ABSTRACTS

6th Iran International Conference on Quantum Information 2018

IICQI-18 8-11 Sept, Sharif University of Technology, Tehran, Iran

Contents

Part I
Talks

1 Talks

1.1 Mehdi Abdi: *Color centers in hexagonal boron nitride membranes: Quantum sensing and quantum simulation*

Department of Physics, Isfahan University of Technology, Iran

Recently observed quantum emitters in hexagonal boron nitride (h-BN) membranes have a potential for achieving high accessibility and controllability thanks to the lower spatial dimension. These objects naturally have a high sensitivity to the vibrations of the hosting membrane due to its low mass density and high elasticity modulus. Here, we propose and analyze a spin-mechanical system based on color centers in a suspended h-BN mechanical resonator. Through group theoretical analyses and ab initio calculations of the electronic and spin properties of such a system, we identify a nonzero spin for the electronic ground state and demonstrate that a spin-motion interaction can be engineered. We present a toolbox for initialization, rotation, and readout of the defect spin qubit. And show that the proposed setup presents the possibility for studying a wide range of physics. To illustrate its assets, we show that a fast and noise-resilient preparation of a multicomponent cat state and a squeezed state of the mechanical resonator is possible. We then discuss about applicability of such states in quantum sensing of weak forces. The setup is also shown to provide the ground for entangling spin degree of freedom of multiple color centers and possibility of engineering their interactions. Hence, allowing us to quantum simulate the dynamics of spin systems.

1.2 Dimitris G. Angelakis: *Quantum simulations with strongly interacting photons : Simulating exotic phases of matter and applications in quantum technology*

Technical University of Crete, Greece, Centre for Quantum Technologies, Singapore

Classical computers require enormous computing power and memory to simulate even the most modest quantum systems. That makes it difficult to model, for example, why certain materials are insulators and others are conductors or even superconductors. R. Feynman had grasped this since the 1980s and suggested to use instead another more controllable and perhaps artificial quantum system as a "quantum computer" or specifically in this case a "quantum simulator". I will briefly review in non-specialist terms the main results in this area including our early ideas on realizing Mott insulators, Fractional Hall states and Luttinger liquids with photons [1,2]. After that I will present in more detail a recent experiment realizing the Hoeftstaedter butterfly and the many-body localization (MBL) transition using interacting photons in the latest superconducting quantum chip of Google [3]. A simple method to study the energy-levels-and their statistics - of many-body quantum systems as they undergo the ergodic to the MBL transition, was proposed and implemented. The formation of a mobility edge of an energy band was observed and its shrinkage with disorder toward the center of the bands was measured. Beyond the applications in understanding fundamental physics, the potential impact of quantum simulators in different areas of quantum and nano technology, material science as well as machine learning and big data processing will be touched upon.

References

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2. "Quantum Simulations with Photons and Polaritons: Merging Quantum Optics with Condensed Matter Physics" by D.G. Angelakis (ed), Quantum Science and Technology Series, Springer, 2017, ISBN 978-3-319-52023-0.

3. P. Roushan, C. Neill, J. Tangpanitanon, V.M. Bastidas,. . . , H. Neven, D. G. Angelakis, J. Martinis, "Spectral signatures of many-body localization with interacting photons in superconducting qubits" Science, 358, 1175 2017

1.3 Angelo Bassi: *Gravitational decoherence and gravitational wave function collapse*

Department of Physics, University of Trieste, Italy

Gravitational decoherence and gravitational wave function collapse will be introduced as two related but conceptually distinct ideas. Some of the most popular models will be reviewed, with an emphasis on their conceptual status, stage of development, and experimental implications.

1.4 Abolfazl Bayat: *Measurement quench in many-body systems*

Institute of Fundamental and Frontier Sciences, University of Electronic Science and Technology of China, China

Measurement is one of the key concepts which discriminates classical and quantum physics. Unlike classical systems, a measurement on a quantum system typically alters it drastically as a result of wave function collapse. Here we suggest that this feature can be exploited for inducing quench dynamics in a many-body system while leaving its Hamiltonian unchanged. Importantly, by doing away with dedicated macroscopic devices for inducing a quench – using instead the indispensable measurement apparatus only – the protocol is expected to be easier to implement and more resilient against decoherence. By way of various case studies, we show that our scheme also has decisive advantages beyond reducing decoherence – for spectroscopy purposes and probing nonequilibrium scaling of critical and quantum impurity many-body systems.

1.5 Fabio Benatti: *Mesoscopic quantum fluctuations*

Department of Physics, University of Trieste, Italy

The first part of the talk will focus upon the algebraic description of collective quantum behaviors by means of observables that scale with the inverse square root of the number of degrees of freedom.Within this setting, it will be discussed the possible emergence of macroscopic entanglement from the dissipative dynamics of large numbers of microscopic degrees of freedom. The second part of the talk will consider modified mesoscopic scalings able to describe the phenomenology of quantum Josephson circuits.

1.6 Dagmar Bruß: *Hypergraph states: properties and applications*

Department of Physics, Heinrich-Heine-Universität Düsseldorf, Germany

Hypergraph states are multiqubit quantum states which generalize graph 11states.They can be described either via the corresponding mathematical hypergraph, or via a non-local stabilizer formalism. We show their properties concerning local unitary equivalence and entanglement, and investigate possible applications for Bell inequality violation and quantum error correction.

1.7 Jens Eisert: *Towards certifiable quantum advantages of quantum devices*

Department of Physics, Freie Universität Berlin, Germany

Quantum devices promise computational speedups over classical computers. Fully-fletched fault tolerant quantum computers, once realized, allow to solve some problems in polynomial time that are believed to be intractable on quantum computers. They do not exist yet, however, despite recent progress in experimental realizations. What does exist are quantum simulators - large scale quantum devices providing new insights into dynamical and static properties of complex quantum systems. 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. 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. The discussed schemes are experimentally implementable and if time allows, we will discuss data from a proof-of-principle experiment involving trapped ions.

1.8 Ting Gao: *Permutationally Invariant Part of a Density Matrix and Nonseparability of N-partite States*

College of Mathematics and Information Science, Hebei Normal University, China

We consider the concept of the permutationally invariant (PI) part of a density matrix and show that the concept is basis dependent. By considering the PI part of a general (mixed) N-partite state, we obtain (i) strong bounds on quantitative nonseparability measures, (ii) a whole hierarchy of multipartite separability criteria that can be experimentally determined by just 2N+1 measurement settings, and (iii) a definition of an efficiently measurable degree of separability, which can be used for quantifying a novel aspect of decoherence of N qubits. Moreover, we show that if the PI part of a state is k nonseparable, then so is the actual state. We further argue to add as requirement on any multipartite entanglement measure.

