Poster Abstracts

ISCQI-2016

Title: ***An algorithmic approach to digital quantum simulation***

Swathi S. Hegde, K. R. Koteswara Rao, and T. S. Mahesh

Abstract: A key task in quantum computation is the application of a sequence of gates implementing a specific unitary operation. However, the decomposition of an arbitrary unitary operation into simpler quantum gates is a nontrivial problem. Here we propose a general and robust protocol to decompose any 2^{n} dimensional target unitary into a sequence of n-qubit Pauli operators. The procedure involves identifying a commuting subset of Pauli operators having a high trace overlap with the target unitary, followed by a numerical optimization of their corresponding phases. We demonstrate the protocol by decomposing several standard quantum operations and analyse the overall efficiency of the decomposition. We also describe the applications of this method in digital quantum simulation.

Title: ***BEC in a double-well potential: Nonclassical effects, NOON-like states and logic gate operations***

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Abstract: Following the experimental realization of a Bose-Einstein condensate (BEC) in 1995[1], both wave packet revivals[2] and squeezing[3] have been demonstrated in BECs. The amenability of a BEC to the tuning of the interaction between condensate atoms enables its use in testing quantum mechanical principles. A nonlinear, interacting two-mode model[4] of a BEC in a double-well potential exhibits rich dynamics, allowing us to study analytically various nonclassical effects such as full and fractional revivals, quadrature and higher-order squeezing, via the expectation values of appropriate combinations of observables. The symmetry between the modes (arising from a nonlinearity criterion) makes revivals in the system robust. The sub-system von Neumann entropy and linear entropy are used to quantify the degree of entanglement. We have identified NOON-like states in the system which are expected to be useful for quantum information processing when used along with the quantum gate operations proposed in recent studies[5, 6]. While earlier results from the single-mode case[7] are recovered for mode-symmetric initial states, new nontrivial results emerge for asymmetric initial states.

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Title: ***NMR Investigation of the Quantum Pigeonhole Effect***

Anjusha.V. S

Abstract: NMR quantum simulators have been used for studying various quantum phenomena. Here, using a four-qubit NMR quantum simulator, we investigate the recently postulated quantum pigeonhole effect. In this phenomenon, a set of three particles in a two-path interferometer often appears to be in such a superposition that no two particles can be assigned a single path, thus exhibiting the non-classical behaviour. In our experiments, quantum pigeons are emulated by three nuclear qubits whose states are probed jointly and noninvasively by an ancillary spin. The experimental results are in good agreement with quantum theoretical predictions.

Reference:

1.Y. Aharonov et al., arXiv: 1407.3194 (2014)
2. Anjusha.V. S et al., arXiv: 1509.03963(2014). (recently got accepted in Physics letters a. Will be appearing online soon.)

Title: ***Optimal quantum violation of Clauser-Horne-Shimony-Holt like steering inequality***

Arup Roy, S. S. Bhattacharya, A. Mukherjee and M. Banik

Abstract: We study a recently proposed Einstein-Podolsky-Rosen steering inequality [1]. Analogous to Clauser-Horne-Shimony-Holt (CHSH) inequality for Bell nonlocality, in the simplest scenario, i.e., two parties, two measurements per party and two outcomes per measurement, this newly proposed inequality has been proved to be necessary and sufficient for steering. We find the optimal violation amount of this inequality in quantum theory. Interestingly, the optimal violation amount matches with optimal quantum violation of CHSH inequality, i.e., Cirel'son quantity. We further study the optimal violation of this inequality for different classes of 2-qubit quantum states and also discuss some interesting features.

Reference:

1. Cavalcanti et al., 2015 J. Opt. Soc. Am. B 32 A74-A81.
Journal Ref: J. Phys. A: Math. Theor., 48 415302 (2015).

Title: ***Information complementarity in multipartite quantum states and security in cryptography***

Anindita Bera

Abstract: We derive complementarity relations for arbitrary quantum states of multiparty systems, of arbitrary number of parties and dimensions, between the purity of a part of the system and several correlation quantities, including entanglement and other quantum correlations as well as classical and total correlations, of that part with the remainder of the system. We subsequently use such a complementarity relation, between purity and quantum mutual information in the tripartite scenario, to provide a bound on the secret key rate for individual attacks on a quantum key distribution protocol.

