Workshop on Quantum Information and Quantum Dynamics

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Department of Physics, IIT Bombay

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Venue: Room No 13, VMCC, IIT Bombay

TITLE AND ABSTRACT

Sai Vinjanampathy
Department of Physics, IIT Bombay

Exotic Synchronisation of Time Crystals Outside Symmetric Subspaces

Exploring continuous time crystals (CTCs) within the symmetric subspace of spin systems has been a subject of intensive research in recent times. Thus far, the stability of the time-crystal phase outside the symmetric subspace in such spin systems has gone largely unexplored. Here, we show the effect of including the asymmetric subspaces on the dynamics of CTCs in a driven dissipative spin model. This results in multistability, and the dynamics become dependent on the initial state. Remarkably, this multistability leads to exotic synchronization regimes such as chimera states and cluster synchronization in an ensemble of coupled identical CTCs. Reference: arXiv:2401.00675.

Aditi Sen De
Harish-Chandra Research Institute, Prayagraj, India

Benefits of building quantum devices with long-range interacting spin systems

Quantum systems with long-range (LR) interactions naturally emerge in numerous experiments in atomic, molecular, and optical physics. Moreover, these systems are often known to possess rich and striking properties that are not typically observed in models with short-range (SR) interactions. We will present the advantages of building quantum technologies including measurement-based quantum computers, and quantum sensors using variable-range interactions. In particular, we will show that a variable-range power-law interacting Ising model can generate a weighted graph state whose genuine multipartite entanglement may reveal intrinsic characteristics of the evolving Hamiltonian. We also find that a sensor with a long-range Hamiltonian outperforms the same with an SR Hamiltonian in terms of estimating precision although quantum advantage with the LR model is not ubiquitous.

Hoi-Kwan Lau
Department of Physics, Simon Fraser University, Burnaby, Canada

Making quantum wave great again by using particles

Bosonic quantum systems are ubiquitous and exhibit many practical advantages. However, the linearity of the predominant control in these platforms impose limitations on how the encoded wave-like (continuous-variable, CV) information can be manipulated. In this talk, I will introduce two novel methods to resolve these limitations by harnessing the non-linearity of the hybrid interaction between bosonic modes and particle-like qubits. In the first half, I will discuss a scheme to download many-qubit entanglement from efficiently generable CV cluster states. Our scheme corresponds to a hybrid teleportation of the correlation embedded in CV entanglement, and can be implemented with interactions available in many bosonic platforms. By using an equivalent circuit model, we show that both finite squeezing errors and practical imperfections to be mapped to single qubit preparation errors, and suggest respective corrective measures. Particularly, we show that 12dB squeezing is sufficient for fault-tolerant quantum computing, and robust memory requires as low as 6dB squeezing. In the second half, I will discuss applying quantum signal processing (QSP) techniques to engineer non-Gaussian bosonic operations. We show that QSP generally reduces the gate time when comparing to direct implementation with resonant drives. The versatile QSP method can also implement new types of gate, such as the mod-k gate that can deterministic create multi-component Cat states and generically entangle multiple qudits, and measurements that are tailored for entanglement transfer and error correction.

Pavithran Iyer
Xanadu Quantum Technologies,Toronto, Canada

A Framework for Quantum Computation Using Gottesman Kitaev Preskill codes

I will introduce the Gottesman-Kitaev-Preskill (GKP) code, a method for encoding quantum information in continuous-variable states well-suited for optical hardware. Comparing other methods of encoding quantum information in optical states, I will outline the advantages of GKP codes from the perspective of experimental realization of quantum computation. I will explain the mathematical modeling of noise in optical devices and present quantum error correction techniques for GKP codes to protect the encoded logical information. Additionally, I will discuss how these methods can be integrated with traditional approaches, such as the quantum Low-Density Parity-Check codes and measurement-based quantum computation schemes.

Sudipto Singha Roy

Department of Physics, IIT (ISM) Dhanbad

Link representation of entanglement entropy in quantum states

In this talk, I will present the “link representation formalism” that we introduced in our recent works, where we assume that entanglement entropy of any bipartition of a quantum state can be approximated as the sum of certain link strengths connecting internal and external sites. I will provide examples where this representation is exact, as well as discuss several non-exact cases where we can employ various approximation techniques, including tensor network states and both free and interacting modes. Additionally, we will demonstrate how this definition naturally gives rise to an entanglement contour for the system. Lastly, I will illustrate how this representation aids in extending the quasi-particle picture, which is valuable for understanding the growth of entanglement entropy in long-range initial states when subjected to a quench under a critical Hamiltonian. I will conclude with a brief overview of the ongoing extension work in this area.

Anindita Bera

Department of Mathematics, Birla Institute of Technology, Mesra

A class of optimal positive map in M_n

Abstract: Positive maps provide a powerful tool for characterizing entanglement and hence plays a key role in various aspects of quantum information theory. In this talk, I will talk about a certain class of positive maps in the matrix algebra M_n that consists of optimal maps, i.e. maps from which one cannot subtract any completely positive map without losing positivity. This class provides a generalization of a seminal Choi positive map in M_3.

Siddhartha Santra

Department of Physics, IIT Bombay

Title: TBA

Abstract: TBA