Presented in alphabetical order

Guillaume Aubrun, University Lyon, France

General probabilistic theories and tensor norms

Abstract:
The study of general probabilistic theories (GPT) aims at an axiomatization of probabilistic physical models and is a branch of the theory of convex cones and normed spaces. Considering composite GPTs naturally leads to tensor products of normed spaces. The tensor product of two normed spaces can be equipped with several different natural norms, the most important being the injective and projective norms. In the context of GPTs, we give an operational interpretation to both of them. A natural question is then to quantify how much the injective and projective norms can differ; we present some results in this direction.

(joint with Ludovico Lami, Carlos Palazuelos, Stanislaw Szarek and Andreas Winter)

Remigiusz Augusiak, Center for Theoretical Physics, Polish Academy of Sciences, Poland

Bell inequalities for maximally entangled states and self-testing

Abstract: Bell inequalities have traditionally been used to demonstrate that quantum theory is nonlocal, in the sense that there exist correlations generated from composite quantum states that cannot be explained by means of local hidden variables. With the advent of device-independent quantum information protocols, Bell inequalities have gained an additional role as certificates of relevant quantum properties. We present a class of Bell inequalities valid for an arbitrary number of measurements and results, derive analytically their tight classical, nonsignaling, and quantum bounds and prove that the latter is attained by maximally entangled states of any local dimension. We then prove analitycally that these inequalities can be used to self-test maximally entangled states of local dimension d=3,4,5.

Erik Aurell, Royal Institute of Technology - KTH, Sweden

A path integral theory of heat flow through a system of qubits

Abstract:
Quantum thermodynamics is the common term for efforts from quantum information theory and other fields to extend statistical physics to small systems well below the thermodynamic limit, with full inclusion of quantum effects (Vinjanampathy & Anders, 2016). The promise of quantum thermodynamics are potential applications to refrigerators and heat engines, and ways to optimize work extraction or minimizing heat production in such devices (Pekola, 2015).
A fundamental challenge in quantum thermodynamics is that heat does not fit into standard quantum theory, as it is a a property of a process, and not of a state. One approach to this problem is to define heat as energy changes in an environment interacting with the system. The generating function of such energy changes can be written as a functional of system variables only. When the environment is a bosonic bath (harmonic oscillators interacting linearly with the system) these functionals are of the same type as the Feynman-Vernon influence functionals, and have been given explicitly (Aurell & Eichhhorn 2015, Carrega et al 2015, Aurell 2018).
I will report on efforts to apply these functionals to a system of qubits interacting among themselves as in quantum annealing, and with the bath through the z-components of spin. The path integrals of the spin system dynamics can then be formulated as in the spin-boson problem, widely studied in the open quantum systems literature since the 80ies. Quantum heat is in this setting analogously described by generalizations of the functionals first introduced by Leggett and collaborators i.e. as interactions between "blips" and sojourns". I will discuss what is new in the path integral description of heat compared to the path integral description of the system

state. I will also common upon ways to go beyond the spin-boson paradigm, originally motivated by other considerations (Aurell 2016).

References

1. S Vinjanampathy & J Anders, "Quantum thermodynamics", Contemporary Physics, 57:545-579 (2016)
2 J Pekola, "Towards quantum thermodynamics in electronic circuits", Nature Physics, 11:118 (2015)
3. E Aurell and R Eichhorn, "On the von Neumann entropy of a bath linearly coupled to a driven quantum system", New Journal of Physics, 17:065007,
4. M Carrega, P Solinas, A Braggio, M Sassetti & U Weiss, "Functional integral approach to time-dependent heat exchange in open quantum systems: general method and applications", New Journal of Physics, 17: 045030 (2015),
5. E Aurell, "The characteristic functions of quantum heat with baths at different temperatures", arXiv:1801.04235
6. E Aurell, "Global estimates of errors in quantum computation by the Feynman-Vernon formalism", arXiv:1606.09407

Konrad Banaszek, Centre of New Technologies, University of Warsaw, Poland

From quantum information to deep-space optical communication

Abstract:

One of striking effects in quantum information theory is superadditivity of accessible information, i.e. the ability to increase the transmission rate by performing collective measurements at the output of a communication channel. This phenomenon turns out to offer new solutions to the challenge of transferring to Earth data collected by deep space missions. With increasing distance, conventional approaches require unboundedly growing peak-to-average power ratio of the laser source used in the onboard transmitter. This difficulty can be overcome with the help of structured optical receivers, which attain the same efficiency by processing jointly codewords constructed from alphabets with uniform distribution of instantaneous power, such as binary phase shift keying.