1.9 Marco Genovese: *Quantum optics as a tool for visualizing fundamental phenomena: from Page - Wootters model of emerging time to open timelike curves..*

Department of Physics, Instituto Nazionale di Ricerca Metrologica, Italy

Quantum optical systems present several interesting properties that allow using them as a tool for visualizing physical phenomena otherwise subject of theoretical speculation only, as Bose Einstein condensation for Hawking radiation [1].Here we consider Page and Wootters [2] model. This model, considering that exist states of a system composed by entangled subsystems that are stationary but one can interpret the component subsystems as evolving, suggests that the global state of the universe can be envisaged as one of this static entangled state, whereas the state of the subsystems (us, for example) can evolve.

In the first part of this talk I will briefly present two experiments addressed to visualise this phenomenon. The first is based on PDC polarisation entangled photons, that allows showing with a practical example a situation where this idea works, i.e. a subsystem of an entangled state works as a "clock" of another subsystem [3]. However, the simple original Page and Wootters model needs some extension for describing several time measurements [4]. Similarly, in our first experiment the use of a two-dimensional clock implies that the time is discrete, periodic and can take only two values: 0 and 1. In a second experiment [5], that I present here for the first time, we use a continuous system (theposition of a photon) to describe time, which gives us access to measurements at arbitrary times and hence arbitrary two-time correlations. As a second example, we consider Closed Time-like Curves (CTC), one of the most striking predictions of general relativity, are another example of untestable theoretical speculation. They are notorious for generating paradoxes, such as the grandfather's paradox, but these paradoxes can be solved in a quantum network model [6], where a qubit travels back in time and interacts with its past copy. However, there is a price to pay. The resolution of the causality paradoxes requires to break quantum theory's linearity. This leads to the possibility of quantum cloning, violation of the uncertainty principle and solving NP-complete problems in polynomial time. Interestingly, violations of linearity occur even in an open time-like curve (OTC), when the qubit does not interact with its past copy, but it is initially entangled with another, chronology-respecting, qubit. The non-linearity is needed here to avoid violation of the monogamy of entanglement. To preserve linearity and avoid all other drastic consequences, we discuss how the state of the qubit in the OTC is not a density operator, but a pseudo-density operator (PDO) - a recently proposed generalisation of density operators, unifying the description of temporal and spatial quantum correlations. Here we present an experimental simulation of the OTC using polarization-entangled photons, also providing the first full quantum state tomography of the PDO describing the OTC, verifying the violation of the monogamy of entanglement induced by the chronology-violating qubit. At the same time the linearity is preserved since the PDO already contains both the spatial degrees of freedom and the linear temporal quantum evolution. These arguments also offer a possible solution to black hole entropy problem.

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1.10 Aeysha Khalique: *Exploring Photon Interferometry: Immanent Calculation and Biphoton Coincidences*

Department of Physics, School of Natural Sciences, National University of Sciences and Technology, Pakistan

We investigate photon interferometry for single and bi-photon coincidences. We propose time-bin entangled states and photon coincidence measurements for direct calculation of immanants of the special unitary transformation representing the interferometer. For n photons injected into an n-channel passive, linear interferometer described by a SU(n) matrix, such that each input port has precisely one photon but the arrival times are entangled according to some character of the permutation group of n elements, the n-photon coincidence rate is proportional to the determinant, permanent and combination of immanants of a partition of the SU(n) matrix, corresponding to the chosen group character. We construct the theory formally for any natural number n and solve explicitly for n=2, n=3 and n=4. In addition bi-photon injection into a three-port interferometer and the related coincidence probabilities at the output are also explored.

1.11 Mohammad Sadegh Khazali: *Applications of highly interacting Rydberg atoms in the generation of large quantum cat states*

Department of Physics - QIS group, Sharif University of Technology, Iran

In the effort towards the generation of macroscopic quantum states, cat state i.e. superposition of maximally different quantum states, are of special interest. Cat states play an important role in the fundamental test of quantum mechanics [1] and quantum metrology [2]. In this talk, I will propose the generation of spin cat state [3,4] within the ultra-stable Cesium atomic clock states, using the strong Rydberg interaction and the fast entanglement generation scheme based on the Lipkin-Meshkov-Glick type Hamiltonian. By detail optimization of all the parameters in the scheme and by considering destructive sources namely spontaneous emission, collective decoherence, molecule formation, level mixing, and simulating decoherence effects using Quantum Jump Monte Carlo, this proposal predicts the generation of 700 atoms cat state. The generated superposition is very demanding in improving the precision of atomic clocks. Following that I will propose the transfer of the created spin cat state to the superposition of vibrational modes of two spatially separated mechanical oscillators using the interaction between Rydberg atoms and charged cantilevers. Thanks to the long-range interaction, the long separation between the superposed elements would be ideal for the test of spontaneous wave-function collapse models [5]. [1] Greenberger, et al., Am. J. Phys. 85, 1131 (1990); Sanders, B. C. Phys. Rev. A 45, 6811 (1992); Wenger, J., et al., Phys. Rev. A 67, 012105 (2003); Jeong, H., et al., Phys. Rev. A 67, 012106 (2003); Stobinska, et al., Phys. Rev. A 75, 052105 (2007). [2] W. Munro et al., Phys. Rev. A 66, 023819 (2002); Leibfried,

D. et al. Science 304, 1476 (2004). [3] M. Khazali, H. W. Lau, A. Humeniuk, C. Simon, Phys. Rev. A 94, 023408 (2016) [4] M. Khazali, arXiv:1711.03821 (2017) [5] A. Bassi, K. Lochan, S. Satin, T. P. Singh, and H. Ulbricht, Rev. Mod. Phys. 85, 471 (2013).

1.12 Jarosław Korbicz: *TBA*

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1.13 Lorenzo Maccone: *Digital quantum metrology*

Department of Physics, University of Pavia, Italy

Quantum Metrology calculates the ultimate precision of all estimation strategies, measuring what is their root mean-square error (RMSE) and their fisher information. Here, instead, we ask how many bits of the parameter we can recover, namely we derive an information-theoretic quantum metrology. In this setting we redefine "Heisenberg bound" and "standard quantum limit" (the usual benchmarks in quantum estimation theory), and show that the former can be attained only by sequential strategies or parallel strategies that employ entanglement among probes, whereas parallel-separable strategies are limited by the latter. We highlight the differences between this setting and the RMSE-based one.