Title: ***Nonlocal correlations: Fair and Unfair Strategies in Bayesian Game***

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Abstract: Interesting connection has been established between two apparently unrelated concepts, namely, quantum nonlocality and Bayesian game theory. It has been shown that nonlocal correlations in the form of advice can outperform classical equilibrium strategies in common interest Bayesian games and also in conflicting interest games. However, classical equilibrium strategies can be of two types, fair and unfair. Whereas in fair equilibrium payoffs of different players are same, in unfair case they differ. Advantage of nonlocal correlation has been demonstrated over fair strategies. In this work we show that quantum strategies can outperform even the unfair classical equilibrium strategies. For this purpose we consider a class of two players games which as a special case includes the conflicting game proposed in [Phys. Rev. Lett. 114, 020401 (2015)]. These games can have both fair and unfair classical equilibria and also can have only unfair ones. We provide a simple analytic characterization of the nonlocal correlations that are advantageous over the classical equilibrium strategies in these games.

Ref: arXiv: 1601.02349.

Title: ***Entanglement sharing through noisy qubit channels: One-shot optimal singlet fraction***

Rajarshi Pal

Abstract: Faithful implementation of QIP tasks require maximally entangled states shared between distant parties.In the simplest scenario these are shared by a process where Alice prepares a maximally entangled state of two particles (say, qubits) and sends one of them to Bob through a noiseless channel. In practice, available channels are noisy resulting in mixed states. Entanglement distillation provides a solution by converting these mixed states to fewer almost-perfect entangled states of purity close to unity while requiring many uses of the channel and joint measurements on many copies of the output. The yield in an entanglement distillation protocol depends on the purity of the mixed states, which in turn is a function of the amount of noise present in the quantum channel. Thus, in the simplest case of entanglement sharing, a basic question is: Given a noisy quantum channel what is the maximum achievable purity for single use of the channel? We will answer this question completely for an arbitrary qubit channel considering arbitrary trace preserving LOCC operations for enhancing the purity. We will show that for non-unital qubit channels the optimal input state must be non-maximally entangled. We will also show that the optimal singlet fraction achieved is a linear function of the negativity of the mixed state dual to the channel. This will imply that the ordering of entanglement monotone negativity is reversed under channel action unlike concurrence or any other entanglement measure which for two qubits reduces to a nondecreasing function of concurrence. Finally we will provide an example of a qudit channel for which the optimal singlet fraction must be achieved by sharing a non-maximally entangled state.

Jour. Ref: Phys. Rev. A 90, 052304(2014).

Title: ***Arrival Time in Quantum Mechanics : An Operational Approach***

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Abstract: Measurement of arrival time of a quantum particle at a given location in space is a problem of fundamental interest in quantum mechanics. This is firstly due to the reason that the construction of a suitable self-adjoint time operator has been found to be controversial and secondly due to the fact that the process of measurement itself alters the state of the particle. We approach the problem from an operational point of view. We consider a quantum particle moving on a lattice under a tight binding Hamiltonian. A detector placed at a site or a set of sites is turned on at regular finite intervals of time τ and its clicking signifies the time of arrival t of the particle at the detector. The detector keeps on making repeated projective measurements on the particle which renders the evolution of the particle non-unitary. Using a perturbative analysis, we study the distribution of the probability of survival of the particle with respect to time t which exhibits power law decay [2, 3]. Also in the limit $\tau \rightarrow 0$, Quantum Zeno Effect is recovered.

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[2] S. Dhar, S. Dasgupta, A. Dhar and D. Sen, Phys. Rev. A, 91, 062115 (2015).
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Title: ***Visualization of separable mixed symmetric states using the multi axial representation***

Suma S P

Abstract: Majorana Representation of symmetric N qubit pure states has been successfully employed in entanglement classification of pure states [1]. The absence of Majorana like geometric representation for mixed symmetric states has been a hindrance for very long time in understanding their complexity. This was overcome by *Samin and Sirsi* [2] in the study of local unitary classification of of N qubit mixed Symmetric States by making use of the elegant geometrical representation of spin-j system, called the Multi Axial Representation (MAR), [3] in terms of local unitary invariants. Mixed symmetric states are of experimental importance [4] and offers elegant mathematical analysis as the dimensionality of the hilbert space reduces from 2^N to N + 1. We show here that MAR can be used to visuallize the mixed symmetric N-qubit seperable systems and also to characterize them in terms of local unitary invariants. We explicitly demonstrate our separability criteria for two qubit mixed symmetric systems.

