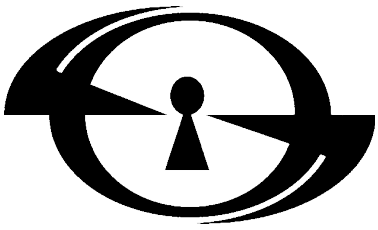
Abstracts



International Iran Conferences on Quantum Information 2012

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Contents

Part I
Talks

1 Plenary Talks

1.1 Buzek, Vladimir: *On the origin of (statistical) temperature in quantum Universe*

Slovak Academy of Sciences, Slovakia

In my talk we will argue that within a non-relativistic quantum-mechanical model of a Universe (the q-Universe) the statistical temperature emerges as a consequence of quantum entanglement. In particular, I will model the q-Universe as a system of interacting spin-1/2 particles described by a specific Hamiltonian (e.g. the Ising Hamiltonian). The q-Universe is assumed to be in a pure state of its Hamiltonian. I will show that any (almost) sub-system of the q-Universe is in a mixed state described by a density operator such that probabilities of outcomes of measurements in the energy eigenbasis of the sub-system can be very well approximated by the Boltzmann distribution

1.2 Pascazio, Saverio: *Quantumness Witnesses*

University of Bari, Italy

We introduce a method to witness the quantumness of a system. The method relies on the fact that the anticommutator of two classical states is always positive, while there is always a nonpositive anticommutator due to any two quantum states. We notice that interference depends on the trace of the anticommutator of two states and it is therefore more natural to detect quantumness by looking at anticommutators of states rather than their commutators.

1.3 Rudolph, Terry: *Quantum States: Are they the real thing?*

Imperial College, UK

What is the quantum state? There is no widely agreed answer to this question, despite the ubiquitous and crucial role this mathematical object plays in our lives. Two broad schools of thought can be identified. The "ontic view" is that the quantum state describes (partially or completely) the real physical state of affairs. The "epistemic view" is that it instead represents some agent's knowledge or information about the physical system in question.

1.4 Sanders, Barry: *Universal Quantum Simulation for Fun & Profit*

Institute for Quantum Information Science, University of Calgary, Canada

By making certain classically intractable computational problems easy-to-solve with quantum algorithms, quantum computers offer long-term disruptive capability. In the near term, the original motivation of quantum computers being efficient universal simulators of quantum dynamics is even more exciting. Quantum simulators are especially important to physicists as a potentially efficient means to discover otherwise hard-to-evaluate properties of Hamiltonian systems. Furthermore just dozens of qubits and hundreds of quantum gates on a quantum Turing machine are required to exceed the processing capability of current and foreseeable classical computers, which makes useful quantum simulators feasible in the foreseeable future. Digital quantum simulators are a hot topic now, and the first prototype has been realized experimentally. The term digital is employed to separate a circuit-based quantum simulation from an experiment specifically designed to emulate a given Hamiltonian, which is known as analogue quantum computation. Scalable digital quantum simulation would require strategies such as quantum error correction, but, for now, the experimental challenge is to realize quantum simulation even without scalability hence without the onerous quantum error correction overhead.

Practical universal quantum simulators will be valuable for studying spectral properties or ground states of Hamiltonians and perhaps in relativistic quantum eld theory to determine particle scattering. The quantum simulator is also applicable to studying open-system dynamics. Moreover, the quantum simulator has applications beyond modeling physical systems, for example simulating quantum-walk dynamics or solving otherwise-intractable problems concerning giant sets of linear coupled equations. Quantum al-

gorithms for Hamiltonian-generated evolution are directly employed in the linear-equations problem to solve certain functions of its solutions exponentially faster than known classical algorithms.

I present an historical account of quantum simulator research since Feynmans proposal of a universal quantum simulator and Deutschs quantum Turing machine for implementing quantum computation. Then we delve into the essence of quantum algorithms for realizing universal quantum simulation based on Lie-Trotter-Suzuki expansions and the assumption of sparse Hamiltonians. Simulations of n-qubit k-local Hamiltonians are amenable to highly efficient quantum-circuit constructions. Time-dependent Hamiltonian evolution poses special challenges but also great benefits such as adiabatic state generation. Finally we will explore experimental developments in realizing quantum simulation in various systems such as the Rydberg atom simulator and ion trap realization.

2 Keynote Talks

2.1 Adesso, Gerardo: *Quantum correlations in composite systems*

University of Nottingham, UK

I will give an overview on the subject of general quantum correlations beyond entanglement in multipartite quantum systems. I will focus on the main concepts, on the interplay between those correlations and entanglement, and on quantitative approaches to measure them. I will then sketch possible applications to quantum information and metrology.

