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DEPARTMENTAL SEMINAR

Department of Astrophysics and High Energy Physics

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SPEAKER

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TITLE OF THE TALK

Quantum homogenization in Markovian and non-Markovian collisional models

ABSTRACT

Collisional models are a category of microscopic framework designed to study open quantum systems. The framework involves a system sequentially interacting with a bath comprised of identically prepared units. In this regard, quantum homogenization is a process where the system state approaches the identically prepared state of bath unit in the asymptotic limit. Here, we study the homogenization process for a single qubit in the non-Markovian collisional model framework generated via additional bath-bath interaction. With partial swap operation as both system-bath and bath-bath unitary, we demonstrate -- based on numerics as well as analytics -- that homogenization is achieved irrespective of the initial states of the system or bath units. This is reminiscent of the Markovian scenario, where partial swap is the unique operation for a universal quantum homogenizer. On the other hand, we observe that the rate of homogenization is
slower than its Markovian counterpart. Interestingly, a different choice of bath-bath unitary speeds up the homogenization process but loses the universality, being dependent on the initial states of the bath units. We discuss briefly about the issue of information backflow in this latter type of bath-bath interaction [1]. We next demonstrate faster than Markovian thermalisation (more generally, homogenisation) — for arbitrary initial state of system qubit — by considering collision model based realisation of a post-Markovian dynamic, a special kind of non-Markovian dynamics where a non-selective measurement on bath is performed with prior probability in between two Markovian dynamics of the system qubit [2]. Such a faster thermalisation rate is counterintuitive as a generic non-Markovian dynamic seems to spend more time in interacting with the bath due to backflow of information. If time permits, I will also discuss about the thermodynamic compatibility of our post-Markovian master equation.

References:-
[1] Tanmay Saha, Arpan Das, and Sibasish Ghosh, ``Quantum homogenization in non-markovian collisional model", New J. Phys., vol. 26, pp. 023011 (2024).
[2] Tanmay Saha, Sahil, K. P. Atulya, and Sibasish Ghosh, ``Post-Markovian master equation `a la microscopic collisional model", arXiv:2411.16878 (quant-ph).

HOST FACULTY

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