1.14 Archan S. Majumdar: *Tighter Einstein-Podolsky-Rosen steering inequalities*

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In the hierarchy of quantum correlations EPR-steering lies between Bell nonlocality and entanglement, with the latter being the weakest. Steering inequalities analogous to Bell-inequalities have been formulated to rule out the existence of LHS models and demonstrate steerability. The quantum uncertainty principle is of fundamental importance in the manifestation of EPR-steering. Various versions of uncertaintry relations such as entropic uncertainty and fine-grained uncertainty have been used to derive corresponding steering inequalities. An advantage of variance based uncertainty relations is that they are easily amenable for experimental verification compared to other forms such as entropic or fine-grained uncertainty relations. Here we consider two forms of variance based uncertainty relations and show that they lead to tighter steering criteria compared to some existing steering relations. We derive steering inequalities using the Robertson-Schrodinger uncertainty relation as well as a steering relation

based on the sum of variances. The tightness of the obtained uncertainty relations is exemplified for various categories of discrete and continuous variable states. In particular, we show that our sum uncertainty based steering relation matches quantitatively the necessary and sufficient steering condition for two qubits with two measurement settings per party. Moreover, the photon subtracted squeezed vacuum state is shown to reveal steering in regions that are not displayed upon using other exisiting steering inequalities.

References:

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2. A tighter steering criterion using the Robertson-Schrodinger uncertainty relation, S. Sasmal, T. Pramanik, D. Home, A. S. Majumdar, Phys. Lett. A 382, 27 (2018).

1.15 Hamed Mohammady: *A quantum Szilard engine without heat from a thermal reservoir*

Condenced Matter Theory Group, Lancaster University, United Kingdom

We study a quantum Szilard engine that is not powered by heat drawn from a thermal reservoir, but rather by projective measurements. The engine is constituted of a system S, a weight W, and a Maxwell demon D, and extracts work via measurement-assisted feedback control. By imposing natural constraints on the measurement and feedback processes, such as energy conservation and leaving the memory of the demon intact, we show that while the engine can function without heat from a thermal reservoir, it must give up at least one of the following features that are satisfied by a standard Szilard engine: (i) repeatability of measurements; (ii) invariant weight entropy; or (iii) positive work extraction for all measurement outcomes. This result is shown to be a consequence of the Wigner-Araki-Yanase (WAY) theorem, which imposes restrictions on the observables that can be measured under additive conservation laws. This observation is a first-step towards developing "second-law-like" relations for measurement-assisted feedback control beyond thermality.

1.16 Klaus Mølmer: *Measurement signals, correlation functions and quantum trajectories*

Department of Physics, Aarhus University, Denmark

Glauber's theory of photodetection and the quantum master equation permit calculation of average values and correlations in signals from light emitting quantum systems. For decades, these theories formed the main curriculum of theoretical quantum optics (with occasional interpretations offered by the intuition of measurement back action and quantum jumps). With the development of quantum trajectory theory we can now track the dynamics of individual, open quantum systems, conditioned on a real (or simulated) measurement record. Quantum trajectories thus establish a link between master equation theory and the general theory of quantum measurement and it fills a need for the modelling and control of individual quantum systems.After a brief review of the above concepts, I shall discuss how the measurement back action in the quantum trajectories establishes a general, rather than just occasional, connection between the noisy detection records and their statistical correlations. The theory will be illustrated with a number of examples.

1.17 Jonathan Oppenheim: *Entanglement batteries and fluctuation theorems*

Department of Physics and Astronomy, University College London, UK

Both thermodynamics and entanglement are examples of resource theories and have a closely related mathematical structure. This allows us to apply results from one field to derive new ones in another. For example, in entanglement theory, there are many constraints on state transformations, and in thermodynamics, this translates into the existence of many second laws. Likewise, fluctuation theorems from thermodynamics can also be found in entanglement theory. These connections are made possible due to a recent result showing the relationship between fluctuation relations and majorisation theory. Based on https://arxiv.org/abs/1709.06139. Joint work with Álvaro M. Alhambra, Lluis Masanes, and Christopher Perry.

1.18 Matteo Paris: *Quantum metrology: the quantum Cramer-Rao bound and beyond*

Department of Physics, University of Milan, Italy

Quantum estimation theory (QET) is a powerful tool for quantum metrology and the search of new physics. This talk is devoted to QET and it is divided in two parts. In the first part, I provide an invitation to QET, introducing ideas and methods from scratch, and providing examples of application. In the second part, I go back to foundation of QET and emphasize that a crucial assumption to prove the quantum Cramer-Rao theorem is that the unknown parameters label the possible states of the system, while they influence neither the sample space of outcomes, nor the measurement aimed at extracting information on the parameters itself. However, there are relevant estimation problems where this assumption does not hold and an alternative approach should be developed to find the genuine ultimate bound to precision of quantum measurements. We investigate physical situations where there is an intrinsic dependence of the measurement strategy on the parameter, and find that quantum-enhanced measurements may be more precise than previously thought.

1.19 Mauro Paternostro: *Revealing quantumness without looking*

Department of Physics, Queens University Belfast, UK

Your prankster friend gave you a box into which, he says, there is a quantum system. He asks you to hold the box for him, and not to ruin the fragile quantum system that is inside. But you do not trust him and want to find out if he is telling the truth or not. How would you ascertain that the system within your friend's box is indeed genuinely quantum? As preposterous as this situation might sound, it is not far from conditions routinely found in quantum labs: the direct revelation of the non-classical properties of a system is often either too disruptive for the system itself (if you measure it, you ruin it!), or simply technically difficult to realise (the system might be difficult to access, just like the one in your friend's box). In this talk I will illustrate a scheme based on quantum communication and the theory of quantum correlations, that allows you to "certify" the quantum nature of an inaccessible system. I will show how, besides its fundamental interest, the scheme is prone to verification in a number of experimental settings, including quantum optomechanics. finally, I will conjecture that it can be used as a trojan horse to investigate the possible quantum nature of gravity – for which I will describe a recent proposal for an experiment – and biological processes.The work presented in this talk is based on the following papers

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[see also Synopsis in Physics: https://physics.aps.org/synopsis for/10.1103/PhysRevLett.119.240402]

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1.20 Ángel Rivas: *TBA*

Departamento de Física Teórica I, Universidad Complutense de Madrid, Spain

TBA

1.21 Barbara Terhal: *Quantum Error Correction with the Toric-GKP code*

Department of Physics, Delft University of Technology, Netherlands

One can encode a qubit in a bosonic mode and the Gottesman-Preskill-Kitaev (GKP) code is an interesting example of such bosonic code, of experimental interest in the circuit-QED community. We show how the decoding problem of repeated noisy error correction on a single GKP qubit represents the evaluation of a 1D Euclidean path-integral of a particle moving in a random cosine potential. We demonstrate the efficiency of a minimal-action decoding strategy numerically. One may concatenate these GKP qubits with Kitaev's toric code to obtain a toric-GKP code for scalable quantum error correction. We show by analytical and numerical means how this code has a threshold and how it differs from the usual analysis for the toric code.