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Title: ***Nonlinear quantum Zeno and anti-Zeno effects in a nonlinear optical coupler***

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Abstract: Recently, a set of counterfactual quantum computation [1] and communication [2, 3, 4] schemes have been proposed using quantum Zeno effect in chained interferometer. Specifically, a few quantum communication protocols of teleportation [2], quantum key distribution [3], secure direct communication [4], etc., have been reported. This sets the motivation of the present work. Here, quantum Zeno and anti-Zeno effects are studied in a symmetric nonlinear optical coupler, which is composed of two nonlinear ($\chi^{(2)}$) waveguides that are interacting with each other via the evanescent waves [5]. Both the waveguides operate under second harmonic generation. However, to study quantum Zeno and anti-Zeno effects one of them is considered as the system and the other one is considered as the probe. Considering all the fields involved as weak, a completely quantum mechanical description of the coupler is provided, and the analytic solutions of Heisenberg's equations of motion for all the field modes are obtained using a perturbative technique. Photon number statistics of the second harmonic mode of the system is shown to depend on the presence of the probe, and this dependence is considered as quantum Zeno and anti-Zeno effects. Further, it is established that as a special case of the momentum operator for $\chi^{(2)} - \chi^{(2)}$ symmetric coupler we can obtain momentum operator of $\chi^{(2)} - \chi^{(1)}$ asymmetric coupler [6, 7] with linear ($\chi^{(1)}$) waveguide as the probe, and in such a particular case, the expressions obtained for Zeno and anti-Zeno effects with nonlinear probe (which we referred to as nonlinear quantum Zeno and anti-Zeno effects) may be reduced to the corresponding expressions with linear probe [7] (which we referred to as the linear quantum Zeno and anti-Zeno effects). Linear and nonlinear quantum Zeno and anti-Zeno effects are rigorously investigated, and it is established that in the stimulated case, we may switch between quantum Zeno and anti-Zeno effects just by controlling the phase of the second harmonic mode of the system or probe.

References:

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Title: ***Non-locality in Coupled N-level Systems***

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Abstract: We look at the non-locality in coupled N-level systems in terms of violations of the standard form of the Bell inequality. We show that not only do Bell violations survive as we move from 2-level to higher N-level systems, they thrive due to an exponentially increasing number of correlations. Each correlation associated with an N-level system shows a large violation.

Title: ***To freeze or not to: Quantum correlations underlocal decoherence***

Titas Chanda

Abstract: We provide necessary and sufficient conditions for freezing of quantum correlations as measured by quantum discord and quantum work deficit in the case of bipartite as well as multipartite states subjected to local noisy channels. We recognize that inhomogeneity of the magnetizations of the shared quantum states plays an important role in the freezing phenomena. We show that the frozen value of the quantum correlation and the time interval for freezing follow a complementarity relation. For states which do not exhibit "exact" freezing, but can be frozen "effectively", by having a very slow decay rate with suitable tuning of the state parameters, we introduce an index -- the freezing index -- to quantify the goodness of freezing. We find that the freezing index can be used to detect quantum phase transitions and discuss the corresponding scaling behaviour.

Title: ***Quantum contextuality for a single qutrit sans realist model***

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Abstract: Recently, an interesting form of quantum contextuality has been demonstrated for a four-level system by discriminating the different routes that are taken for measuring a single observable. In this paper, we provide a simpler version of that proof for a single qutrit, which is also within the formalism of quantum mechanics and without recourse to any realist hidden variable model. The degeneracy of the eigenvalues and the Lu¨der projection rule play important role in our proof. The implications of such form of quantum contextuality is discussed.

