as well as the short-time sensitivity scalings, and investigate the relevant time scales on which the transition between the two regimes appears. This allows us to characterize, via simple algebraic conditions (in terms of the Hamiltonian, the jump operators as well as their parameter derivatives), the four classes of metrological models that represent: quadratic-linear, quadratic-quadratic, linear-linear and linear-quadratic time scalings. We also provide universal numerical methods to obtain quantitative bounds on sensitivity that are the tightest that exist in the literature.

Anita Dąbrowska, Faculty of Mathematics, Physics and Informatics, University of Gdańsk, Poland

Optimization of two-photon absorption for three-level atom

Abstract: We study the interaction of a three-level atom of a ladder configuration with a traveling light prepared in a continuous-mode two-photon state [1]. We analyze the probability of two-photon absorption by the atom using the formula obtained within the input-output formalism [2, 3], which is formulated in the framework of standard assumptions made in quantum optics. Namely, a flat coupling constant, rotating wave approximation, and the extension of the lower limit of integration over frequency to minus infinity [2, 4]. The evolution of the atom interacting with a wave packet of a definite number of photons is given by the set of hierarchical master equations [5, 6, 7]. As shown in [6] this set can be solved analytically.

The starting point in our consideration is the analytical formula for the probability of two-photon absorption for the three-level atom driven by the light in the two-photon state. We study the time-dependent probability of the excitation of the system. We show how the field drives the atom and how the effectiveness of this process depends on the state of light and the parameters of the atom such as the lifetime of the excited states. We present the solution to this problem for different states of light. Our principal goal is to optimize the pulse shape to achieve the highest probability of two-photon absorption. We study and compare different scenarios including entangled and unentangled

photon pairs. We show that the correlations between the photons can significantly enhance the two-photon absorption probability for atoms with short-lived middle states. The excitation probability is considerable even in the virtual-state regime for correlated two-photon inputs, whereas it goes to zero for uncorrelated photon pairs.

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Piotr Dulian, University of Warsaw, Poland

Quantum metrology using quantum combs and tensor network formalism

Abstract: We develop an efficient algorithm for determining optimal adaptive quantum estimation protocols with arbitrary quantum control operations between subsequent uses of a probed channel.We introduce a tensor network representation of an estimation strategy, which drastically reduces the time and memory consumption of the algorithm, and allows us to analyze metrological protocols involving up to N=50 qubit channel uses, whereas the state-of-the-art approaches are limited to N<5. The method is applied to study the performance of the optimal adaptive metrological protocols in presence of various noise types, including correlated noise.

Jorge Escandón-Monardes, Millennium Institute for Research in Optics, Universidad de Concepción, Chile

Transcribing quantum channels into quantum states

Abstract: We introduce a circuit that takes an arbitrary quantum channel on a d-dimensional system and outputs its process matrix, a.k.a. χ-matrix. Our circuit consists in one target qudit and two control qudits. Interestingly, at the end of the circuit the χ-matrix gets encoded in the control register, while the target qudit recovers its arbitrary initial state, regardless of the quantum channel applied on it. We briefly discuss some features of the circuit and its eventual application in quantum process tomography and other computational tasks.

Ghosh Dastidar, Indian Institute of Technology Madras, India

Quantum Random Number Generation using 2-emitter systems

Abstract: Random number sequences have wide applications in science and technology. Such sequences can be generated by algorithmic methods via pseudorandom number generators. However, for a truly unpredictable random number sequence, inherent properties of a quantum system can be used. This, in turn, is useful for applications such as quantum communication. Here, we implement

a quantum random number generator (QRNG) based on single photon detection from solid-state emitters. The principle is based on the inherent randomness of path selection by a photon incident on a symmetric beam splitter. We discuss the difference in the randomness of the binary sequences produced by single and two emitter systems, and correlate them with their intensity correlation properties.

Ryszard Paweł Kostecki, ICTQT, University of Gdańsk, Poland

Extended Br\`{e}gman entropic geometry and nonlinear operators on state spaces of GPTs

