Workshop on

Frontiers in Quantum Information and Technologies (FQIT)

March 26-29, 2026

Indian Institute of Information Technology Allahabad

Anusandhan National Research Foundation

Short Talks (Oral Presentations)

Name	Affiliation	Title	Abstract
Akshay Kulkarni	BITS Pilani, Hyderabad campus	Entanglement entropy for screened interactions via dimensional mapping to harmonic oscillator.	We investigate interaction-induced corrections to entanglement entropy by mapping a screened Yukawa-type interaction to an effective harmonic oscillator system with controlled anharmonic perturbations. Starting from a one-dimensional interaction V(x) = -g^2 exp(-α m x)/x, we reformulate the problem in terms of a four-dimensional radial oscillator, where the finite screening length generates a systematic hierarchy of polynomial interactions in the radial coordinate. This mapping enables a controlled Rayleigh-Schrodinger perturbative treatment of the ground-state wavefunction and an explicit spectral analysis of the reduced density matrix. Working in the weak-screening regime, we compute the leading non-Gaussian correction arising from the quartic interaction ρ^4, which appears at order α^2 in the expansion of the Yukawa-like potential. We obtain closed analytic expressions for the resulting small eigenvalues of the reduced density matrix and evaluate their contribution to the von Neumann entanglement entropy. We show that the entropy receives analytic corrections at order α^2, originating both from explicit anharmonic state-mixing effects and from the implicit α-dependence of the Gaussian width parameter. Our results clarify the distinct roles of harmonic renormalization and genuinely non-Gaussian interactions in generating entanglement, establish a systematic power-counting and normalization scheme for higher-order ρ^(2n) perturbations, and provide a transparent oscillator-based framework for computing entanglement entropy in weakly interacting low-dimensional and field-theoretic systems.
Debkanta Ghosh	Harish-Chandra Research Institute	Entanglement of weighted graphs uncovering transitions in variable-range interacting models	The cluster state acquired by evolving the nearest-neighbor (NN) Ising model from a completely separable state is the resource for measurement-based quantum computation. Instead of an NN system, a variable-range power law interacting Ising model can generate a genuine multipartite entangled (GME) weighted graph state (WGS) that may reveal intrinsic characteristics of the evolving Hamiltonian. We establish that the pattern of generalized geometric measure (GGM) in the evolved state with an arbitrary number of qubits is sensitive to fall-off rates and the range of interactions of the evolving Hamiltonian. We report that the time-derivative and time-averaged GGM at a particular time can detect the transition points present in the fall-off rates of the interaction strength, separating different regions, namely long-range, quasi-local and local ones in one- and two-dimensional lattices with deformation. Moreover, we illustrate that in the quasi-local and local regimes, there exists a minimum coordination number in the evolving Ising model for a fixed total number of qubits which can mimic the GGM of the long-range model. In order to achieve a finite-size subsystem from the entire system, we design a local measurement strategy that allows a WGS of an arbitrary number of qubits to be reduced to a local unitarily equivalent WGS having fewer qubits with modified weights.
Jhankaar Nayyar	Dayalbagh Educational Institute	Analysis of BB84 and B92 Protocols for Quantum Key Distribution: Theoretical Insights and Experimental Validation	Our work investigates Quantum Cryptography through experimental implementation and validation of the BB84 and B92 quantum key distribution (QKD) protocols using Thorlabs' Quantum Cryptography Analogy Demonstration Kit. Experiments examined the effect of Alice's state preparation, Bob's measurement choices, and Eve's intervention on key establishment in BB84, and were extended to B92 using two non-orthogonal states to study state discrimination and inconclusive outcomes. The study validates the expected operational behavior and security features of both protocols within an educational testbed, demonstrating their correctness and reproducibility. A comparative evaluation of both protocols was performed under identical conditions. Results also demonstrate reliable operation of both protocols at varying distances with sufficient laser intensity, confirming the robustness and practical feasibility of QKD systems for secure communication. Unlike classical cryptographic methods, whose security relies on computational complexity, QKD derives its security from fundamental quantum mechanical laws, enabling detection of any eavesdropping attempt.
Paranjoy Chaki	Harish Chandra research Institute	Measurement induced phase transition in a quantum Ising model by periodic measurements	Measurement-induced phase transitions are often studied in random quantum circuits, with local measurements performed with a certain probability. We present here a model where a global measurement is performed with certainty at every time step of the measurement protocol. Each time step, therefore, consists of evolution under the transverse Ising Hamiltonian for a time, followed by a measurement that provides a ``yes/no'' answer to the question, ``Are all spins up?'' The survival probability after n time steps is defined as the probability that the answer is ``no'' in all the n time steps. We show the existence of a measurement-induced phase transition by survival probability, bipartite entanglement, and multipartite entanglement. Finally, in the thermodynamic limit, we show that there doesn't exist any phase transition.
Priyam Srivastava	University of Pittsburgh	Variational Quantum Sensing for Structured Linear Function	
Sayan Mondal	Harish-Chandra Research Institute	Mpemba effect in self-contained quantum refrigerators: Accelerated cooling	We investigate the emergence of the quantum Mpemba effect in a self-contained qubit–qutrit quantum refrigerator. In our model, the qutrit functions as the refrigerator while the qubit serves as the system to be cooled. The composite system interacts with three bosonic heat baths, and its dynamics is governed by a Gorini–Kossakowski–Sudarshan–Lindblad master equation. By analyzing the structure of the Liouvillian generator, we show that it admits a block-diagonal decomposition, allowing independent treatment of different sectors of the density matrix. We identify that the steady state resides entirely within the block associated with energy-basis populations. Numerical analysis reveals steady-state cooling across a broad parameter regime. Most importantly, we demonstrate the quantum Mpemba effect in this refrigerator: a specially prepared "Mpemba state," generated via a unitary transformation of the equilibrium state, relaxes to the steady state faster than the equilibrium state itself, despite being initially farther from it. This accelerated relaxation enhances the cooling rate of the qubit. We further show that both local and global unitary operations can generate such Mpemba states and analyze how system–bath coupling strengths influence the effect. Our results highlight how coherent control can accelerate thermalization and enhance the performance of quantum thermal machines. Ref: https://doi.org/10.1103/8fp4-15mq