Iwo Bialynicki-Birula, Center for Theoretical Physics, Polish Academy of Sciences, Poland

Trapping of bodies by gravitational waves endowed with angular momentum

Abstract:

It has been shown some time ago that electromagnetic waves endowed with angular momentum trap charged particles near the beam center. In this talk I will show that the trapping also occurs for gravitational wave endowed with angular momentum. Such waves are not uncommon. In particular, they are emitted by inspiralling black holes which must get rid of their orbital angular momentum.

Mohamed Bourennane, Stockholm University, Sweden

Avoiding apparent signaling in Bell tests for quantitative applications

Abstract:

Bell tests have become a powerful tool for quantifying security, randomness, entanglement, and many other properties, as well as for investigating fundamental physical limits. In all these cases, the specific experimental value of the Bell parameter is important as it leads to a quantitative conclusion. However, most experimental implementations aiming for high values of the Bell parameter suffer from the defect of showing signaling. This signaling can be attributed to systematic errors occurring due to weaknesses in the experimental designs. Here we point out the importance, for quantitative applications, to identify and address this problem. We present a set of experiments with polarization entangled photons in which

we point out common sources of systematic errors and demonstrate approaches to avoid them. This allows us to establish a reliable estimate for the Bell parameter.

Wojciech Bruzda, Jagiellonian University in Kraków, Poland

Excess of a matrix and Bell inequalities

Abstract:
We recall the standard definition of excess of a Hadamard matrix and propose some generalizations of this notion. We study the bounds of excess for several classes of matrices: unitary (Hadamard), hermitian, circulant, etc. A connection between the notion of excess and Bell inequalities (CHSH) is provided.

Jakub Czartowski, Jagiellonian University in Kraków, Poland

Five isoentangled mutually unbiased bases and mixed states designs

Abstract:
Complex projective t-designs are known to have wide application in quantum information, including quantum tomography, fingerprinting and encryption. Based on this we propose mixed states t-designs for the space of density matrices and show an easy way to obtain such arrangements by partial tracing. We take a closer look at some examples of 1-qubit mixed states designs induced by projective designs in H_4 and visualize them in the Bloch ball. Finally we show previously unknown complete set of five isoentangled mutually unbiased bases in H_4 which exhibits the structure of a regular dodecahedron

Borivoje Dakic, University of Vienna, Austria

Single-copy entanglement detection

Abstract:
A main focus of current practical quantum information research is on the generation of large-scale quantum entanglement involving many particles with the goal of achieving real applications of quantum technologies. An important instance of this challenge is the verification problem: how to reliably certify the presence of quantum resources, in particular quantum entanglement. The plausibility of standard verification schemes (for example, based on entanglement witnesses) is questionable, since they require repeated measurement on large ensemble of identically prepared copies, which is highly demanding to achieve in practice when dealing with large-scale entangled quantum systems. In this talk, I will present our recent work [1] where we develop a novel method by formulating verification as a decision procedure, i.e. entanglement is seen as the ability of quantum system to answer certain “yes-no questions”. We show that for a variety of large quantum states even a single copy suffices to detect entanglement with a high probability by using local measurements. For example, a single copy of a 24-qubit linear cluster state suffices to verify entanglement with more than 95% confidence. Our method is applicable to many important classes of states, such as cluster states or ground states of local Hamiltonians in general.

References

[1] A. Dimic, and B. Dakic, “Single-copy entanglement detection”, npj Quantum Information 4, 11 (2018).