Abstract: From the perspective of foundations of information geometry, there are two main characteristic families of relative entropies on finite dimensional probability simplexes: Csisz\'{a}r--Morimoto and Br\`{e}gman. While the former satisfy nonincreasing under (completely) positive maps, the latter satisfy a nonlinear generalisation of a pythagorean theorem. (Information theoretically, this corresponds, respectively, to nonincreasing of information under processing and to nonlinear additive decomposition of information into data and noise.) Third-order Taylor expansions of these relative entropies determine the respective classes of Norden--Sen torsion-free metric--affine geometries, Chencov--Amari and hessian, describing the asymptotic/local statistical properties of sets of states, while preserving the above information theoretic properties. While a generalisation of the former family of relative entropies and metric--affine geometries to quantum state spaces has been established (respectively, by Kosaki and Petz, and by Morozova, Chencov, Petz, and Jen\v{c}ov\'{a}), so far there has been no satisfactory treatment of Br\`{e}gman relative entropies over arbitrary dimensional quantum (i.e. W*), Jordan algebraic (i.e. JBW), and GPT (i.e. radially compact base normed) state spaces.
We provide a solution to this problem, by considering nonlinear embeddings (in the best case: homeomorphisms) of the (subsets of) base normed spaces in spectral duality into suitable reflexive Banach spaces (constructed over the corresponding order unit spaces), and using these embeddings to extend br\`{e}gmanian structures from the reflexive to the nonreflexive setting, establishing a joint generalisation of finite dimensional information geometric and reflexive Banach space theoretic approaches to Br\`{e}gman relative entropy. As a result, we obtain rich framework for nonlinear convex analytic optimisation over arbitrary dimensional state spaces of GPTs, with several detailed quantitative results (e.g., the H\"{o}lder continuity estimates of extended Br\`{e}gman entropic projections) in W$^*$- and semifinite JBW-algebraic cases. Another extended feature are the monoids of nonlinear Br\`{e}gman quasi-nonexpansive operators, generalising Br\`{e}gman entropic projections, and providing a family of operations for nonlinear resource theory.
Since this framework provides a fusion of two branches of nonlinear analysis on Banach spaces (convexity and homeomorphy) with the integration theory on order unit spaces in spectral duality, it forms a gateway to a range of interesting functional analytic problems at the intersections of these theories (with information theoretic applications as a surplus benefit). We give few interesting examples, including, e.g., nonassociative Orlicz spaces, noncommutative Lozanovski\u{\i}--Gillespie homeomorphism, and a new family of L_p spaces over order unit spaces.
For embeddings into rearrangement invariant spaces, and a family of convex functions of a norm given by integrals of gauge functions, one can express conditions of good behaviour of the corresponding extended Br\`{e}gman entropic projections and operators over the (subsets of) preduals of W*-algebras in terms of the characteristic properties of norms of respective

commutative rearrangement invariant spaces. This allows to exhibit quantitative control over the properties of br\`{e}gmanian nonlinear quantum convex optimisation with a small set of easily computable variables. E.g., for extended Br\`{e}gman relative entropies over positive cones of preduals of semifinite W*-algebras, induced by Kaczmarz embeddings into noncommutative Orlicz spaces, we determine good behaviour of the key properties (e.g.: existence and uniqueness of entropic projections; existence and monoid composability of the suitable family of quasi-nonexpansive operators) in terms of only two convex functions from positive reals to positive reals (the gauge and the Orlicz function).

Ryszard Kukulski, Jagiellonian University in Kraków, Poland

Causal order discrimination

Abstract: In this work, we would investigate to what extend the causal order of events can be correctly deduced. Basing on the formalism of the process matrices, we propose N-player communication task in which players try to maximize the probability of successful discrimination of the hidden causal order.

Ankit Kumar, ICTQT, University of Gdańsk, Poland

Correlation Tests of Gravitation at Quantum Length Scales

Abstract: We demonstrate of an experiment searching for departures from (quantum) Newtonian predictions in a bipartite setting with tiny gravitational accelerations, i.e., where the effective force needs to be stronger than Newtonian to account for the Dark Matter effects. We show that two nearby mesoscopic quantum masses accumulate significantly larger entanglement in modified gravity models. We also note that the quantized Schrodinger-Poisson model of semi-classical gravity assumes a strong form of locality that preserves the product form of the initial state. Accordingly, any gain in quantum correlation is incompatible with the model, and the experiments aimed at observing gravitational entanglement can be utilized to test this in laboratory.

Stanisław Kurdziałek, University of Warsaw, Poland

Fundamental bounds and optimal strategies in adaptive quantum metrology

Abstract: We derive new bounds on achievable precision in the most general adaptive quantum metrological scenarios. The bounds are proven to be asymptotically saturable and equivalent to the known parallel scheme bounds in the limit of large number of channel uses. This completely solves a long standing conjecture in the field of quantum metrology on asymptotic equivalence between parallel and adaptive strategies. The new bounds also allow to easily assess the potential benefits of invoking the non-standard causal superposition strategies, for which we prove, similarly to the adaptive case, the lack of asymptotic advantage over the parallel ones.