2.2 Benatti, Fabio: *Markovian and non-Markovian Open Quantum Systems*

University of Trieste, Italy

An introduction will be given of the main features of the reduced dissipative and noisy dynamics of quantum systems in weak interaction with their environments. In particular, the physical meaning of complete positivity will be discussed in relation to quantum entanglement, both with and without

memory effects in the time-evolution.

2.3 Brandao, Fernando: *Exponential Decay of Correlations Implies Area Law*

Federal University of Minas Gerais, Brazil

Quantum states of many particles are fundamental to our understanding of many-body physics. Yet they are extremely daunting objects, requiring in the worst case an exponential number of parameters in the number of subsystems to be even approximately described. How then can multi-particle quantum states be useful for giving predictions to physical observables? The intuitive explanation, based on several decades of developments in condensed matter physics and more recently also on complementary input from quantum information theory, is that physically relevant quantum states, defined as the ones appearing in nature, are usually much simpler than generic quantum states. In this talk I will discuss a very recent theorem about quantum s states that gives further justification to this intuition. The theorem states that exponential decay of correlations, a physically motivated restriction on the set of multi-particle quantum states, implies an area law for the entanglement entropy of systems defined on a line, and thus also an efficient classical description for such systems. The result can be seen as a rigorous justification to the intuition that states with exponential decay of correlations, usually associated with non-critical phases of matter, are simple to describe. The proof relies on several previous tools from quantum information theory -including the quantum state merging protocol, properties of single-shot smooth entropies, and the quantum substate theorem -and also on developing some new ones. In particular we derive a new bound on correlations established by local random measurements, and give a generalisation to the max-entropy of a result of Hastings concerning the saturation of mutual information in multi-particle systems. The proof can also be interpreted as providing a limitation to the phenomenon of data hiding in quantum states. Based on joint work with Michal Horodecki.

2.4 Datta, Nilanjana: *Generalized Relative Entropies and One-Shot Information Theory*

University of Cambridge, UK

We introduce two relative entropy quantities called the minand max-relative entropies and discuss their properties and operational meanings. These relative entropies act as parent quantities for tasks such as data compression, information transmission and entanglement manipulation in one-shot information theory. Moreover, they lead us to define entanglement monotones which have interesting operational interpretations..

2.5 Illuminati, Fabrizio: *Fundamental quantum information: correlations, resources, complexity*

University of Salerno, Italy

I will review recent and ongoing progress on three basic subjects in fundamental quantum physics and quantum information. I will first discuss the problem of quantifying quantum correlations beyond entanglement and illustrate some groundbreaking progress on the quest for maximally quantum correlated states. I will then report current advances in the theory and ngineering of entangled resources in the post-Gaussian scenario. Finally, I will introduce and discuss novel tools of entanglement theory that may provide hitherto unaccessible insights in the study of complex many-body quantum systems.

3 Invited Talks

3.1 Cramer, Marcus: *Measuring entanglement in many-body systems*

University of Ulm, Germany

This talk will be concerned with how entanglement may be quantified without any assumptions using simple measurements. I will show how bipartite entanglement may be followed across quantum phase transitions in recent experimental quantum simulations of spin chains. Further, a scheme will be

presented that allows to directly read of lower bounds to multi-partite entanglement from the scattering cross section of Neutrons deflected from solid state samples and the time-of-flight distribution of bosons in optical lattices.

3.2 Datta, Animesh: *Quantum Discord in Quantum Information Science*

University of Oxford, UK

I will discuss the role of quantum discord as a resource in quantum information processing. I will address the basis of this claim and argue that there is increasing evidence to justify this. I will also present a framework that allows us to discuss a large class of quantum protocols in general, and prospects this has for the future.

3.3 Genoni, Marco: *Noise-enhanced entanglement and squeezing generation by quantum feedback*

Imperial College London, UK

It is well known that the quantum features of an open system are washed out by the leakage of information into the environment. Having access to the environment one can ask the following question: up to what extent quantum features could be restored by exploiting classical information gathered from environment? In this framework, we study the possibility of enhancing peculiar quantum properties (such as squeezing and entanglement) of bosonic systems subject to quadratic Hamiltonians and a noisy thermal environment, by performing weak Gaussian measurements and conditioned linear driving. We derive general analytical upper bounds for the single mode squeezing and multimode entanglement at steady state, depending only on the Hamiltonian parameters and on the number of thermal excitations of the bath. Our findings show that, rather surprisingly, larger number of thermal excitations in the bath allows for larger steady-state squeezing and entanglement. We provide a rather simple phase-space description, to understand such counterintuitive result, finding the physical relationship between the bath temperature and the achievable squeezing and entanglement. After that we focus on specific examples and discuss findings of direct applicative interest; in particular we present the details of the optimal feedback strategies achieving the upper

bounds, in different relevant physical settings.