Michał Eckstein, University of Gdańsk, Poland

Information processing in spacetime

Abstract:
We present an operational formalism of information processing, which explicitly takes into account the spacetime aspects of physics. It is inspired by the algebraic approach to quantum field theory and grounded on the foundational principle of locality. The formalism is based on the C*-algebraic approach to quantum information, enhanced by the optimal transport theory. The unique opportunity offered by our formalism is itsgeneral covariance - we allow the quantum systems to evolve on any curved spacetime. The basic channels will be illustrated with simple protocols including the EPR--Bell test, the Mach--Zehnder interferometer and the Hong--Ou--Mandel effect.

Jens Eisert, Free University of Berlin, Germany

Towards verifiable quantum advantages

Abstract:
Quantum simulators and more generally synthetic quantum systems promise to give rise to new insights into dynamical and static properties of complex quantum systems, beyond those accessible on classical supercomputers. There is already some good evidence that quantum simulators have the potential to outperform classical computers. Yet, in order to be prone against arguments claiming a lack of imagination, this superior computational capabilities should be expressed in terms of notions of computational complexity. One of the main milestones in quantum information science is hence to realize quantum devices that exhibit an exponential computational advantage over classical ones without being universal quantum computers in complexity theoretic terms, a state of affairs dubbed exponential quantum advantage or simply "quantum computational supremacy". In this talk, we will discuss several surprisingly simple and physically plausible schemes that once realized show such a quantum advantage. Both aspects of physical implementation are discussed as well as mathematical arguments used in proofs relating to notions of computational complexity. We will see that while there is good evidence that these devices computationally outperform classical computers, they can still be efficiently and rigorously certified in their trustworthy functioning, in an error detecting fashion. While full fault tolerance seems out of scope for such architectures, basic variants of approximate error correction are still conceivable.

Gregory A. Howland, Rochester Institute of Technology, Rochester, NY, USA

Practical approaches for experimentally characterizing large quantum systems

Abstract:
State-of-the-art quantum systems across many platforms far exceed experimentalists' ability to completely determine their quantum state. Instead, any practical characterization method must get by with extremely limited data. I will describe some of our recent efforts for estimating and certifying the amount of quantum entanglement shared by photon-pairs entangled in large dimensions. By exploiting prior knowledge, we dramatically reduce needed measurement resources and are able to certify over 7 ebits of entanglement-of-formation in a 68-billion dimensional quantum system. Our approach does not require numerical optimization and has straightforward error analysis, making it suitable for guaranteeing quantum security.

Krzysztof Kowalski, University of Łódź, Poland

Coherent states in the relativistic quantum mechanics

Abstract:
The coherent states are discussed for a spin-zero relativistic particle on a line.

Thao Le, University College London, United Kingdom

Strong Quantum Darwinism

Abstract:
Quantum Darwinism and spectrum broadcast structure are two similar frameworks that can be used to study the emergence of objectivity (a flavour of classicality). However, a number of recent works have demonstrated that quantum Darwinism and spectrum broadcasting can have conflicting conclusions on the objectivity of state—in particular, quantum Darwinism may conclude objectivity when spectrum broadcasting does not. To resolve this conflict, we define "strong Quantum Darwinism", which distinguishes between classical and quantum information. Subsequently, we prove that strong quantum Darwinism is equivalent to spectrum broadcasting when combined with strong independence of the subenvironments, thus highlighting the correspondence between these frameworks and strengthening our understanding of the quantum-to-classical transition.

Justyna Łodyga, Adam Mickiewicz University in Poznań, Poland

Closed timelike curves and the second law of thermodynamics

Abstract:
One out of many emerging implications from solutions of Einstein's general relativity equations are closed timelike curves (CTCs), which are trajectories through spacetime that loop back on themselves in the form of wormholes. Two main quantum models of computation with the use of CTCs were introduced by Deutsch (D-CTC) and by Bennett and Schumacher (P-CTC). Unlike the classical theory in which CTCs lead to logical paradoxes, the quantum D-CTC model provides a solution that is logically consistent due to the self-consistency condition imposed on the evolving system, whereas the quantum P-CTC model chooses such solution through post-selection. Both models are non-equivalent and imply nonstandard phenomena in the field of quantum computation and quantum mechanics. In this talk we present the implications of these two models on the second law of thermodynamics -- the fundamental principle which states that in the isolated system the entropy never decreases. In particular, we construct CTC-based quantum circuits which lead to decrease of entropy.