Sudipta Mondal	Harish Chandra Research Institute	Efficient formulation of quantum network under amplitude damping noise: Highlighting benefits over its Pauli-twirled counterpart	At the heart of building a large-scale quantum internet lies the challenge of establishing long-distance entanglement using quantum repeaters, which mitigate direct transmission losses but introduce additional noise in the nodes via interactions with the environment and imperfect operations. This effect has typically been studied under a simplifying Pauli channel assumption. Our study focuses on distributing end-to-end entanglement in a homogeneous, repeater-based linear quantum network operating under a non-Pauli noise, specifically, amplitude damping noise, which we refer to as amplitude damping-affected quantum network (AQN). Unlike its twirled counterpart (TAQN), where the resulting state is fully Bell-diagonal with a single parameter, we prove that the AQN produces a block-diagonal state in the Bell basis with four parameters. We develop a method for the simulation of AQN, where we keep track of these four parameters of each entangled link, along with the number of times noise acts on it, i.e., its age, until it is consumed for swapping. Our results reveal that across diverse policies, including NESTING and SWAP-ASAP, AQN consistently outperforms TAQN in terms of both fidelity and average entanglement. The benefit is most significant in the low-probability regime of elementary link generation, highly relevant for near-term experiments. Notably, we also identify the coherence-time and link-probability regions where TAQN fails while AQN succeeds in distributing end-to-end entanglement.
SUVECHHA INDU	University of Calcutta	The Origin of the Non-uniform Phases in a Dissipative Rydberg System	We investigate a two-level dissipative bosonic Rydberg system in an optical lattice with multiple occupancy per site. The system dynamics are analyzed using two complementary approaches: a mean-field solution of the master equation and direct numerical simulations of an equivalent quantum model. We show that on-site interactions drive a transition between a uniform phase and an antiferro-like density-wave order in terms of the Rydberg excitation distribution. In the mean-field framework, the population distribution across sublattices plays a decisive role: homogeneous populations lead to a sharp transition, while initializing alternating sites with unequal occupancies produces a smooth crossover. In contrast, finite-size quantum simulations always yield a smooth crossover, and an abrupt phase transition never takes place. This simulation is performed to find the phase plot of the system, which complements the results found from the mean-field analysis. The origins of the uniform and the non-uniform phases are explored through spatial correlation analysis and the identification of dynamical fixed points. The correlation is maximum in the antiferromagnetic phase and negligible in the uniform phase. Furthermore, scaling analysis reveals a signature of weak universality in the homogeneous case.
URJJARANI PATEL	BITS-Pilani Hyderabad Campus	Entanglement Evolution of Noisy Quantum Systems: Master Equation--TFD Solutions	We investigate the dynamics of entanglement in a class of dissipative nonlinear quantum optical systems by reformulating the master equation within the Thermofield Dynamics (TFD) framework. This mapping converts the open-system evolution into a Schrödinger-like equation in an enlarged Hilbert space, making the problem more tractable for arbitrary initial states. To handle the nonlinear operator structure induced by dissipation, we employ the Hartree–Fock approximation, which reduces the effective Hamiltonian to a solvable form. Using this approach, we analyze two physically distinct regimes determined by the interplay between the external driving field and the Hartree–Fock field, namely the cases $\eta = 0$ and $\eta \neq 0$. In the first regime, the system is described in terms of two-mode squeezing, while in the second regime it is naturally expressed through single-mode squeezed states. For both cases, we derive the corresponding time-dependent solutions using disentanglement techniques and evaluate quantum correlations through the covariance-matrix formalism. In particular, we compute the logarithmic negativity and quantum mutual information to characterize entanglement generation and correlation dynamics in the presence of noise. Our analysis shows that the initially separable states can evolve into oscillatory entangled and disentangled configurations over time, while the mutual information captures the accompanying redistribution of total correlations. These results demonstrate that the TFD-based treatment provides an efficient analytical route for studying noisy quantum systems of relevance to quantum optics, open quantum dynamics, and quantum information processing.