3.4 Paternostro, Mauro: *Quantum discord bounds the amount of distributed entanglement*

Queen's University Belfast, UK

The ability to distribute quantum entanglement is a prerequisite for many fundamental tests of quantum theory and numerous quantum information protocols. Two distant parties can increase the amount of entanglement between them by means of quantum communication encoded in a carrier that is sent from one party to the other. Intriguingly, entanglement can be increased even when the exchanged carrier is not entangled with the parties. However, in light of the defining property of entanglement stating that it cannot increase under classical communication, the carrier must be quantum. In this talk I will show that, in general, the increase of relative entropy of entanglement between two remote parties is bounded by the amount of non-classical correlations of the carrier with the parties as quantified by the relative entropy of discord.

3.5 Paunkovic, Nikola: *Fidelity, Fidelity Spectrum and Geometric Phases as Signatures of Phase Transitions*

Technical University of Lisbon, Purtugal

We show that the fidelity, a measure of state distinguishability, used in quantum information and computation, can be efficiently used as a tool to detect some macroscopic phase transitions, and we establish its relation to standard many-body properties. In particular, we make the analytical study of the anisotropic XY spin chain in a magnetic field, the Stoner-Hubbard model of itinerant magnetism and the BCS model of superconductivity, and make the numerical study of an impurity in a superconductor film. We show that the sudden drop of the fidelity marks the line of the phase transition. We study the fidelity-induced metric on the space of parameters that define system's Hamiltonian and its connection to geometric Berry and Uhlmann phases. We also establish the relation between the fidelity-induced metric, often referred to as fidelity susceptibility, and thermodynamical susceptibil-

ity associated to a given phase transition. Finally, we study the logarithmic spectrum of the operator whose trace defines the quantum fidelity between two density operators, and denote it by the fidelity spectrum. We find that the fidelity spectrum can be a useful tool in giving a more detailed characterization of different phases of many-body quantum systems and of the particular modes that drive the phase transition

3.6 De Vicente, Julio: *Understanding multipartite entanglement in systems of few particles*

University of Innsbruck, Austria

Whereas bipartite entanglement of pure states is well understood, multipartite entanglement is much more subtle. For instance, in the bipartite case there exists a unique maximally entangled state (MES) (in the sense that it cannot be obtained from any other state by deterministic local operations and classical communication (LOCC)), while in the multipartite case there are infinitely many. In fact, our understanding of the nonlocal properties of many-body states is far from complete even in the simplest case of just three subsystems. In this talk, we characterize the entanglement contained in a pure 3qubit state via operational entanglement measures. To this end we derive a new decomposition for arbitrary 3qubit states, which is characterized by five parameters (up to local unitary operations). We show that these parameters are uniquely determined by bipartite entanglement measures. These quantities, which are easily computable, characterize the different forms of bipartite entanglement required to generate the state following a particular preparation procedure and, hence, have a clear physical meaning. In addition to this, we show that the classification of states obtained in this way is strongly related to the one obtained when considering LOCC and that MES can be characterized by a simple condition in terms of our parameters. Moreover, our insights can be used to devise protocols in which a provider remotely prepares arbitrary (maximally) entangled states for spatially separated parties. These protocols are shown to efficient in terms of the quantum and classical communication that needs to be used to achieve them.

4 Contributed Talks

4.1 Alipour, Sahar: *Quantum estimation in open quantum systems*

Sharif University of Technology, Iran

We investigate estimation of an unknown parameter in quantum systems which are in interaction with an environment. We introduce a generalized quantum Fisher information in the vectorized space and show that this provides an upper bound for the genuine quantum Fisher information of the subsystem. Next we study the scaling relations of quantum Fisher information in open quantum systems.

4.2 Bayat, Abolfazl: *Quantum effects in ion channels*

Ulm University, Germany

Ion-channels are protein complexes that regulate the flow of particular ions across the cell membrane and are essential for a large range of cellular functions such as neuronal communications and muscle contractions. Ion channels have two main features: (i) they support a very high throughput, comparable with the diffusion rate; (ii) they are highly selective in respect to the ion types. The mechanisms responsible for these two important features are still not well understood. We show that how quantum mechanics might be responsible for functionality of the ion channels despite the high temperature and wet environment of biological systems. Furthermore, we propose an experiment to determine any possible quantum effects in ion channels based on quantum interference.