Marek Mozrzymas, University of Wroclaw, Poland;
Michał Studziński, University of Cambridge, United Kingdom

Port-based teleportation in arbitrary dimension with optimality studies

Abstract:
Port-based teleportation (PBT) protocol is a variant of quantum teleportation scheme which transmits the unknown state to the receiver without requiring any corrections on his\her side. The lack of mentioned correction allows for many important applications such as engineering efficient protocols for instantaneous implementation of measurements and computation, new attacks on the cryptographic primitives or studies on connection between communication complexity and a Bell inequality violation. Unfortunately,

evaluating the performance of PBT was computationally intractable and up to now all attempts succeeded only with small systems. In our work we study both versions: probabilistic and deterministic PBT scheme, and fully characterize their performance in the most general case by finding optimal resource state and optimal measurements. In the latter case the optimal performance depends only on the largest eigenvalue of a particular matrix which encodes the relationship between a set of Young diagrams. To obtain our results we develop the representation theory of the algebra of partially transposed permutation operators by introducing concept of partially reduced irreducible representations as well as we use extensively theory of semidefinite programming.

Jonathan Oppenheim, University College London, United Kingdom

Entanglement fluctuation theorems

Authors: Álvaro M. Alhambra, Lluis Masanes, Jonathan Oppenheim, Christopher Perry

Abstract:

Pure state entanglement transformations have been thought of as irreversible, with reversible transformations generally only possible in the limit of many copies. Here, we show that reversible entanglement transformations do not require processing on the many copy level, but can instead be undertaken on individual systems, provided the amount of entanglement which is produced or consumed is allowed to fluctuate. We derive necessary and sufficient conditions for entanglement manipulations in this case. As a corollary, we derive an equation which quantifies the fluctuations of entanglement, which is formally identical to the Jarzynski fluctuation equality found in thermodynamics. One can also relate a forward entanglement transformation to its reverse process in terms of the entanglement cost of such a transformation, in a manner equivalent to the Crooks relation. We show that a strong converse theorem for entanglement transformations is related to the second law of thermodynamics, while the fact that the Schmidt rank of an entangled state cannot increase is related to the third law of thermodynamics. Achievability of the protocols is done by introducing an entanglement battery, a device which stores entanglement and uses an amount of entanglement that is allowed to fluctuate but with an average cost which is still optimal. This allows us to also solve the problem of partial entanglement recovery, and in fact, we show that entanglement is fully recovered. Allowing the amount of consumed entanglement to fluctuate also leads to improved and optimal entanglement dilution protocols.

Michał Parniak, University of Warsaw, Poland

Multidimensional quantum optics of spin waves

Abstract:

In a recent experiment performed in our group we demonstrated the ability to generate on-demand single photons using a cold atom quantum memory [1]. The photons originating from a laser-cooled atoms held in a magnetooptical trap are an ideal candidate for implementation of a quantum repeater protocol - an essential component of a quantum communications network. By introducing the multiplexing of angular emission modes we effectively create a highly multimode source of quantum light. We are able to multiplex at least 600 independent modes and store atomic excitations for over 50 µs. The memory feature enables real-time feedback, that could lead to a nearly-deterministic single-photon source.

We also certify that the system contains atom-photon multidimensional entanglement. This is witnessed by entropic methods, which we find particularly well-suited to study position-momentum entanglement. We utilize Bayesian entropy estimation techniques that reliably estimate entropy of a spatial distribution even in the undersampled regime [2].