1.22 Fengli Yan: *Exploration of multipartite entangled states by using weak nonlinearities*

College of Physics Science and Information Engineering, Hebei Normal University, China

We propose several schemes for exploring multipartite entangled states based on linear optics and weak nonlinearities. Compared with the previous schemes the present methods are more feasible because there are only small phase shifts instead of a series of related functions of photon numbers in the process of interaction with Kerr nonlinearities. In the absence of decoherence we analyze the error probabilities induced by homodyne measurement and show that the maximal error probability can be made small enough even when the number of photons is large. This implies that the present schemes are quite tractable and it is possible to produce entangled states involving a large number of photons.

1.23 Mário Ziman: *Incompatibility and nonlocality in quantum process*

Institute of Physics, Slovak Academy of Science, Slovakia

I will introduce the quantum process theory as an existing example of general probabilistic theory. Further, I will study the incompatibility of the measurements in such framework pointing out the qualitative and quantitative differences from the incompatibility of POVMs. These results motivate the analysis of nonlocality and we will show that in CHSH settings this framework beat the Tsirelson bound and achieve the maximal algebraic value.

Part II
Posters

2 Posters

2.1 Tahereh Abad: *Critical slowing down in multi-atom entanglement by Rydberg blockade*

Department of Physics - QIS group, Sharif University of Technology, Iran

Laser excitation pulses that lead to perfect adiabatic state transfer in a cloud of three level ladder atoms lead to highly entangled states of many atoms if their highest excited state is subject to Rydberg blockade. We show that difficulties to ensure the adiabatic evolution as the number of atoms increases are due to a quantum phase transition-like behavior of the system. This transition is quantified by a diminishing energy gap, and we show that macroscopicity measure, work fluctuations, ground state fidelity, and Kibble-Zurek scaling confirm a quantum phase transition-like behavior of the system.

2.2 Farkhondeh Abbasnezhad: *Dynamics of entanglement and decoherence of three-mode full symmetric Gaussian states in a bosonic bath*

Physics Department, Shahid Chamran University of Ahvaz, Iran

we study the continuous variable entanglement and decoherence of an open quantum system consisting of three uncoupled oscillators interacting with a bosonic bath in a thermal equilibrium state. Assuming Born-Markov approximation, we solve the Lindblad master equation. Then, the entanglement and decoherence evolution of two important examples of full symmetric Gaussian states, GHZ and T states, have been described. With the use of PPT criteria and purity, it has been shown that the relaxation rate to entanglement sudden death (RRESD) is an increasing function of temperature, dissipation coefficient and noise while it is decreasing function of squeezing. Moreover, it is observed that decoherence occurs sooner with the increase of all the involved parameters. In addition, we compare the results for two initial states (GHZ and T states) and it is observed that the entanglement of the system with GHZ initial state can survive more.

2.3 Ashkan Abedi: *SCP in special probabilistic quantum networks*

Department of Physics, Sharif University of Technology, Iran

Quantum networks play a major role in quantum communication and quantum information processing. In a quantum network, a set of qubits are prepared and distributed in different nodes and the generated entanglement is considered as the quantum resource.

2.4 Maryam Afsary & Sadeq Salehi: *A Carnot-like Heat Engine*

Department of Physics - QIS group, Sharif University of Technology, Iran

The operation of the network is by performing local measurements and classical communications in arbitrary nodes. Since each measurement exploits entanglement, two important topics are: 1- Studying the entanglement resource in the initial network. 2- Optimising measurement protocols.

2.5 Borhan Ahmadi: *Quantum Thermodynamic Force and Flow*

Department of Physics, University of Kurdistan, Iran

In this poster, a special kind of probabilistic quantum network is introduced and the distribution of SCP is studied as a figure of merit to measure the performance of the network.

2.6 Azadeh Ahmadian: *comparing efficiency of two integrated system including source and fiber including two different sources*

Science/Physics/Atomic Molecular Group, Tarbiat Modares University, Iran

Quantum Networks, which are recently very interesting includes many elements such as quantum sources, channels, nods, quantum repeaters, quantum protocols and detectors. There are many challenges for employing each of them. In this research, one of these challenges, which is related to the interface between photons and single-mode fibers is investigated. For this aim, two different sources are considered: one is a nitrogen-vacancy center in diamond as a good candidate for single photon source, and the other is a nanotube carbon as a newly introduced single photon source. The results of Electromagnetic fields, powers, and energy are compared and as a conclusion, the collection efficiency is estimated for both of sources and the more appropriate integrated fiber-source system is introduced.

2.7 Sakineh Ashorisheikhi: *Multiaxial Classification of Symmetric N-Qubit Mixed states into Entanglement Classes*

Physics Department, University of Golestan, Iran

Entanglement is a key source for quantum Computation and quantum information. Classification of Multipartite entangled states is of paramount importance because states belonging to each class can be used for similar quantum computation tasks. We develop here a method of classifying entanglement equivalent classes under Local Unitary (LU) transformation of symmetric N-qubit mixed states based on multiaxial representation of the density matrix. In addition to the two parameters characterizing the symmetric pure states, namely, diversity degree and degeneracy configuration, we define another parameter called rank. A recipe to identify the most general symmetric N-qubit pure separable state is also given. LU Classification and separability of some entangled states is studied in details.

2.8 Marzieh Asoudeh: *Sequential quantum secret sharing*

Department of physics, Azad University, Tehran, Iran

Quantum protocols for secret sharing usually rely on multi-party entanglement which with present technology is very difficult to achieve. Recently it has been shown that sequential manipulation and communication of a single d-level state can do the same task of secret sharing between N parties, hence alleviating the need for entanglement. However the suggested protocol which is based on using mutually unbiased bases, works only when d is a prime number. We propose a new sequential protocol which is valid for any d.

2.9 Mahsa Azhdargalam: *Criterion for detection of genuine multipartite continuous-variable entanglement*

Department of Physics, Azarbaijan Shahid Madani University, Iran

We propose a criterion for detecting genuine multipartite continuous-variable entanglement. This criterion is based on the condition introduced by Shchukin et al. [E. Shchukin and P. van Loock, Phys. Rev. A 92, 042328 (2015)]. As the bound of our criterion is greater than theirs one, it is able to detect more genuine entangled states. We illustrate this through an example.