4.3 Hosseini, Elham: *Estimation of spin-spin interactions strength for a chain of three-spin in NMR setup; Case study of*

Osaka City University, Japan

It has been shown that the strength of spin-spin interactions in a spin-1/2 chain can be evaluated through one of the edge spins only. We experimen-

tally demonstrate this for a three-spin chain with NMR techniques. The three spins in the chain interact through the nearest-neighbor Ising-type interactions under site-dependent transverse fields. The molecule employed is alanine containing three 13C nuclei, each of which has spin-1/2.

4.4 Koochakie, Mear Muhammad Reza: *A Lieb-Robinson Bound for Adiabatic Evolution*

Sharif University of Technology, Iran

We formulate a Lieb-Robinson bound for Hamiltonians local in an arbitrary basis. We also obtain an adiabatic inequality by adopting the approach of the Lieb-Robinson bound.

4.5 Marvian, Iman: *Symmetry, Asymmetry and quantum information*

Perimeter Institute for theoretical Physics, Institute for quantum computing, Canada

The asymmetry properties of a state relative to some symmetry group specify how and to what extent the given symmetry is broken by the state. Characterizing these is found to be surprisingly useful for answering the following question: when a systems dynamics has a particular symmetry, how does this constrain which final states of the system can be reached from a given initial state? This question can be considered for both open-system and closed-system dynamics. It turns out that even for closed-system dynamics, one can find constraints on the possible state evolutions which are stronger than the conservation laws implied by Noether's theorem. Another motivation for the study of asymmetry comes from the field of quantum metrology. It turns out that the degree of success one can achieve in many metrological tasks depends only on the asymmetry properties of the state used for metrology. So a systematic study of these properties can help to develop optimal protocols and strategies for dealing with practical constraints such as noise.

4.6 Nakahara, Mikio: *Geometric Aspects of Composite Pulses*

Kinki University, Japan

Unitary operations acting on a quantum system must be robust against systematic errors in control parameters for reliable quantum computing. Composite pulse technique in NMR realises such a robust operation by employing a sequence of possibly poor quality pulses. In this talk, we demonstrate that two kinds of composite pulses, one compensates for a pulse length error in a one-qubit system and the other compensates for a J-coupling error in a two-qubit system, have vanishing dynamical phase and thereby can be seen as geometric quantum gates, which implement unitary gates.

4.7 Raeisi, Sadegh: *Designing Quantum Circuits for Efficient Many-Body Quantum Simulation*

University of Waterloo, Canada

We construct an efficient autonomous quantum-circuit design algorithm for creating efficient quantum circuits to simulate Hamiltonian many-body quantum dynamics for arbitrary input states. The resultant quantum circuits have optimal space complexity and employ a sequence of gates that is close to optimal with respect to time complexity. We also devise an algorithm that exploits commutativity to optimize the circuits for parallel execution. As examples, we show how our autonomous algorithm constructs circuits for simulating the dynamics of Kitaevs honeycomb model and the Bardeen-Cooper-Schrieffer model of superconductivity.

4.8 Saberi, Hamed: *Sequential generation of entanglement under real-life conditions*

Shahid Beheshti University, Iran

Quantum renormalization group techniques provide an in situ criterion for keeping the most relevant information and integrating out the superfluous degrees of freedom that do not contribute to the essential physics. A synergy of such renormalization group techniques is achieved upon rephrasing them in

terms of the so-called matrix-product formalism as a unifying framework for performing systematic comparisons and further variational optimization of the results. On the quantum information side, such a systematic and controllable reduction of the effective "size of my system" significantly facilitates the realization of various quantum informational and computing protocols and help to elevate them from an abstract theoretical level to practical recipes of experimental eminence. Paradigmatic examples encompass sequential generation of entangled multiqubit states, two-qubit decomposition of global unitary entanglers, and optimal quantum cloning. It is the purpose of this talk to demonstrate

4.9 Sarkar, Debasis: *Decoherence Dynamics of Measurement-Induced Nonlocality and comparison with Geometric Discord*

University of Calcutta, India

We check the decoherence dynamics of Measurement-induced Nonlocality and compare it with geometric discord. There are quantum states, on which the action of dephasing channel cannot destroy MIN in finite or infinite time. We also investigate the additive dynamics of MIN on a qubit state under two independent noise. Geometric discord also follows such additive dynamics like quantum discord.