Along with these ideas I will discuss current efforts to manipulate single photons stored as spin waves in our quantum memory, which could be a way

to realize simple quantum processing protocols within the linear-optical scheme [3]. In particular, we demonstrated Hong-Ou-Mandel interference of two spin waves, which constitutes a primitive protocol of more complex quantum operations

References:

[1] M. Parniak, M. Dąbrowski, M. Mazelanik, A. Leszczyński, M. Lipka, W. Wasilewski, Nat. Commun. 8, 2140 (2017)

[2] M. Dąbrowski, M. Mazelanik, M. Parniak, A. Leszczyński, M. Lipka, W. Wasilewski, arXiv:1711.08948

[3] M. Parniak, M. Mazelanik, A. Leszczyński, M. Lipka, M. Dąbrowski, W. Wasilewski, arXiv:1804.05854

Zbigniew Puchała, Institute of Theoretical and Applied Informatics, Polish Academy of Sciences, Poland

Strategies for optimal single-shot discrimination of quantum measurements

Abstract:

In this talk we consider the problem of single-shot discrimination of von Neumann measurements. We associate each measurement with a measure-and-prepare channel. There are two possible approaches to this problem. The first one, which is simple, does not utilize entanglement. We focus only on discrimination of classical probability distribution, which are outputs of the channels. We find necessary and sufficient criterion for perfect discrimination in this case. A more advanced approach requires the usage and entanglement. We quantify the distance of the two measurements in terms of the diamond norm (called sometimes the completely bounded trace norm). We provide an exact expression for the optimal probability of correct distinction and relate it to the discrimination of unitary channels. We also state a necessary and sufficient condition for perfect discrimination and a semidefinite program which checks this condition. Our main result, however, is a cone program which calculates the distance of these measurements and hence provides an upper bound on the probability of their correct distinction. As a by-product the program also finds a strategy (input state) which achieves this bound. Finally, we provide a full description for the cases of Fourier matrices and mirror isometries.

Łukasz Rudnicki, Max Planck Institute for the Science of Light, Germany; Center for Theoretical Physics, Polish Academy of Sciences, Poland

Mutual unbiasedness in coarse-grained continuous variables

Abstract:

We develop the notion of mutual unbiasedness in the interesting setting of coarse-grained continuous variables. Our goal while constructing coarse-grained mutually unbiased measurements is threefold: to overcome difficulties related to infinite dimension of continuous variables; to make an analogy with finite-dimensional systems; to demonstrate in an experiment, which is a convenient way of implementation for the proposed scheme.

Kazimierz Rzążewski, Center for Theoretical Physics, Polish Academy of Sciences, Poland

Cold dipolar bosons: from many to a few

Abstract:

Quantum degenerate gases typically interact via short range forces. However, of interest are cases, like dysprosium, where long range dipole-

dipole forces are relevant. I will talk about dark solitons and rotons in such systems. I will mention a relation between a simplified mean field approach and the detailed multi particle description, stressing the role of measurement.

Anna Sanpera, University Autònoma Barcelona, Spain

Quantum thermometry: the art of estimating very cold temperatures

Abstract:
What is a quantum thermometer? Why is so notoriously difficult to measure ultracold temperatures with high precision? Are there fundamental limitations for such fact? Is local versus global thermometry a possible strategy to hamper the accuracy of the measurement or are the measurements themselves affecting irremediable the low temperature of a sample? These and closely related questions are of paramount importance in our quest for quantum technologies and forces us to look into novel schemes, some of them, quite counterintuitive, to provide tight bounds on quantum thermometry. Equilibration, strong coupling, entanglement between the probe and sample and open systems dynamics are some of the tools needed to reach the limits of thermometry in quantum domain.

Leszek Sirko, Institute of Physics, Polish Academy of Sciences, Warsaw, Poland

On missing levels in correlated spectra and some unusual properties of microwave networks and quantum graphs

Abstract:
We present experimental studies of the power spectrum and other fluctuation properties in the spectra of microwave networks simulating chaotic quantum graphs with violated and preserved time reversal invariance. We demonstrate that the power spectrum in combination with short-range and other long-range spectral fluctuations provides a powerful tool for the identification of the symmetries and the determination of the fraction of missing levels [1, 2]. Such a procedure is indispensable for the evaluation of the fluctuation properties in the spectra of real physical systems like, e.g., nuclei or molecules, where one has to deal with the problem of missing levels. We also discuss the properties of isoscattering networks and graphs and show that their certain properties are independent from their topology [3, 4].