2.10 Ali Beheshti: *Comparing the optimal measurement of relative quantum information encoded in product and entangled spin pairs*

Department of Physics - QIS group, Sharif University of Technology, Iran

The notion of relative and collective quantum information of composite quantum systems for the case of entangled and product spin pairs is discussed and then the efficiency of them for communicating a relative parameter is compared. The results shows that making use of entanglement can be, the same as many other quantum information processing tasks, beneficial and provide a better probability of success for measuring an encoded relative information in the case of spin pairs.

2.11 Fateme Bibak: *Quantum algorithms for state preparation on IBM mechine*

Department of Physics - QIS group, Sharif University of Technology, Iran

Quantum simulation is composed of three steps: initial state preparation, time evolution simulation, and variable measurement. Here, we deal with the first step, initial state preparation. For this goal, we begin by deriving the preparation circuit for an arbitrary initial state and a Gaussian wave packet. finally, we investigate how to prepare a circuit for a Matrix Product State (MPS). The benefit of MPS is that it bounds the exponentially growing Hilbert space and limits the entanglement between parts of the system. Thus, initial state preparation of MPS is of great importance.

2.12 Mohammad Bohloul: *Demonstration of Memory effect in Opto-mechanical Micro-Macro Entanglement*

Department of physics, Payame Noor University, Iran

We , use the setup the addition of a non- markovian environment inside the cavity ,seeking to refresh and stabilize macroscopic entanglement. One of the goals is examine the boundaries between the macroscopic and microscopic worlds. In the setup, an entanglement state of the two squeezed-optical modes produced by the SPDC is initially developed and send one mode directly to the detector. Another mode is first amplified by using a displacement field, and then we send this mode to a Cavity. By storing this mode in a mechanical cavity oscillator, we create an opto-mechanical entanglement. The result is that in the absence of a memory-based environment, macroscopic-optomechanical incoherence is rapidly increasing by increasing the number of photons from (sudden death). However, in the presence of a spatially stored medium, the volatility of the entanglement with a large number of photons decreases to zero.

2.13 Mahmoud Bordbar & Negar Naderi: *The study of randomized graph states entanglement*

Department of Physics, Shahid Chamran University, Iran

In this research, we show that randomized graph states, for p (probability parameter) between zero and one are mixed, and find the maximum of mixture for 2 qubit randomized state, 3 qubit full randomized state and 3 qubit tree randomized state In the following, we study entanglement evolution in terms of p by use of negativity measures and show that in this range (between zero and one) by increasing p, a system entanglement increases. Also, by comparing the full randomized state and the tree randomized state, we observe that the full graph state entanglement is more than the tree graph state entanglement, but by increasing full randomized graph states or tree randomized graph states decrease.

2.14 Hazhir Dolatkhah & Soroush Haseli: *Tighten entropic uncertainty relations for multiple measurements and application in quantum coherence*

Department of Physics, University of Kurdistan, Iran

We present a method by which uncertainty relations without the presence of quantum memory can be converted to uncertainty relations in the presence of quantum memory. We show that the lower bounds obtained by this method will be tighter in comparison with the bounds that have been achieved so far. We use this method to obtain the uncertainty relations for multiple measurements in the presence of quantum memory. We also provide lower bounds on the sum of the relative entropies of unilateral coherence of a given state, and show which lower bound is tighter.

2.15 Mina Doosti: *Universal superposition of orthogonal states*

Department of Physics - QIS group, Sharif University of Technology, Iran

It is known that no quantum process can produce a predetermined superposition of unknown arbitrary states. It has already been shown that with some partial information about the states, one can produce with some probability such superpositions. In general the success probability of these machines, even for orthogonal states, are less than unity. Here we show that there are specific machines that can produce superpositions of orthogonal qubit states with unit probability.

2.16 Marco Fanizza: *Optimal programmable machines for quantum state discrimination*

Classe di Scienze Matematiche e Naturali, Scuola Normale Superiore, Italy

A basic machine learning setting is supervised learning, which deals with the task of inferring a labeling rule on a data set, given a certain number of labeled points.
We consider a formulation of this problem in the quantum setting, where a quantum programmable machine aims to identify an unknown state of a two-dimensional quantum system (qubit). This task is a generalization of quantum state discrimination: an agent is presented with a quantum system Q and asked to identify its state knowing that the latter was randomly drawn from an ensemble of possible alternatives
which are not provided as classical information but encoded in a collection of quantum ancillary systems initialized into the same template states the agent has to assign to Q. Explicit expressions for the asymptotic behavior of the optimal excess risk functions are provided under a number of different classical prior information.

2.17 Majid Hassani: *Continuity of the quantum fisher information*

Department of Physics - QIS group, Sharif University of Technology, Iran

We prove extended continuity properties for the quantum fisher information (Qfi) and the symmetric logarithmic derivative (SLD) for arbitrary density matrices. These roperties are general and irrespective of dynamics or how quantum states acquire their parameter dependence. Specifically, the extended continuity implies that in general cases the Qfi and the SLD are not necessarily continuous functions of density matrices. The Qfi and the SLD, however, become respectively close for two close density matrices with close first derivatives (with respect to the unknown parameter). However, when dependence of the states on an unknown parameter comes from a given general dynamics (as in general dynamical metrology scenarios), these properties reduce to the usual continuity. In the making of our main results, we also introduce a regularized SLD which works for general density matrices even with incomplete rank. We also illustrate our results with two further examples.

2.18 Ali Hosseinzadeh Aghdam: *Quantum-Controlled Transmittance In One-dimentional systems Surrounded by Quantum Rings*

Department of Physics, Institute for Advanced Studies in Basic Sciences, Zanjan, Iran

In this work, we investigate the transport of charged particles through a quantum wire in the presence of an external potential imposed by charged quantum rings. Using a 2D harmonic potential as the transverse constraint, we investigate the transport of the electron through the wire. We show that in the low energy limit, for a suitable configuration,which fulfills the resonance conditions, the CIR condition is met which in turn, enables us to control the transport of the particle. In the rest, we look for some practical requirements for a switchable spin-current and realizing a kind of qubit based on spin-orbit coupling.