4.10 Toloui, Borzoumehr: *Simulating Symmetric Time Evolutions with Local Operators and Identifying New Selection Rules*

University of Calgary, Canada

For closed systems, time evolution symmetries lead to conservation laws. However, such conservation laws no longer apply to open system that undergo irreversible transformations. Therefore, in such cases, we must look elsewhere for selection rules that help determine what transitions are possible. We show that entanglement theory can address this problem, and that new and more general selection rules can be found solely in terms of entanglement monotones. Our method involves using local operations to simulate a system's symmetric time evolution by first embedding the system's Hilbert

space in the tensor product of two Hilbert spaces. Studying how the entanglement of the embedded states change under local operations help us determine what transitions are possible under the initial symmetry. In addition, our results enable us, for the first time, to construct a wide range of new monotones in order to quantify the asymmetric properties of general quantum states. Where the time evolution is reversible, these monotones give rise to totally new conservation laws.

4.11 Zaraket, Haitham: *Quantum Discord in higher dimensions*

Lebanese university, Lebanon

We present the progress in quantum discord for Nubit systems.

4.12 Zarei, Mohammad Hossein: *An algorithmic proof for the completeness of 2D Ising model*

Sharif university of technology, Iran

We show that the two dimensional Ising model is complete, in the sense that the partition function of any lattice model on any graph is equal to the partition function of the 2D Ising model with complex coupling. The latter model has all its spin-spin coupling equal to $i\frac{\pi}{4}$ and all the parameters of the original model are contained in the local magnetic fields of the Ising model. This result has already been derived by using techniques from quantum information theory and by exploiting the universality of cluster states. Here we do not use the quantum formalism and hence make the completeness result accessible to a wide audience. Furthermore our method has the advantage of being algorithmic in nature so that by following a set of simple graphical transformations, one is able to transform any discrete lattice model to an Ising model defined on a (polynomially) larger 2D lattice.

Part II
Posters

5 Posters

5.1 Ahmadi, Fatemeh: *Spin Entanglement of Three qubit GHZ and W states in Gravitational field*

Amirkabir University of Technology, Iran

Entanglement degradation caused by gravitational field is studied for a system of three massive spin 1/2 particles described by a wave packet with Gaussian momentum distribution and a spin part in the form of GHZ or W states. The fidelity for particles moving around the Schwarzschild spacetime. Both the acceleration of the system and the curvature of the spacetime cause to produce a wigner rotation acting on the wave packet as it moves along a path in the curved spacetme. For considered circular paths, the spin fidelity of initial and final state is obtained as a function of angular velocity , elapsed proper time and radius of circular paths. Using a numerical approach, the behavior of the spin fidelity in terms of the sngular velocity, as well as the radius of paths is described for both GHZ and W states.

5.2 Baghbanzadeh, Sima: *Weak-measurement quantum control*

Sharif University of Technology, Iran

We investigate controllable preparation of d-level quantum systems by applying only weak measurements. We also discuss a method through which one can prepare quantum registers by only oneand two-qudit weak measurements. A relevant application of this scenario is amplification of quantum correlation of weakly correlated quantum systems.

5.3 Bagheri, Mehran: *Excitonic Qbits in Electron-Hole Bilayer Nanotubes*

Shahid Beheshti University, Iran

We present a new candidate for quantum bits based on magneto-excitons cofined in quasi-one-dimensional electron-hole bilayer nanotubes. It is shown that the magnetization of the exciton is suddenly changed at critical values of the magnetic fieds. In other words, the exciton bahaves like a two-level system around special values of the magnetic field and show a paramagnetic-diamagnetic transition as the magnetic field is increased[1]. 1Mehran Bagheri, Magneto-excitons in electron-hole bilayer nanotubes made of rolled-up type-II band aligned quantum wells, J. Appl. Phys.107, 114305 (2010), * Selected for a simultaneous publication in the Virtual Journal of Nanoscale Science and Technology, Volume 21, Issue 24 (2010), * Selected for a simultaneous publication in the Virtual Journal of Quantum Information, Volume 10, Issue 6 (2010).

5.4 Cakmak, Baris: *Nonlinear quantum mechanics allows better cloning without signalling*

Sabanci University, Turkey

We present a nonlinear generalization of quantum mechanics where one can copy arbitrary pure states with fidelities higher than those of the quantum cloners. Weinberg's nonlinear quantum mechanics has been criticized for its possible implications for superluminal communication. We demonstrate that universal symmetric cloners can make better copies than standard quantum ones and yet they do not violate the no-signalling principle. If linearity constraint is added, we show that for a given fidelity there is a unique cloner which can be written down explicitly. [1] Z. Gedik, B. Cakmak, arXiv:1203.3054v2 (2012).

5.5 Karimi, Naser: *Analytical calculation of optimal POVM for unambiguous discrimination of quantum states using KKT me*

Shahid Madani University Of Azarbaijan, Iran

In the present paper, an exact analytic solution for the optimal unambiguous state discrimination(OPUSD) problem involving an arbitrary number of pure linearly independent quantum states with real and complex inner product is presented. Using semidefinite programming and Karush-Kuhn-Tucker convex optimization method, we derive an analytical formula which shows the relation between optimal solution of unambiguous state discrimination problem and an arbitrary number of pure linearly independent quantum states.