Owidiusz Makuta, **Centre for Theoretical Physics, Polish Academy of Sciences, Poland**

All genuinely entangled stabilizer subspaces are multipartite fully nonlocal

Abstract: Understanding the relationship between entanglement and Bell nonlocality is one of the long-lasting open problems in quantum physics which is important both from the fundamental and application points of view. In particular, while both entanglement and Bell nonlocality are key resources in quantum information, the latter appears to be a stronger one because it allows for information processing in the device-independent framework in which the players need not trust their devices. Thus, understanding which entangled states give rise to Bell nonlocality and thus are resourceful in this framework is an important and interesting task. Here we establish the equivalence between genuine entanglement and genuine nonlocal for a broad class of multipartite (pure and mixed) states originating from the stabilizer formalism.

In fact, we demonstrate a much stronger result that any (mixed) stabilizer state defined on a genuinely entangled subspace is multipartite fully nonlocal meaning that it gives rise to correlations that have no contribution coming from local hidden variable models of any type. We thus also introduce the first examples of genuinely nonlocal subspaces in multiqubit Hilbert spaces in which every single pure state is genuinely nonlocal.

André Malavazi, ICTQT, University of Gdańsk, Poland

Quantum switch instabilities with an open contro

Abstract: Given a quantum system of interest (S) and distinct available quantum operations, one can condition the application orders of the latter with the state of a control ancillary system (C). Such a process, along with the subsequent measurement of the control, is commonly referred to as a quantum switch (QS). The QS has been investigated in different contexts, ranging from computation and communication protocols to thermodynamic scenarios. In this sense, considering the extensive research and current interests in the topic, it is imperative to understand the QS behaviour in more realistic scenarios, i.e., one should take into account the unavoidable coupling of C with external uncontrollable degrees of freedom. In this work, we explicitly include an external environment - following the so-called collisional model framework - capable of interacting with C between the steps of the QS map application and control measurement. By following this procedure, we will show how an external bath influences the QS, and we will illustrate it with two paradigmatic examples: in the application of monitoring maps and a quantum refrigerator.

Robert Okuła, **Gdańsk University of Technology, Poland**

How decoherence affects the security of BB84 quantum key distribution protocol

Abstract: We present how the mechanisms of quantum Darwinism allow for the leakage of information in the standard BB84 quantum key distribution protocol. We investigate how much of the information about the results crucial for the cryptographic key to be kept secret can be leaked during the quantum measurement process and subsequently how much of that information might be

later used by the third party to obtain such information using a type of Van Eck side-channel wiretapping. We also show how this can be affected by different ways of organizing the surrounding environment into layers, e.g. rooms or other divisions affecting the spread in the environment and their interaction.

Ekta Panwar, Faculty of Mathematics, Physics and Informatics, University of Gdańsk, Poland

Robust self-testing of Bell inequalities tilted for maximal loophole-free nonlocality

Abstract: The degree of experimentally attainable nonlocality, as gauged by the amount of loophole-free violation of Bell inequalities, remains severely limited due to inefficient detectors. We address an experimentally motivated question: Which quantum strategies attain the maximal loophole-free nonlocality in the presence of inefficient detectors? For any Bell inequality and any specification of detection efficiencies, the optimal strategies are those that maximally violate a tilted version of the Bell inequality inideal conditions (*). In the simplest scenario, we demonstrate the quantum strategies that maximally violate the tilted versions of Clauser-Horne-Shimony-Holt inequality are unique up to local isometries. However, self-testing via the standard sum of squares decomposition method turns to be analytically intractable since even high levels of the Navascu´es–Pironio–Ac´ın hierarchy are insufficient tosaturate the maximum quantum violation of these inequalities. Instead, we utilize a novel Jordan's lemma-based proof technique to obtain robust analytical self-testing statements for the entire family of tilted-Bell inequalities

Aravinth Balaji Ravichandran, ICTQT, University of Gdańsk, Poland

Dark state charging of quantum batteries

Abstract: The work studies the charging and stabilization of quantum batteries in extended cavity QED systems with dark states (tentative).

Oliver Reardon-Smith, Center for Theoretical Physics, Polish Academy of Sciences, Warsaw, Poland

Epsilon-nets t-designs and heat kernels

Abstract: t-designs have emerged as important objects in the study of quantum information, cryptography and computation. In recent years they have been employed in protocols from classical shadows, randomized benchmarking and even classical simulation of quantum computers. More tentatively they have even been suggested as models of information scrambling in black holes. While less widely studied epsilon nets serve an important role in the theory of the compilation of quantum circuits.