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References
[1] B. Dietz, V. Yunko, M. Białous, S. Bauch, M. Ławniczak, and L. Sirko, Phys. Rev. E **95**, 052202 (2017).
[2] M. Białous, V. Yunko, S. Bauch, M. Ławniczak, B. Dietz, and L. Sirko, Phys. Rev. Lett. **117**, 144101 (2016).
[3] O. Hul, M. Ławniczak, S. Bauch, A. Sawicki, M. Kuś, L. Sirko, Phys. Rev. Lett **109**, 040402 (2012).
[4] M. Ławniczak, A. Sawicki, S. Bauch, M. Kuś, L. Sirko, Phys. Rev. E **89**, 032911 (2014).

Carlo Sparaciari, University College London, United Kingdom

General framework for multi-resource theories and the first law

Abstract:
The resource theoretic framework is a versatile tool that can be used to describe several different branches of quantum physics, from entanglement theory to thermodynamics. Within this framework, one usually identifies a

single quantity as being the resource associated with the theory. For example, in entanglement theory the resource is entanglement, while in thermodynamics it is work. However, it is often the case in physics that, in order to perform a specific task, one needs more than a single resource. For instance, to perform a quantum computation we need the input states to be both pure and coherent in the computational basis. In this talk, we provide a formalism to describe resource theories with multiple resources, together with a way to uniquely quantify the resources contained in the system. We also study the inter-conversion of resources, i.e., under what circumstances we can exchange one resource with another. The study of interconversion relations allows us to introduce a first law for general multi-resource theories, that is, a single relation that links all the resources exchanged during a transformation with the change in the properties of the main system. We then provide an example, by applying these results to the case of thermodynamics with multiple charges.

Jan Sperling, Oxford University, United Kingdom

From optics to quantum information

Abstract:
The well-developed theory of quantum optics is a versatile prime example when studying the impact of quantum features on a physical system. However, new resource theories provide a much broader understanding of quantum phenomena, beyond optical systems. For this reason, we examine the established methodology of quantum optics and provide its extension to general notions of quantum coherence. Our analyses include the formulation of experimentally accessible witness criteria and novel aspects of the evolution of quantum coherence. Moreover, we generalize the idea of quasiprobabilities from quantum optics for the aim of uncovering quantum coherences. In particular, we characterize multipartite quantum entanglement as one relevant resource in quantum information science.

Aleksander Streltsov, Gdańsk University of Technology, Poland

Entanglement and coherence in distributed scenarios

Abstract:
Understanding the resource consumption in distributed scenarios is one of the main goals of quantum information theory. In this talk I review recent advances in this direction from the point of view of quantum resource theories. I discuss the role of entanglement and coherence as a resource in fundamental quantum protocols for quantum communication, including quantum state merging and quantum state redistribution.

Stanisław Szarek, Sorbonne, France/Case Western Reserve University, USA

PPT separability test via Sinkhorn-Gurvits normal form

Abstract:
We sketch a simple essentially self-contained proof for the 2 x 2 case of Peres-Horodecki PPT separability test. The argument is based on a version of Sinkhorn-Gurvits's normal form for positive maps, in turn proved via Brouwer's fixed point theorem (joint work with G. Aubrun).

Konrad Szymański, Jagiellonian University in Kraków, Poland

Joint expectation values, uncertainty relations and phase transitions

Abstract:
Non-commutativity lies at the heart of quantum theory and provides a rich set of mathematical and physical questions. We address this topic through the concept of the joint numerical range – the set of simultaneously

attainable expectation values for multiple quantum observables. We discuss possible applications of the numerical range in quantum information: new bounds for additive uncertainty relations are provided, phase transitions in exemplary models are explained within this formalism and relevance to the entanglement detection is examined.