5.6 Karpat, Goktug: *Critical Point Estimation and Long-Range Behavior in the One-Dimensional XY Model Using Thermal Quan*

Sabanci University, Turkey

We investigate the thermal quantum and total correlations in the one-dimensional anisotropic XY spin chain with transverse magnetic field. While we adopt concurrence and an easily observable version of geometric quantum discord to measure quantum correlations, we use measurement-induced nonlocality and an alternative quantity defined in terms of Wigner-Yanase information to quantify total correlations. We show that all of these measures are able to detect the critical point of the quantum phase transition at zero temperature. Moreover, we explore the ability of the measures to estimate the critical point at finite temperature, and show that their performance strongly depends on the anisotropy parameter of the Hamiltonian. Lastly, we study the effect of temperature on long-range correlations of the system. [1] B. akmak, G. Karpat, and Z. Gedik, arXiv:1206.1019.

5.7 Khashami, Fatemeh: *Grassmanian Representatives of Multimode Entangled states*

Young Researcher Club, Ardabil Branch, Islamic Azad University, Ardabil, Iran

In this paper Generalized Grassmann representatives of multi-mode state vectors are constructed. In fact the Grassmann coherent states enables use to map the Hilbert space of the multi-mode states to the space of the some Grassmanian polynomial functions. The Grassmann representatives of maximally entangled states are constructed, and it is shown that their is a relation between the entangled states and their Grassmann representatives

5.8 Khademi, Siamak: *Measuring the Squeezing Parameter for the Squeezed Number States by the Displaced Wigner Function*

University of Zanjan, Iran

In this paper an experimental setup, which is proposed by Lutterbach and Davidovich, for non-demolition measurement of photon counting is applied to measure the displaced Wigner distribution function. Then the relation between the measured Wigner distribution function and the squeezing parameter is obtained. This method is applied for the determination of squeezing parameter of a squeezed number state.

5.9 Khatam, Iman: *How an entropic uncertainty relation breaks down?*

Sharif University of Technology, Iran

This work is devoted to the question of whether information-based uncertainty relations, especially Deutschs inequality, could be a better alternative than standard deviation-based uncertainty relations. We use two filter-type experiments in which a single half-spin particle passes through two Stern-Gerlach apparatuses in two successive times. In the first experiment the apparatuses are orthogonal, while in the second experiment as a general case, the apparatuses are arbitrarily arranged. We show that for the second experiment Deutschs inequality doesnt satisfy the quantum uncertainty and is violated.

5.10 Khatibi Moqadam, Jalil: *Quantum Control Methods in Chain of Superconducting Qubits*

National Laboratory of Scientific Computing, Brazil

It has recently been shown in Ref. [1] how to realize a Toffoli gate in a circuit QED using quantum control techniques. The method is based on using the bilinear model with a XY-type Hamiltonian for the system and a Zeeman-like Hamiltonian for the controls. Piecewise-constant control fields can then be designed in a way to realize the gate in a given time. The values of the control fields are obtained through maximizing the relevant fidelity. In this work, we analyze the implementation of Toffoli gates in disordered QED system, in special, we consider the effect of uniform static disorder, that is, the couplings no longer remain constant and belong to the interval [1-d,1+d]J, where J is the coupling constant and parameter d quantifies the disorder. We show that the engineered gate is robust when disorder is less than 10

5.11 Khazali, Mohammad: *Polaritonic Quantum Memory with Two-Level Systems and Photon Bandwidth Compression*

University of Calgary / Institute for Quantum Information Science, Canada

Authors: Mohammad Khazali, Dr. Christoph Simon Co-Authors: Hamidreza Kaviani, Khabat Heshami, Roohollah Ghobadi Generating efficient quantum memories is crucial for the future Information processing. One of the well-known methods for describing quantum memories and analyzing the nature of coupling between light and matter is Polariton model. We analyze a light storage protocol based on cavity arrays [1] in terms of two-level polaritons, which is different from the typical EIT polaritons [2]. The cavity array scheme moreover inspires us to propose a quantum memory scheme with atomic ensembles. The scheme [1] is based on two types of cavities, wave-guide and side cavities. The coupled system possesses two eigen-states (polaritons) corresponding to two different group velocities. One can launch the incoming light into one of these polaritons and changes its group velocity by adiabatic modulation of the detuning between side-cavities and waveguide-cavities. In principle, this allows u

5.12 Kordi, Zeinab: *phase-controlled atom-photon entanglement in a three-level lambda type closed-loop atomic systems*

Zanjan University, Iran

In this paper we investigate the dynamical behavior of atom-photon entanglement in a three-level lambda type closed-loop atomic system. By using the reduced quantum entropy approach, it is shown that the entanglement depend on the relative phase and intensity of applied fields. Thus, we can control the atom-photon entanglement via the relative phase and intensity of applied fields. In addition, the atom-photon disentanglement is obtained for special selected parameters.