Recent work employing a polynomial approximation of nacient delta functions on the space of (projective) unitaries has shown a strong link between these concepts, specifically showing that an approximate epsilon net serves as an approximate t-design with appropriate parameters and vice-versa. While the construction in this paper is asymptotically optimal in epsilon, it has only been shown to be near optimal in it's dimension scaling. Specifically the size of the required approximate t-design

to obtain an epsilon net must grow at least quadratically, while that of the known construction grows as order n^5/2. We attempt to address this discrepancy and improve on the prior work by replacing the construction of the nacient delta function with one which allows better polynomial approximation and which is easier to mathematically handle. Our approach is based on an extension of results known about the heat kernel of compact, simply connected Lie groups to cover the (non-simply connected) projective unitary group.

Sumit Rout, ICTQT, University of Gdańsk, Poland

A Novel Instance of Unbounded Quantum Advantage

Abstract: We investigate the one-way zero-error classical and quantum communication complexities for aclass of relations induced by a distributed clique labelling problem. We consider two variants: 1) the receiver outputs an answer satisfying the relation - the traditional communication complexity of relations (CCR) and 2) the receiver has non-zero probabilities of outputting every valid answer satisfying the relation (equivalently, the relation can be fully reconstructed), that we denote the strong communication complexity of the relation (S-CCR). We prove that for the specific class of relations considered here when the players do not share any resources, there is no quantum advantage in the CCR for any graph. On the other hand, we show that there exist classes of graphs for which the separation between one-way classical and quantum communication in the S-CCR grows with the order of the graph m, specifically, the quantum complexity is $\Theta(1)$ while the classical complexity is $\Theta(\log m)$. Secondly, we prove a lower bound (that is linear in the number of cliques) on the amount of shared randomness necessary to overcome the separation in the scenario of fixed restricted communication and connect this to the existence of Orthogonal Arrays. Finally, we highlight some applications of this task to semi-device-independent dimension witnessing as well as to the detection of Mutually Unbiased Bases.

Abhyoudai Sajeevkumar Shaleena, ICTQT, University of Gdańsk, Poland

Analysis of Qubit-Qutrit Correlations

Adam Sawicki, Center for Theoretical Physics, Polish Academy of Sciences, Warsaw, Poland

Random approximate t-designs

Abstract: Approximate t-design are ensembles of unitaries that (approximately) recover Haar averages of polynomials in entries of unitaries up to the order t. As such, they find numerous applications throughout quantum information, including randomized benchmarking , efficient estimation of properties of quantum states, decoupling, information transmission and quantum state discrimination. In this posterI will characterize how finite random gate-sets mimic the Haar measure. The talk will be based on: P. Dulian, A. Sawicki, A random matrix model for random approximate t-designs, IEEE Transactions on Information Theory, vol. 70, no. 4, pp. 2637-2654, (2024)

Akshata Shenoy, ICTQT, University of Gdańsk, Poland

*Noise Adapted Quantum Random Access Codes**

Abstract: Quantum random access codes (QRACs) are the quantum counterparts of RACs where the dataset held by Alice is encoded onto a quantum state sent over a transmitting channel for the other party Bob to partly decode using appropriate quantum measurements. Here, the acts of state preparation and measurement correspond as encoding and decoding functions at Alice's and Bob's ends respectively. Separately, dimension witnesses (DW) are shown to be useful in certifying the security aspect of semi-device -independent quantum key distribution. DW characterise the distinction between classical and quantum systems by lower bounding the dimension d required in establishing a specific information processing task. These witnesses form a simple method in recognising the characteristic feature of quantum systems as a potentially more useful resource in comparison to its classical counterpart of the same dimension, d. Restricting to the case of d= 2, we consider a DW which is analogous to a RAC. We then explore the effect of stochastic operations on a noisy quantum channel employed for establishing a QRAC. We show that it is possible to enable restoration/activation of the quantum advantage in the task of RAC even in the presence of noise in the channel.

*Joint Work With:
1. Karthik H. S. and Marcin Pawlowski (ICTQT, UG, Poland).
2. Felipe Moro, Esteban Gomez, Santiago Gomez, Stephen Walborn and Gustavo Lima (Universidad de Concepción, Chile).