Title: ***Study of Rydberg blockade mediated optical non-linearity in thermal vapour***

Arup Bhowmick

Abstract: We demonstrate Rydberg blockade by coupling to Rydberg state via two-photon excitation in rubidium thermal vapor. The probe beam coupling to the D2 transition was blue detuned by 1.3 GHz and a coupling beam was scanned to excite the atoms to Rydberg state via two-photon transition (5s_1/2 → ns_1/2). The dispersion of the probe beam is modified due to the 2-photon excitation and is measured using an optical heterodyne detection technique in the experiment. We have observed that the dispersion of the probe beam depends linearly on atomic vapor density while coupling to a Rydberg state with principal quantum number, n = 30. However, density dependent suppression of the dispersion is observed while coupling to the Rydberg state with n = 60. Since the dispersion of the probe beam due to 2-photon excitation depends on the Rydberg population, the density dependent suppression is explained by introducing the concept of blockade. The blockade radius is measured to be about 2.2 μm which is consistent with the scaling due to Doppler width of the 2-photon resonance in thermal vapour. Our result promises the realization of single photon source and strong single photon non-linearity based on Rydberg blockade in thermal vapour.

Title: ***Decoy qubits under noisy environment***

R D Sharma

Abstract: In secure quantum communication protocols, a set of single qubits prepared using 2 or more mutually unbiased bases or a set of n-qubit ($n \geq 2$) entangled states of a particular form are usually used to form a verification string which is subsequently used to detect traces of eavesdropping. The qubits that form a verification string are referred to as decoy qubits, and there exists a large set of different quantum states that can be used as decoy qubits. In the absence of noise, any choice of decoy qubits provides equivalent security. In this paper, we examine such equivalence for noisy environment (e.g., in amplitude damping, phase damping, collective dephasing and collective rotation noise channels) by comparing the decoy-qubit assisted schemes of secure quantum communication that use single qubit states as decoy qubits with the schemes that use entangled states as decoy qubits. Our study reveals that the single qubit assisted scheme perform better in some noisy environments, while some entangled qubits assisted schemes perform better in other noisy environments. Specifically, single qubits assisted schemes perform better in amplitude damping and phase damping noisy channels, whereas a few Bell-state-based decoy schemes are found to perform better in the presence of the collective noise. Thus, if the kind of noise present in a communication channel (i.e., the characteristics of the channel) is known or measured, then the present study can provide the best choice of decoy qubits required for implementation of schemes of secure quantum communication through that channel.

Title: ***Preservation of quantum key rate under decoherence***

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It is well known that decoherence, i.e. the interaction of quantum systems with environment reduces the quantum correlation between systems. But, under special case the effect can be reversed. For example, the interaction modelled by amplitude damping channel can improve the teleportation fidelity of a bipartite quantum state. However, this fails in the case of quantum key distribution protocol. Here we show that pre- and post-selection technique can slow down the process of decoherence, i.e. it helps to preserve the quantum key rate when systems are interacting with environment via amplitude damping channel.

Title: ***Polarisation rotation of light due to four wave mixing in Zeeman - degenerate two-level atomic system***

Sushree Subhadarshinee

Abstract: We have studied experimentally the four wave mixing process in thermal rubidium vapour with co-propagating pump and probe fields. The Zeeman coherence introduced by orthogonally polarised light fields results in a large optical nonlinearity and hence an efficient FWM process. Based on this result, we have studied the polarisation rotation of an elliptically polarised beam passing through the vapour corresponding to both Rb^{85} and Rb^{87} transitions. The basic theoretical background for the phenomenon is discussed. The theoretical as well as the experimental data are represented on the Poincare sphere as a demonstration of the polarisation rotation. Our result promises application towards wave guiding nature of light and the generation of squeezed states of light.