5.13 Mahdian, Mahmoud: *Quantum correlations of Two-Qubit XXZ Heisenberg Chain with Dzyaloshinsky-Moriya interaction coupled*

University of Tabriz, Iran

We consider the quantum correlations (entanglement and quantum discord) dynamics of two coupled spin qubits with Dzyaloshinsky-Moriya interaction influenced by a locally external magnetic field along z-direction and coupled to bath spin-$\frac{1}{2}$ particles as independent non-Markovian environment. We find that with increasing D_z and decreasing J_z, the value of entanglement and quantum discord increase for both antiferromagnetic and ferromagnetic materials. Not that, this growth is more for the ferromagnetic materials. In addition, we perceive that entanglement and quantum discord decrease with increased temperature and increased coupling constants between reduced system and bath. But, strong quantum correlations within the spins of bath reduce decoherence effects. We discuss about type of the constituent material of the central spins that it can speedup the quantum information processing and as a result, we perceive that one can improve and control the quantum informat

5.14 Makaremi, Tayebeh: *noisy channel effects on two relativistic particles*

Kurdistan University, Iran

We study the entanglement and geometric discord and quantum discord dynamics of two relativistic particles which is transmitted through one of the Pauli channels $\sigma_x, \sigma_y, \sigma_z$ and in Markovian and non-Markovian limit. We show that these quantum correlations depend on speed of observer in Pauli channels but they are invariant in Markovian and non-Markovian limits.

5.15 Mani, Azam: *Quantum discord and non-Markovianity of quantum dynamics*

Sharif University of Technology, Iran

The problem of recognizing (non-)Markovianity of a quantum dynamics is revisited through analyzing quantum correlations. We argue that instantaneously-vanishing quantum discord provides a necessary and sufficient condition for Markovianity of a quantum map. This is used to introduce a measure of non-Markovianity. This measure, however, requires demanding knowledge about the system and the environment. By using a quantum correlation monogamy property and an ancillary system, we propose a simplified measure with fewer requirements. Non-Markovianity is thereby decided by quantum state tomography of the system and the ancilla.

5.16 Mazaheri, Mojtaba: *Quantum opto-mechanical sensor*

Hamedan University of Technology, Iran

One of the main milestones in the study of opto-mechanical system (OMS) is to increase the sensitivity of the measurement of weak forces up to the quantum limit. We have studied the detection of weak periodic force by OMS. Because of applying periodic forces, the dynamics of the system behave asymptotically similar to stationary state in which the signal to noise ratio is obtained by covariance matrix. We have shown the maximum sensitivity is reached in the bistable region. We also studied the destructive

effects of thermal noise on the sensitivity of OMS. Our approach is based on the covariance matrix formalism.

5.17 Mehri-Dehnavi, Hossein: *Quantum teleportation with nonclassical correlated states in noninertial frames*

Babol Noshirvani University of Technology, Iran

Quantum teleportation with nonclassical correlation is studied in noninertial frame, for fermionic case. It is shown that a separable but a nonclassically correlated state gives the fidelity of teleportation greater than half. In noninertial frames two fidelities of teleportation are given and it is discussed that from a practical point of view the minimum fidelity should be evaluated since the state to be teleported is generally an unknown quantum state.

5.18 Mohseni, Naieme: *Entanglement dynamics in the dispersive interaction of a trapped ion system with a quantized radiation*

Esfahan University, Iran

In this paper the mode-mode entanglement between trapped ions and cavity fields is investigated in the dispersive regime. We consider a cluster of N ions and investigate the entanglement dynamics in circumstance that both the ions and field initially prepared in squeezed vacuum state. In this case, entanglement is due to the dependence of stark shifts on the ions state of motion manifested as cross-kerr interaction between each ion and the field.

5.19 Najarbashi, Ghader: *Floating Entanglement Witness Measure and...*

Mohaghegh Ardabili University, Iran

In this paper based on the notion of entanglement witness, a new measure of entanglement called floating entanglement witness measure is introduced which satisfies some of the usual properties of a good entanglement measure.

By exploiting genetic algorithm, we introduce a classical algorithm that computes floating entanglement witness measure. This algorithm also provides a method for finding entanglement witness for a given entangled state.