Géza Tóth, University of the Basque Country UPV/EHU, Spain

Entanglement between two spatially separated atomic modes

Abstract:
First, a review is given on detecting entanglement with collective measurements in an ensemble of particles with a spin. We show the full set of such entanglement conditions called spin squeezing inequalities. We also show an entanglement criterion that detects multipartite entanglement, i.e., the depth of entanglement, with collective measurements a multi-qubit Dicke state. The method has been used in a cold gas experiment, where a 28-particle entanglement has been detected [1].
In the second part of the talk, a method is introduced that detects entanglement between two halves of a multi-qubit Dicke state. It is based on a simple uncertainty relation with the collective angular momentum components, resembling the angle-phase uncertainty. Our entanglement condition takes into account the various imperfections arising in an experimental realization of the state, such as for instance that the particle number varies from experiment to experiment. The criterion has been used to detect entanglement between two Bose-Eisntein condensates of cold atoms [2].

References:
[1] B. Lücke, J. Peise, G. Vitagliano, J. Arlt, L. Santos, G. Tóth, and C. Klempt, Detecting multiparticle entanglement of Dicke states, Phys. Rev. Lett. 112, 155304 (2014).
[2] K. Lange, J. Peise, B. Lücke, I. Kruse, G. Vitagliano, I. Apellaniz, M. Kleinmann, G. Toth, and C. Klempt, Entanglement between two spatially separated atomic modes, arxiv:1708.02480.

Marcin Wieśniak, University of Gdańsk, Poland

The entire history of a photon

Abstract:
A common agreement on the nature of light seems to be that it propagates as a wave, but cause particle-typical effects. However, more recently, this understanding was somewhat questioned with Danan-Farfunik-Bar-Ad-Vaidman in experiment with a nested Msch-Zender experiment. The experiment includes mirrors or phase modulators operated at various frequencies to mark the presence of photons at various locations in the setup. Not all expected peaks are observed in the spectrum. I analitically present the derivation of spectra in experiments of the type and show, that indeed certain prominent peaks are missing, but higher-order effects (neglected in the experiment analysis) confirm the continuity of propagation of light.

Andreas Winter, University Autònoma Barcelona, Spain

Interferometric visibility and coherence

Abstract:
Recently, the basic concept of quantum coherence (or superposition) has gained a lot of renewed attention, after Baumgratz et al. [PRL 113:140401 (2014)], following Aberg [arXiv:quant-ph/0612146] and Braun/Georgeot [PRA 73:022314 (2006)], have proposed a resource theoretic approach to quantify it. This has resulted in a

large number of papers and preprints exploring various coherence monotones, and debating possible forms for the resource theory. Here we take the view that the operational foundation of coherence in a state, be it quantum or otherwise wave mechanical, lies in the observation of interference effects. Our approach here is to consider an idealised multi-path interferometer, with a suitable detector, in such a way that the visibility of the interference pattern provides a quantitative expression of the amount of coherence in a given probe state. We present a general framework of deriving coherence measures from visibility, and demonstrate it by analysing several concrete visibility parameters, recovering some known coherence measures and obtaining some new ones. (Based on arXiv:1701.05051 with T. Biswas and M. Garcia Diaz.)

Dong Yang, University of Bergen, Norway

Distributed private randomness distillation

Abstract:
We develop the resource theory of private randomness extraction in the distributed and device-dependent scenario. We begin by introducing the notion of independent bits (ibits), which are bipartite states that contain ideal private randomness for each party, and motivate the natural set of the allowed free operations. As the main tool of our analysis, we introduce Virtual Quantum State Merging (VQSM), which is essentially the flip side of Quantum State Merging, without the communication. We focus on the bipartite case and find the rate regions achievable in different settings. Perhaps surprisingly, it turns out that local noise can boost randomness extraction. As a consequence of our analysis, we resolve a long-standing problem by giving an operational interpretation for the reverse coherent information capacity in terms of the number of private random bits obtained by sending quantum states from one honest party (server) to another one (client) via an eavesdropped quantum channel.