2.19 Farzad Kianvash: *Optimal Quantum Subtractor*

School of Natural Science, Scuola Normale Superiore, Italy

Quantum No-Go Theorems and how to bypass them with Optimal Machines have had a significant importance since the beginning of Quantum Information Theory. In this poster, I will present No Subtraction Theorem and the Optimal Subtracting Machine and its applications. The Optimal Subtracting Machine acts like the inverse of Incoherent Quantum adder which adds two density matrices with some probabilities. In fact, the Optimal Subtraction Machine is designed to subtract a density matrix from the other with high fidelity. We try to find the optimal machine and the highest achievable fidelity.

2.20 Behzad Lari: *Quantum Authentication Protocols for GSM*

Physics Department, Ahvaz Azad University, Iran

Security deficiencies and bugs in Authentication of SIM cards in Global Systems for Mobile (GSM) have led us to present new protocols for these networks using the principles of quantum cryptography. In this paper first, we provide a protocol for detecting and removing SIM card that has a copy, using three entangle particles source and quantum channel when the original SIM card and its copy simultaneously logging in the mobile network. Then, another protocol based on the use of quantum memory (which is embedded in SIM card) is presented. Both of these protocols can use to authenticate and remove SIM card that has a copy.

2.21 Peyman Mahmoudi: *Identifying Locations and Number of Quantum Change Points*

Department of Physics, Azarbaijan Shahid Madani University, Iran

Dynamical systems with random abrupt changes in a wide variety of applications including medicine, finance, civil engineering modeled by a sequence of random variables are described by a finite number of structural parameters.

Detecting the unknown change points and their locations can help people avoid unnecessary losses, improving quality, and controlling the causes. Here we extend detecting abrupt change points and their location in the quantum domain. We consider a sequence of N given particles supposed that all be in a default state. We find the optimal measurement of two common strategies of quantum state discrimination (Unambiguous and Minimum Error Discrimination) to identify the number of particles that have changed their state and location. The local measurement of both strategies are globally optimal but surprisingly, when states of particles after the change is unknown, local measurements essentially underperform the optimal quantum measurement although each particle changed independently.

2.22 Nayereh Majd: *A quantum heat engine as a quantum thermometer*

College of Engineering, University of Tehran, Iran

Optimal estimation of temperature in quantum systems has attracted much attention recently due to its various fundamental and technological applications. In this article by considering an interaction Hamiltonians between the probe and sample, we consider a quantum probe in thermal equilibrium with the sample. We investigate optimal probe Hamiltonian for highest sensitivity of thermometry, when the probe interacts with the sample. We find that in any case of sample, by choosing suitable interaction strength one can reach to a more sensitive thermometer with a restriction on its energy levels. We also consider our model of estimation as a Heat engine with Carnot cycle and efficiency, and investigate the highest efficiency requires the most sensitive thermometer satisfies the restriction on its energy levels. In the limit of very large number of thermometer energy levels we reach to the Carnot efficiency. finally we illustrate our results through an example

2.23 Azam Mani: *A class of analytically solvable Markovian master equations*

College of Engineering, University of Tehran, Iran

Most physical systems are not isolated and have interactions with their surrounding environments. Such systems have complicated dynamics which is not described by the Schrodinger equation. In the regime of weak interactions, when specific approximations are valid, the dynamics of the density matrix of the system will be described by the Markovian master equation. This equation provides $O(d^2)$ coupled differential equations which should be solved to find the dynamics of a d-dimensional density matrix. The point is that the number of coupled differential equations increases exponentially with the number of particles involved in the system ($d = 2^N$). Here we present a class of Master equations for which the number of coupled equations can be reduced and increases only linearly with the number of system particles. That is the class of master equations for which the Lindblad operators are the ladder operators of the Cartan sub-algebra of a semi-simple algebra. For such systems, the Casimir operator is the constant of motion and hence the dynamics of the system will be restricted to a sub-space with the specific value of Casimir operator, which is determined with the initial state.

2.24 SafouraSadat Mirkhalaf: *Robustifying Twist-and-Turn Entanglement with Interaction-Based Readout*

Qstar, LENS, University of Florence, Italy

The use of multi-particle entangled states has the potential to drastically increase the sensitivity of atom interferometers and atomic clocks. The Twist-and-Turn (TNT) Hamiltonian can create multiparticle entanglement much more rapidly than ubiquitous one-axis twisting (OAT) Hamiltonian in the same spin system. In this paper, we consider the effects of detection noise - a key limitation in current experiments - on the metrological usefulness of these nonclassical states and also consider a variety of interaction-based readouts to maximize their performance. Interestingly, the optimum interaction-based readout is not the obvious case of perfect time reversal. Authors: Safoura S. Mirkhalaf, Samuel P. Nolan, and Simon A. Haine

2.25 Tahmineh Mohammad Ali Zadeh: *Non-Markovian Dynamic In The Extended Cluster Spin-1/2 Xx Chain*

Physics Department, University of Guilan, Iran

We have studied the dynamics of quantum correlation between the nearest neighbor pair spins in the 1D spin-1/2 with TSI. We have implemented the fermionization technique to find analytical results. The desired quantum open system can be coupled to the environment through both two-point Heisenberg and TSI interaction. Although revival phenomenon of quantum correlations as an indication of non-Markovian dynamics is observed for TSI stronger than Heisenberg interaction, the study of the trace distance has proven that the dynamical phase transition from Markovian to non-Markovian regime happens at a critical value where the TSI is equal to the half of the Heisenberg interaction. The dynamics of system is Markovian in the absence of the TSI. However, in the presence of the TSI, Markovian dynamics remains unchanged up to a critical value where non-Markovian dynamics shows up.

2.26 Zohre Nafari Qaleh: *Upper Bound for Efficiency of Quantum Heat Engines*

Department of Physics - QIS group, Sharif University of Technology, Iran

Heat engine is a machine which performs between two reservoirs with different temperatures ($T_c < T_h$) and converts heat energy to mechanical work.

It gets its energy from high temperature reservoir and converts part of it to useful work and gives the rest of the heat energy to the cold reservoir. There is an upper bound for efficiency (the ratio of work and obtained heat) of heat engines in the classical thermodynamics, i.e. the Carnot efficiency. Quantum heat engine (QHE) similar to classical heat engine is in contact with two non interacting reservoirs. Here, by using Alicki's definitions for heat and work, a general relation and an upper bound for efficiency of quantum heat engines has been derived without using any approximation. Furthermore, correlation heat has been defined which depends on the interaction between system and reservoirs. Our result shows the efficiency of QHE in addition to Carnot efficiency depends on the correlation heat, entropy and energy change of the system and also relative entropy between initial and final states of the total system.