Title**: *Faithful pointer for qubit measurement***

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Abstract: It is an ineluctable feature of the quantum measurement theory that any measurement described by the quantum mechanics entails an interaction between the measuring device and the observed system resulting in the state of the measured system to be necessarily entangled with the state of the observing device. In this work, we study the non-ideal measurement of a qubit system. For an ideal situation of the measurement scenario, it is required that the post-interaction device states need to be *mutually orthogonal (formal idealness)* in the configuration space and *macroscopically distinct (operational idealness)* in the real position space. Note that, mutually *orthogonality* and *macroscopically* distinguishability are two different notions, while the later ensures the former but converse is not true in general. However, *operational idealness* is a key notion in any measurement theory because every measurement is ultimately reduced to the measurement of position. It is then a natural demand that the different outcomes should be distinguished in position space implying that the operational idealness (denoted by $M\epsilon[0,1]$) is a stronger requirement than the formal idealness (denoted by the inner product between the post-interaction device states $I\epsilon[0,1]$). Note that, in non-ideal situation the inner product itself cannot provide the observable probabilities. We need to consider a quantity, an error measure which is directly related to the macroscopic distinguishability, for calculating the empirically verified probabilities. Such an error measure is foreign to the usual von Neumann formalism of quantum measurement. However, if we can find a suitable optimal pointer (which we call here the faithful pointer) for which $M=I$, then we can make the value of I to be zero by choosing the relevant parameters. In such case, one does not need to consider operational idealness condition. Interestingly, we found that Gaussian type probe state is not a good pointer because for suitable choices of relevant parameters, the value of M can be made unity while I can be made zero. Such a pointer cannot be considered as a suitable one for quantum measurement. In this work, we provide a systematic derivation of faithful pointer for which operational idealness and formal idealness become equal. The implications of such a pointer in the issue of macrorealism and the violation of Leggett-Garg inequality are discussed.

Title : ***Non Local State dependent cloner: Cloning and Broadcasting***

Manish Kumar Shuka
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Abstract: In this work, we extensively study the problem of broadcasting of entanglement. In the first part of the work, we re-conceptualize the idea of state dependent quantum cloning machine, and in that process we introduce different types of state dependent cloners like static and dynamic state dependent cloners. We derive the conditions under which we can make these cloners independent of the input state. In the broadcasting part, as our resource initial state, we start with general two qubit state and consider specific examples like, non maximally entangled state (NME), Werner state (WS), and Bell diagonal state (BDS). We apply both state dependent/ state independent cloners, both locally and non-locally, in each of these cases. Incidentally, we find several instances where state dependent cloners outperform state independent cloners in broadcasting. This work gives us a holistic view on the broadcasting of entanglement in various two qubit states, when we have an almost exhaustive sets of cloning machines in our arsenal.

Title: ***From R\'enyi Relative Entropic Generalization to Quantum Thermodynamical Universality***

Avijit Misra

Abstract: We formulate a complete theory of quantum thermodynamics in the R\'enyi entropic formalism exploiting the R\'enyi relative entropies, starting from the maximum entropy principle. In establishing the first and second laws of quantum thermodynamics, we have correctly identified accessible work and heat exchange in both equilibrium and non-equilibrium cases. The free energy (internal energy minus temperature times entropy) remains unaltered, when all the entities entering this relation are suitably defined. Exploiting R\'enyi relative entropies we have shown that this form invariance? holds even beyond equilibrium and has profound operational significance in isothermal process. These results reduce to the Gibbs-von Neumann results when the R\'enyi entropic parameter approaches. Moreover, it is shown that the universality of the Carnot statement of the second law is the consequence of the form invariance of the free energy, which is in turn the consequence of maximum entropy principle. Further, the Clausius inequality, which is the precursor to the Carnot statement, is also shown to hold based on the data processing inequalities for the traditional and sandwiched R\'enyi relative entropies. Thus, we find that the thermodynamics of nonequilibrium state and its deviation from equilibrium together determine the thermodynamic laws. This is another important manifestation of the concepts of information theory in thermodynamics when they are extended to the quantum realm. Our work is a substantial step towards formulating a complete theory of quantum thermodynamics and corresponding resource theory.

Title: ***Information theoretic violation of Macrorealism for unsharp measurement***

Swati Kumari and A. K. Pan
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Abstract: Macrorealism, a classical world view that macroscopic properties of an object exist independently and are not influenced by measurements is empirically tested in terms of the violation of the Leggett-Garg inequality. In this poster, we provide an information theoretic approach for testing the macrorealism for the measurements of unsharp observables. It has been shown that quantum violation for macrorealism occurs for information theoretic Leggett-Garg inequality for unsharp measurements for a range of values of the sharpness parameter. The implications of such a violation and its comparison with the violation of standard and Wigner form of Leggett-Garg inequality are discussed.