5.20 Pourkarimi, Mohammad Reza: *Dynamics of quantum correlation and entanglement in a two-qubit system under Dzyaloshinskii-Moriya interaction*

Shahid Bahonar University of Kerman, Iran

We consider a two-qubit system in Werner state. We let it evolve in Heisenberg XY model with Dzyaloshinskii-Moriya interaction. We evaluate concurrence and quantum discord as a measure of entanglement and quantum correlation respectively, thus comparing them. It is shown that quantum correlation is more robust than entanglement. For instance there are situations where entanglement may vanishe, whereas we may still have quantum correlation.

5.21 Radgohar, Roya: *Spatial search on cayley graphs*

Jahrom University, Iran

In this work, I study the spatial search problem on direct products of cycle and complete graphs by continuous time quantum walks. I first show that search process on these networks is not generally efficient because of having highly degenerate eigenvalue spectra. Then, I enhance this process by considering the tranmission rate of the walk as a tunable parameter and find that for a special range of this parameter; the efficiency will be very high. Also, I investigate the impact of adding or removing a single edge on these networks and observe the faster search process.

5.22 Rafiei, Morteza: *Stationary and uniform entanglement distribution in qubit networks with quasilocal dissipation*

Yazd University, Iran

We consider qubit networks where adjacent qubits besides interacting via XY coupling, also dissipate into the same environment. The steady states are computed exactly for all network sizes and topologies, showing that they are always symmetric under permutation of network sites, leading to a uniform distribution of the stationary entanglement across the network. The maximum entanglement between two arbitrary qubits is shown to depend only on the total number of qubits in the network, and scales linearly with it. A possible physical realization by means of an array of doped cavities is discussed for the case of a linear chain.

5.23 Sang Nour Pour, Nafiseh: *Photon Pair Entanglement in 2-Dimensional Periodically Poled Nonlinear Optical Superlattice*

Tabriz university, Iran

Recent progresses in quantum information processing scheme highlights the necessity for entangled two photon states [1]. Micro structure materials such as photonic crystals and periodically poled optical superlattices have been utilized as a source of entangled photon pairs in down-conversion process [2, 3]. Higher amount of photon pair entanglement with the high efficiency of the emerged photon pairs should be prepared using quasi-phase-matching [4] with the help of one and two-dimensional periodically poled nonlinear optical superlattice [5, 6 and 7]. In the present paper, we study the possibility of using two-dimensional periodically poled lithium niobate (PPLN) as an efficient source of entangled photon pairs via spontaneous parametric down conversion (SPDC) and the PPLN is defined with a periodic poling pattern along two dimensions. The amount of entanglement between photon pairs is investigated by using an appropriate measure such as the Von-Neumann entropy [7].

5.24 Tavakoli Dinani, Hossein: *SU(3) squeezing: quantum and semiclassical evolutions*

Lakehead University, Canada

There is renewed interest in squeezing in systems of higher symmetry, spin-1 and also particles of arbitrary spin. We introduce a criterion for

squeezing in SU(3) systems that is a generalization of the squeezing parameter in SU(2) (spin) systems given by M. Kitagawa and M. Ueda. We investigate squeezing generated by the time evolution of an initially coherent state under nonlinear Hamiltonians in the generators of the su(3) algebra. We show that two broad types of squeezing exist in SU(3) systems. By comparing the semiclassical results with the results of full quantum mechanical calculations, we also show that both types of squeezing can be quantitatively understood using phase space techniques in the semiclassical approximation.

5.25 Yousefjani, Rozhin: *Classical Dephasing Environment and Quantum Correlations*

Kurdistan University, Iran

By starting from the stochastic Hamiltonian of the three correlated spins and modeling their frequency fluctuations as caused by dephasing noisy environments described by Ornstein-Uhlenbeck processes, we study the dynamics of quantum correlations, including entanglement and quantum discord. We prepared initially our open system with Greenberger-Horne-Zeilinger or W state and present the exact solutions for evolution dynamics of entanglement and quantum discord between three spins under both Markovian and non-Markovian regime of this classical noise. By comparison the dynamics of entanglement with that of quantum discord we find that entanglement can be more robust than quantum discord against this noise. It is shown that by considering non-Markovian extensions the survival time of correlations prolong.

5.26 Zarei, Mohammad Hossein: *Completeness of classical ϕ^4 theory on 2D lattice*

Sharif university of technology, Iran

We formulated a quantum formalism for the statistical mechanical models of discretized field theories on lattices and then showed that the discrete version of ϕ^4 theory on 2D square lattice is complete in the sense that the partition function of any other discretized scalar field theory on an arbitrary lattice with arbitrary interactions can be realized as a special case of the partition function of this model