2.27 Farshad Nejadsattari: *Simulating Cyclic Quantum Systems by Single Photons*

Department of Physics, University of Ottawa, Canada

A proper understanding of many phenomena in condensed matter physics is through examining their topological effects. In recent years, exploiting quantum simulators in studying topological properties of simple periodic systems (such as one- and two- dimensional) via invoking single photons has received numerous interests. These photonics quantum simulators are potentially useful in describing the physical properties emerging from the dynamics of electrons in periodic structures and can also be used in designing novel quantum computational systems. In this aspect, generalizing these simulators to consider closed geometries such as ring-shaped structures can lead to a broader range of simulating quantum mechanical phenomena in physics and chemistry. For instance, in aromatic molecules such as benzene or ozone, the transport properties and preferred bond formation is well-understood based on the specific spatial and spin distributions of their valence electrons. Classical simulators are not efficient in describing the mechanisms governing the underlying dynamics and physics of such systems.In this work, we propose a theoretical and experimental model based on the discrete time quantum walk of single photons on a cyclic structure composed of a finite number of identical sites. In particular, we simulate electron wave-packet dynamics under different initial conditions and different quantum walk gates for a six-sited geometry, namely simulating the benzene molecule. We examine charge transport, bond formation, and charge localization, as well as the energy dispersion and group velocity relations in cyclic systems with our photonic quantum simulator. Our model and experiment can be conveniently generalized to more complicated systems using scaling techniques such as micro/nano-fabrication methods.

2.28 Samad Oskouei: *Quantum union bound for sequential projective measurement*

Mathematics Group, Varamin Azad University, Iran

We will give a generalization the Gao's union bound from probability theory which s many applications in quantum communication theory, quantum algorithms, and antum complexity theory. The proof is only on basic properties of projectors, the Pythagorean theorem, and the Cauchy– Schwarz inequality. At the end, we will give a non-trivial application of this bound in the sequential decoding strategy for classical communication over a quantum channel achieves a lower bound on the channel's secon

2.29 Roya Radgohar: *Global entanglement and quantum macroscopisity in quantum phase transition*

Department of physics, University of Shiraz, Iran

We study Ising and anisotropic quantum phase transitions occurring in the XY Heisenberg chain in the transverse magnetic field using the Meyer-Wallach of (global) entanglement as well as macroscopic superposition (macroscopisity). We present analytical expressions of the measures and obtain critical exponents via finite-size scaling with great accuracy for the Ising quantum phase transition. Also, we show that the measures show a cusp singularity across the anisotropic quantum phase transition. Our results prove that the thermodynamic limit exhibits properties which one would have never seen for finite N, even for very large values of N. finally, we compare the computational costs of the measures and conclude that the global entanglement, despite its relative simplicity, can completely identify all the rich structure of ground-state Heisenberg chain.

2.30 Morteza Rafiee: *Irreversibility and quantum correlations in an optomechanical system enhance by Duffing nonlinearity at high initial temperature*

Department of Physics, Shahrood University of Technology, Iran

In this paper, we study theoretically irreversibility generated by a stationary dissipative process in an optomechanical system with mechanical Duffing nonlinearity. We consider the effects of mechanical mode squeezing achieved as the effect of Duffing nonlinearity on steady state entropy production. Here, we show that strong nonlinearity in the steady state at high initial temperature leads the system out of equilibrium. Moreover, this strong nonlinearity enhances stationary quantum correlations such as mutual information and quantum discord.

2.31 Atefeh Ramazani: *Studying the role of entanglement in a iterated quantum prisoner dillema*

Physics department, Shiraz university, Iran

It has been known that the entanglement plays the main role in distinction between quantum games and classical games. Specifically, in quantum prisoner's dilemma game, this problem has been discussed in different ways. In this work, we consider an iterated version of the quantum prisoner's dilemma. We study the rule of entanglement in this game where we consider average degree of entanglement in the iterated game. In particular, we choose the degree of entanglement from a distribution function and compute mean value of pay-off for each player. We show that there is sharp transition from classical to quantum domain when we change the width of distribution. In the other words, we show that, unlike an ordinary quantum game, we can find a case that there is no transition domain with two Nash-equilibriums.

2.32 Maryam Rastkar: *Distance and fidelity of non inertial Werner states in comparison to the inertial one*

Department of Physics, University of Mohaghegh Ardabili, Iran

We will investigate the Werner pseudo entangled state based on vacuum and single-particle states of the fermionic modes for a certain momentum with both parts of the states assumed to be within the inertial frame. We then consider one part of the system as accelerating, which concludes in changes of the accelerated state in comparison to the initial state. We evaluate the quantum distance and fidelity of non-inertial and inertial states for investigation of the measure of variations in single and beyond single-mode approximation. Also, we can consider the acceleration as a quantum channel and evaluate the channel quality for Werner states.

2.33 Marc-Olivier Renou: *Self-testing entangled measurements in quantum networks*

Group of Applied Physics, Geneva University, Switzerland

The advent of quantum communication paves the way towards the development of quantum networks, where local quantum processors exchange information and entanglement via quantum links. It is therefore important, though challenging, to devise certification methods for ensuring the correct functioning of such a complex structure. The first step consists of certifying the correct operation of the building blocks of the quantum network, e.g. sources producing entanglement and nodes performing local quantum operations. Many "self-testing" techniques have been developed to certify sources of entangled states, in a totally device independent way. E.g., based on the degree of violation of the CHSH inequality, one can certify that the (uncharacterized) entangled state prepared in an experiment is close to a maximally entangled state of two qubits. The problem of certifying entangled quantum measurements has received much less attention. No existing method gives a precise characterization of the (entangled) measurement. In this work we present self-testing methods tailored to entangled quantum measurements. We start our presentation with the illustrative and important case of the Bell state measurement (BSM), showing that in the entanglement swapping scenario, in which the two extremal parties performs the standard measurement for maximal violation of the CHSH inequality, the statistics self-test the full scenario and therefore the BSM (under the assumption that the extremal parties have no interaction). We then show a robust version of that result and present a general approach for self-testing entangled measurements, applying it to various examples such as the Tilted Bell State Measurement and the GHZ Measurement. We conclude with some open questions and discuss experimental possibilities. PS: The corresponding paper will be on arxiv soon, before summer.

2.34 Fatemeh Rezazadeh: *Secure alignment of coordinate systems by using quantum correlation*

Department of Physics - QIS group, Sharif University of Technology, Iran

I will present a method for direction sharing, in this method two parties far apart can use shared entangled states and classical communication to align their coordinate systems with a very high fidelity. Moreover,compared with previous methods proposed for such a task, i.e. sending parallel or anti-parallel pairs or groups of spin states, this method has the extra advantages of using single qubit measurments and also being secure, so that third parties do not extract any information about the aligned coordinate system established between the two parties. The latter property is important in many other quantum information protocols in which measurements inevitably play a significant role.