Title: ***Quantum coherence, measurement disturbance and general quantum correlations***

Bobby Tan Kok Chuan

Abstract: We apply the recently developed resource theory of quantum coherence to prove several relationships between coherence and measurement disturbance. In particular, we show that an imprecise measurement performed on a quantum system necessarily decreases the amount of coherence present, and prove that the resulting measurement disturbance is bounded by coherence. We also elaborate of the relationship between quantum coherence and quantum discord.

Title: ***Construction and interpretation of POVM on the symmetric subspace of nqubit states***

H. S. Smitha Rao, Swarnamala Sirsi, Karthik Bharath

Abstract: Positive Operator-Valued Measures (POVMs) are used in quantum information processing tasks including quantum filtering, realization of quantum communication protocols, entanglement verification, Remote State Preparation (RSP) and conclusive teleportation. Their construction and physical realization are of particular interest in quantum information theory. Here we propose a simple but general mechanism for POVM construction based on any orthonormal set of basis matrices on the vector space of complex matrices. The construction leads to a novel interpretation of the POVMs as orthogonal projectors in a space of higher dimension. We show that the interpretation of the action of the POVM becomes transparent using the notion of vectorization, with the post-measurement state suitably viewed as one being projected onto the subspace spanned by chosen bases. This leads to the interpretation of the post-measurement state as a pure state in the higher-dimensional space. n qubits reside in a 2^n -dimensional Hilbert space of which the symmetric space of dimension N = n+1 is a subspace. From the tensor product representation of n qubit state the ClebschGordan decomposition leads to a direct sum of irreducible representations of which, the one with the largest dimension corresponds to the invariant subspace of symmetric states. Consequence of the above mechanism is to dilate a POVM constructed on the symmetric subspace to the 2^n -dimensional Hilbert space. We observe that in the case of symmetric states, the key difference with Neumarks theorem is that the dilated POVM is not a projective measurement ensuring repeatability of measurements; instead, repeatability is to be viewed in the sense that measurements based on the dilated POVM will always result in a symmetric state.

Title: ***Controlled Dense coding with some discrete tripartite and quadrapartite states***

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Abstract: We have studied controlled dense coding scheme for different types of three and four particle states. It consists of GHZ state, GHZ type states, Maximal Slice state, Four particle GHZ state and W class of states. It is shown that GHZ-type states can be used for controlled dense coding in a probabilistic sense. We have shown relations among parameter of GHZ type state, concurrence of the shared bipartite state by two parties with respect to GHZ type and Charlie's measurement angle θ. We have seen that tripartite W state and quadripartite W state cannot be used in controlled dense coding whereas $\vert W_{n}\rangle_{ABC}$ states can be used probabilistically. Finally, we have investigated controlled dense coding scheme for tripartite qutrit states where we have introduced two 9x9 unitary Braid matrices to send 2 classical bits of information from Alice to Bob controlled by third party Charlie. So we can infer that the tripartite qutrit state of GHZ form is an optimal state that achieve the desired task of controlled dense coding. It would be quite interesting to make a quantitative study of this above scheme with GHZ states in arbitrary dimension and for maximally and non - maximally entangled mixed states which is very important from quantum information theoretic perspective.

Title: ***Diverging scaling with converging multisite entanglement in odd and even quantum Heisenberg ladders***

Sudipto Singha Roy

Abstract: We investigate finite-size scaling of genuine multisite entanglement in the ground state of quantum spin-1/2 Heisenberg ladders. We obtain the ground states of odd- and even-legged Heisenberg ladder Hamiltonians and compute genuine multisite entanglement, the generalized geometric measure (GGM), which shows that for even rungs, GGM increases for odd-legged ladder while it decreases for even ones. Interestingly, the ground state obtained by short-range dimer coverings, under the resonating valence bond ansatz, encapsulates the qualitative features of GGM for both the ladders. We find that while the quantity converges to a single value for higher legged odd- and even-ladders, in the asymptotic limit of a large number of rungs, the finite-size scaling exponents of the same tend to diverge. The scaling exponent of GGM is therefore capable to distinguish the odd–even dichotomy in Heisenberg ladders, even when the corresponding multisite entanglements merge.

