SNBNCBS THESIS COLLOQUIUM

Azadi Ka Amrit Mahotsav

Date	21st April, 2022
Time	11:00 AM
Venue	Fermion
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Thesis Title

Various Aspects Of Positive Maps In Quantum Information Theory

Thesis Abstract

Positive maps acting on algebra of operators find several applications in physical problems. Quantum information theory provides an appropriate platform to study the theory of positive linear maps. It stands like one of the pillars of the foundation to study the theory of bipartite quantum entanglement and the dynamics of an open quantum system. In this thesis the theory of positive linear maps has been studied from both of these aspects.

The connection between theory of bipartite entanglement and positive linear maps has been explored further. A new family of positive maps acting on operators over three dimensional complex Hilbert space has been proposed. This class of positive maps contains an indecomposable subclass which can detect a family of bound entangled states. Entanglement witness constructed out of this positive indecomposable map has been shown to be weakly optimal. By constructing a class of completely positive maps a new two qutrit bound entangled state is generated which can not be detected by several other positive indecomposable maps.

We further study the theory of positive linear maps from the aspect of dynamics of open quantum system. A resource theoretic framework for quantum non-Markovianity has been constructed. Under certain conditions the resource theory has been shown to be convex. A measure of non-Markovianity has been proposed and it has been shown to be lower bounded by the famous RHP measure of non-Markovianity. The idea of robustness of non-Markovianity, which is important from operational perspective, has been developed. The idea of linear non-Markovianity witness has been conceptualized under certain condition by exploiting the geometric structures of Markovian operations. Construction of linear non-Markovianity witness has been shown in several ways. The role of two qubit maximally entangled states in detecting qubit non-Markovianity has been discussed for various channels. The structure of Markovian operations has been explored further to prove the existence of non-linear non-Markovianity witness.

Finally quantum non-Markovianity has been studied in the backdrop of resource theory of purity and thermodynamics. The main motivation is to study interconversion of various resources. Lindblad operators corresponding to an unital operation have been characterized completely. The role of non-Markovianity to drive the system away from its equilibrium has been established. The results have been validated through a spin-bath model.

Publication List

The thesis is based on the following publications:

- Generating and detecting bound entanglement in two-qutrits using a family of indecomposable positive maps, Bihalan Bhattacharya, Suchetana Goswami , Rounak Mundra, Nirman Ganguly, Indranil Chakrabarty, Samyadeb Bhattacharya, A. S. Majumdar, J. Phys. Commun. 5, 065008 (2021).
- Convex resource theory of non-Markovianity, Samyadeb Bhattacharya, Bihalan Bhattacharya, A. S. Majumdar, J. Phys. A: Math. Theor. 54, 035302 (2020).
- Convex geometry of Markovian Lindblad dynamics and witnessing non-Markovianity, Bihalan Bhattacharya, Samyadeb Bhattacharya, Quantum Inf. Proc. 20, 253 (2021).
- Thermodynamic utility of non-Markovianity from the perspective of resource interconversion, Samyadeb Bhattacharya, Bihalan Bhattacharya, A. S. Majumdar, J. Phys. A: Math. Theor. 53, 335301 (2020).

Publications not included in the thesis:

- Environmental effects on non-local correlations. Tamal Guha, Bihalan Bhattacharya, Debarshi Das, Some Sankar Bhattacharya, Amit Mukherjee, Arup Roy, Kaushiki Mukherjee, Nirman Ganguly and A. S. Majumdar. Quanta 8, 57-67 (2019).

- One-sided Device-independent Self-testing of any Pure Two-qubit Entangled State, Suchetana Goswami, Bihalan Bhattacharya, Debarshi Das, Souradeep Sasmal, C. Jebaratnam and A. S. Majumdar. Physical Review A 98, 022311 (2018).
- Tripartite entanglement detection through tripartite quantum steering in one-sided and two-sided device-independent scenarios, C. Jebaratnam, Debarshi Das, Arup Roy, Amit Mukherjee, Some Sankar Bhattacharya, Bihalan Bhattacharya, Alberto Riccardi and Debasis Sarkar. Physical Review A 98, 022101 (2018).
- Operational characterization of quantumness of unsteerable bipartite states, Debarshi Das, Bihalan Bhattacharya, Chandan Datta, Arup Roy, C. Jebaratnam, A. S. Majumdar and R. Srikanth. Physical Review A 97, 062335 (2018).
- Characterization of the quantumness of unsteerable tripartite correlations, Debarshi Das, C. Jebaratnam, Bihalan Bhattacharya, Amit Mukherjee, Some Sankar Bhattacharya and Arup Roy. Annals of Physics, 398, 55-79 (2018).

Pre-print:

- Non-Markovianity and entanglement detection, Sourav Chanduka, Bihalan Bhattacharya, Rounak Mundra, Samyadeb Bhattacharya and Indranil Chakrabarty, arXiv:2109.02335.