2.35 Vahid Rezvani: *Dynamical Control of Open Quantum Systems*

Department of Physics - QIS group, Sharif University of Technology, Iran

A quantum system exposes to differnet noises due to interaction with its surronding environments. These interactions have destructive effects on quantum resources such as entangelment and quantum coherence. Thus the control of an open quntum system is a vital task to decrease these effects. Here we shall propose an approach for dynamical control of an open quantum system based on optimal control theory. first we derive a dynamical equation for process matrix (this matrix contains all information about the dynamic of an open quantum system). This dynamical equation has been obtained under some approximations such as Born-Markov and secular approximations. Then by using this equation and optimal control theory, the general scheme to control of the system dynamic has been proposed. By using this scheme, an optimal field has been designed to guide the dynamic of an open quatum system to a unitary evolution, generated only by the system Hamiltonian, at a predetermined final

time. The numerical results show that an open quantun system decouples from its environment partially by this scheme. This decoupling is acheived with an appropriate fidelity at a small predetermined time. Also this dynamical control scheme enables us to design a desired Hamiltonian. For example, a designed optimal field can simulate Hadamard Hamiltonian at a predetermined final time for an open quantum system. This simulation has been performed with a rather high fidelity. In this work, we have expressed our results only for one qubit which interacts with its surronding environment based on pure dephasing model.

2.36 Fereshteh ShahBeigi: *How quantum is a quantum walk?*

Department of Physics, Ferdowsi University Of Mashhad, Iran

We consider the question of characterizing quantumness of so-called quantum random walks. Our measure is based on comparing a quantum walk with its associated nearest classical random walk, and transcends the existing measures in finding quantum properties. We also introduce a technique to attribute a classical random walk to a quantum walk by a contraction noise channel. We then define *total* quantumness for a walk as the minimum quantum relative entropy of a walker with respect to its genuinely classical cousin. This stronger nonclassicality measure is shown to include quantum coherence as well, and thus can have numerous applications. We discuss several examples to represent how this measure behaves under various quantum or classical noise scenarios. In particular, we employ our quantumness measures to investigate energy transfer or quantum transport on graphs, which has recently gained much attention and applications, e.g., in photosynthesis. We show that a nonvanishing quantumness measure unambiguously implies that a quantum-walk-based process can reach a higher energy/transport efficiency compared to its classical counterparts, and that decay noises do not necessarily kill all quantum effects in such processes—whence providing a partial explanation for why such processes may outperform relevant classical effects.

2.37 Zahra Shaterzadeh-Yazdi: *Assembly rules for silicon-surface defects with applications for quantum computing*

College of Engineering, University of Tehran, Iran

Silicon-surface defects have been recently used as building blocks for new computing paradigms, such as quantum computing, quantum cellular automata, and atomic-scale nanoelectronic systems. We employ ab-initio quantum chemical simulations to examine the details associated with the coupling between two surface defects sharing one excess electron and arranged in various configurations on models of phosphorous-doped hydrogen-terminated silicon (100) surfaces. Our results demonstrate that models for approximating coupling, such as the WKB method, that do not incorporate the details of the structure are incapable of providing reasonable estimates of coupling strength. Furthermore, our results reveal that the structure of the silicon surface has a significant effect on how the defects couple with each other. These results provide assembly rules for the efforts related to the development of defect-based computing elements.

2.38 Mohammad Javad Shemshadi: *Quantum fisher information for unitary processes*

Department of Physics, Ferdowsi University Of Mashhad, Iran

Quantum Fisher information plays a central role in the field of quantum metrology. In this paper we study the problem of quantum Fisher information of unitary processes. Associated to each parameter θ_i of unitary process $U(\theta)$, there exists a unique Hermitian matrix $M_{\theta_i} = i(U^\dagger \partial_{\theta_i} U)$. Except for some simple cases, such as when the parameter under estimation is an overall multiplicative factor in the Hamiltonian, calculation of these matrices is not an easy task to treat even for estimating a single parameter of qubit systems. Using the Bloch vector m_{θ_i}, corresponding to each matrix M_{θ_i}, we find a closed relation for the quantum Fisher information matrix of the qubit systems for an arbitrary number of estimation parameters. We extend our results and present an explicit relation for each vector m_{θ_i} for a general Hamiltonian with arbitrary parametrization. We illustrate our results by obtaining the quantum Fisher matrix of the so-called angle-axis parameters of a general $SU(2)$ Hamiltonian. Using a linear transformation between two different parameter spaces of a unitary process, we provide a way to move from quantum Fisher information of a unitary process in a given parametrization to the one of the other parametrization. Knowing this linear transformation enables one to calculate the quantum Fisher information of a composite unitary process, i.e. a unitary process resulted from successive action of some simple unitary processes. We apply this method for a spin-half system and obtain the quantum Fisher matrix of the coset parameters in terms of the one of the angle-axis parameters.

2.39 Nader Sobhkhiz Vayghan & Amin Babazadeh: *Polarization Entangled Photon Pairs Generation*

Iran national Laser Center, Iran Center for Quantum Technologies, Tehran, Iran

The purpose of this experiment was to observe and verify quantum entanglement of the polarization states in photon pairs. The entanglement was accomplished through a nonlinear process called spontaneous parametric down conversion. To verify that entanglement was achieved, it was necessary to use a modified version of Bell's inequalities. If this classical argument is violated, then entanglement is achieved. Using ultra-sensitive single photon detectors, the necessary measurements were taken to calculate the $|S|$ values of the adapted inequality. Having achieved an $|S|$ value of over 2, about 2.36, entanglement was verified for this experimental setup.

2.40 Mohammad Hossein Zarei: *Dual correspondence between quantum CSS states and classical spin models*

Physics Department, Shiraz University, Iran

The correspondence between classical spin models and quantum states has attracted much attention in recent years. However, it remains an open problem as to which specific spin model a given (well-known) quantum state maps to. In this work, we provide such an explicit correspondence for an important class of quantum states where a duality relation is proved between classical spin models and quantum Calderbank-Shor-Steane (CSS) states. In particular, we employ graph-theoretic methods to prove that the partition function of a classical spin model on a hypergraph H is equal to the inner product of a product state with a quantum CSS state on a dual hypergraph $\tilde{H}$. Furthermore, we use the above relation with a well-known fidelity analysis for topological phase transitions to find an exact correspondence from topological phases of quantum CSS states to universality classes of classical spin models.