Title: ***Time dependent spatial entropy of two particles with contact interaction in a double well potential as an indicator of entanglement dynamics***

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Abstract: A system of two particles interacting with each other via a contact potential in a double quantum well structure with a nearly opaque barrier is analyzed. In such a system, each particle can be naturally seen as representing a two-level system, i.e., it can occupy the left or the right well. From a quantum information perspective the system of two particles is a two-qubit or bipartite system. The presence of a contact interaction causes an initially un-entangled (product) state of the two particles to become entangled with time. For a bipartite system, the concurrence and von Neumann entropy of the reduced (one-particle) system are well known measures of entanglement and a non-zero value for these quantities indicate the presence of entanglement. The spatial differential entropy (information entropy in position space) is a quantity which is related to localization and uncertainty in the spatial probability distribution of a state. In this study, the spatial differential entropy for an initial two-particle state has been calculated as a function of time and compared with the concurrence and the von Neumann entropy for the reduced system. The study shows that the concurrence can be described in terms of a time varying function modulated by an envelope. The time dependence of this envelope has been found to be qualitatively similar to the time dependence of the spatial differential entropy. i.e. both quantities attain their minima and maxima at the same times. This comparison has been made possible because of the formation of Bell like entangled states in position as eigenstates under contact interaction for this two qubit system. The study thus suggests that for this system, spatial differential entropy can also be treated as a legitimate indicator or signature of the underlying entanglement dynamics.

Title: ***Qubit thermalization in the presence of two-qubit interactions***

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Abstract: It has always been a difficult issue in Statistical Mechanics to provide a generic interaction Hamiltonian among the microscopic constituents of a macroscopic system which would give rise to equilibration of the system. One tries to evade this problem by incorporating the so-called H − theorem, according to which, the (macroscopic) system arrives at equilibrium when its entropy becomes maximum over all the accessible micro states. This approach has become quite useful for thermodynamic calculations using the (thermodynamic) equilibrium states of the system. Nevertheless, the original problem has still not been resolved. In the context of resolving this problem it is important to check the validity of thermodynamic concepts – known to be valid for macroscopic systems – in the microscopic world. Quantum thermodynamics is an effort in that direction. As a toy model towards this effort, we look here at the process of thermalization of a two-level quantum system under the action of a Markovian master equation corresponding to memory-less action of a huge heat bath, kept at certain temperature. A two-qubit interaction Hamiltonian (Hth, say) is then designed – with a single qubit mixed state as the initial state of the bath – which gives rise to thermalisation of the system qubit in the infinite time limit. We then look at the question of equilibration by taking the simplest case of a two-qubit system A + B, under some interaction Hamiltonian Hint (which is of the form of Hth) with the individual qubits being under the action of individual heat baths of temperatures T_1, and T_2. Different equilibrium phases of the two-qubit system are shown to appear – both the qubits or one of them get cooled down.

Title: ***Detecting genuine entanglement in the semi-device-independent framework***

C. Jebarathinam

Abstract: Einstein-Podolsky-Rosen (EPR) steering is a form of quantum nonlocality which is intermediate between entanglement and Bell nonlocality. EPR-steering is a resource for one-side-device-independent quantum key distribution in that it certifies entanglement between fully characterized and fully device-independent scenarios. I introduce Svetlichny and Mermin steering to distinguish the presence of two types of tripartite EPR-steering in probability distributions arising from local measurements on genuinely entangled states. Two inequalities which detect the presence of Svetlichny and Mermin steering are derived from the structure of Bell-type inequalities detecting genuine nonlocality and GHZ paradox, respectively. When the dimensions of two subsystems are constrained, genuine tripartite entanglement is detected from correlations which exhibit Svetlichny or Mermin steering. It is known that incompatibility of generalized measurements is necessary and sufficient for demonstrating bipartite EPR-steering: Alice's measurement settings are incompatible if she can demonstrate bipartite EPR-steering to Bob. On the other hand, Alice can always find a quantum state to demonstrate bipartite EPR-steering to Bob if her measurement settings are incompatible. However, I demonstrate that Alice can demonstrate tripartite EPR-steering to Bob and Charlie even if her measurement settings are compatible.

Ref: C. Jebarathinam, arXiv:1510.08800