Gerardo Suarez, ICTQT, University of Gdańsk, Poland

Complete positive maps in Open quantum systems

Abstract: In recent years, there has been tremendous focus on identifying whether effective descriptions of open quantum systems such as master equations, provide the correct steady state in the long time limit. The correct steady state is usually not known, however it can be approximated by means of the Mean Force Hamiltonian up to some fixed order, the reaction coordinate mapping or other pseudo-mode like approaches. In this poster we use a CPTP map to describe the dynamics of an open system and go into its benefits, limitations and possible future improvements

Krzysztof Szczygielski, Nicolaus Copernicus University in Toruń / Faculty of Mathematics, Physics and Informatics, University of Gdańsk, Poland

D-divisible quantum evolution families

Abstract: We propose and explore a notion of decomposably divisible (D-divisible) differentiable quantum evolution families on matrix algebras. This is achieved by replacing the complete positivity requirement, imposed on the propagator, by more general condition of decomposability. It is shown that such D-divisible dynamical maps satisfy a generalized version of Master Equation and are totally characterized by their time-local generators. Necessary and sufficient conditions for D-divisibility are found. Additionally, decomposable trace preserving semigroups are examined.

Anuradha Tonipe, **ICTQT, University of Gdańsk, Poland**

Perfect transfer of arbitrary continuous variable states across optical waveguide lattices

Abstract: Perfect state transfer can be achieved in an optical waveguide lattice governed by a Hamiltonian with modulated nearest-neighbor couplings. In particular, reported the condition that the evolution Hamiltonian should satisfy in order to achieve perfect transfer of any continuous variable input state. The states that can be transmitted need not have any specific properties - they may be pure or mixed, Gaussian or non-Gaussian in character, and comprise an arbitrary number of modes. We illustrate that the proposed protocol is scalable to two- and three-dimensional waveguide geometries. With the help of local phase gates on all the modes, our results can also be applied to realize a SWAP gate between mirror-symmetric modes about the centre of the waveguide setup.

Lisa T. Weinbrenner, University of Siegen, Germany

Certifying the topology of quantum networks: theory and experiment*

Abstract: Distributed quantum information in networks is paramount for global secure quantum communication. Moreover, it finds applications as a resource for relevant tasks, such as clock synchronization, magnetic field sensing, and blind quantum computation. For quantum network analysis and benchmarking of implementations, however, it is crucial to characterize the topology of networks in a way that reveals the nodes between which entanglement can be reliably distributed. Here, we demonstrate an efficient scheme for this topology certification. Our scheme allows for distinguishing, in a scalable manner, different networks consisting of bipartite and multipartite entanglement sources, for different levels of trust in the measurement devices and network nodes. We experimentally demonstrate our approach by certifying the topology of different six-qubit networks generated with polarized photons, employing active feed-forward and time multiplexing. Our methods can be used for general simultaneous tests of multiple hypotheses with few measurements, being useful for other certification scenarios in quantum technologies.

* This contribution is joint work with K. Hansenne, S. Denker, O. Gühne, N. Prasannan, J. Sperling, B. Brecht, and C. Silberhorn.

Marek Winczewski, ICTQT, University of Gdańsk, Poland

Cumulant Equation for a Damped Quantum Harmonic Oscillator

Abstract: We examine the dynamics provided by the cumulant equation and its filtered approximation (FA equation) in the context of a damped quantum harmonic oscillator. To benchmark the performance of dynamical equations under study we compare the resulting dynamics with dynamics obtained with Davies-GKSL equation, Heisenberg-Langevin equation, and covariance matrix numerical approach. The early stage result suggest a good agreement of dynamics provided with the cumulant equation and the FA equation with exact methods.

Jan Wójcik, **Adam Mickiewicz University in Poznań, Poland**

Topological invariants of quantum walks

Abstract: We focus our presentation on discrete-time quantum walks and their topological properties. Quantum walks are periodically driven (Floquet) systems. Their discrete model due to its simplicity may be a very powerful tool while studying complex systems. As was previously shown even the most basic model of the quantum walk may have some interesting topological properties.
We define topological properties for translational invariant walks. Due to this symmetry, we define a unique map from the first Brillouin zone to the Bloch sphere. We want to infer the topological properties of discrete-time quantum walks only by studying this map.
Until now the most popular way to approach the distinction of topological phases in quantum walks is the usage of a winding number.
In a recent paper we show possible issues regarding inferring the topological properties of a quantum walk only from studying the winding number. We propose a new approach. Using relative homotopy we propose a new topological invariant. We show that it agrees with previous models and more generalized ones. Our invariant indicates the number of edge states at the interface between two topological phases. We identify those states for arbitrary coin toss operators. Those states we found to be protected by PHS. We manage to find the exact form of topological edge states in the sharp edge model.