Academic Report (2020-21)

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Research Summary:

In the last academic year, I have been working on different aspects of quantum devices, and at the interface of quantum information with other sciences.

In one of these works, I have collaborated with Ahana Ghoshal on heat current and entropy production rate in local non-Markovian quantum dynamics of a global Markovian evolution. We examined the elements of the balance equation of entropy in open quantum evolutions, and their response as we go over from a Markovian to a non-Markovian situation. In particular, we looked at the heat current and entropy production rate in the non-Markovian reduced evolution, and a Markovian limit of the same, experienced by one of two interacting systems immersed in a Markovian bath. The analysis naturally led us to define a heat current deficit and an entropy production rate deficit, being differences between the global and local versions of the corresponding quantities. The investigation brought us, in certain cases, to a complementarity of the time-integrated heat current deficit with the relative entropy of entanglement between the two systems.

In another work, I have collaborated with Kornikar Sen and Chirag Srivastava to provide measurement-device-independent nonlinear entanglement witnesses. Entanglement witnesses are one of the most effective methods to detect entanglement. It is known that nonlinear entanglement witnesses provide better entanglement detection than their linear counterparts, in that the former detect a strictly larger subset of entangled states than the latter. Whether linear or nonlinear, the method is measurement-device dependent, so that imperfect measurements may cause false certification of entanglement in a shared state. Measurement-device-independent entanglement witnesses provide an escape from such measurement dependence of the entanglement detection for linear entanglement witnesses. We presented measurement-device-independent nonlinear entanglement witnesses for non-positive partial transpose entangled states as well as for bound entangled states with positive partial transpose. The constructed measurement-device-independent nonlinear entanglement witnesses certified the entanglement of the same sets of entangled states as their device-dependent parents do, and therefore are better than the linear entanglement witnesses, device-independent or otherwise.

Publications:

1. Riddhi Ghosh, Ahana Ghoshal, and Ujjwal Sen, *Quantum thermal transistors: Operation characteristics in steady state versus transient regimes,* Phys. Rev. A **103**, 052613, (2021).

2. Chirag Srivastava, Sreetama Das, and Ujjwal Sen, *Resource theory of quantum coherence with probabilistically non-distinguishable pointers and corresponding wave-particle duality,* Phys. Rev. A **103**, 022417 (2021).

3. Kornikar Sen, Chirag Srivastava, Shiladitya Mal, Aditi Sen De, and Ujjwal Sen, *Detection loophole in measurement-device-independent entanglement witness,* Phys. Rev. A **103**, 032415 (2021).

6. Ahana Ghoshal and Ujjwal Sen, *Heat current and entropy production rate in local non-Markovian quantum dynamics of global Markovian evolution,* arXiv:2102.06694.

7. Kornikar Sen, Chirag Srivastava, Shiladitya Mal, Aditi Sen De, and Ujjwal Sen, *Noisy quantum input loophole in measurement-device-independent entanglement witnesses,* arXiv:2012.09089.

8. Ahana Ghoshal, Sreetama Das, Amit Kumar Pal, Aditi Sen(De), and Ujjwal Sen, *Three cooling off in two baths: Beyond two-body system-bath interactions in quantum refrigerators,* arXiv:2012.08399.

9. Chirag Srivastava and Ujjwal Sen, *Scaling of non-adiabaticity in disordered quench of quantum Rabi model close to phase transition,* arXiv:2012.04568.

10. Arun Sehrawat, Chirag Srivastava, and Ujjwal Sen, *Equilibrium and dynamical phase transitions in fully connected quantum Ising model: Approximate energy eigenstates and critical time,* arXiv:2012.00561.

11. Asmitha Mekala and Ujjwal Sen, *All entangled states are quantum coherent with locally distinguishable pointers,* arXiv:2008.11148.

12. Shashaank Khanna, Saronath Halder, and Ujjwal Sen, *Quantum entanglement percolation on monolayer honeycomb lattice,* arXiv:2008.09040.

13. Saronath Halder and Ujjwal Sen, *Local indistinguishability and incompleteness of entangled orthogonal bases: Method to generate two-element locally indistinguishable ensembles,* arXiv:2008.01620.

14. Asmita Kumari and Ujjwal Sen, *Local preservation of no-signaling in multiparty PT-symmetric evolutions,* arXiv:2007.13461.

15. C S Sudheer Kumar and Ujjwal Sen, *How many runs ensure quantum fidelity in teleportation experiment?,* arXiv:2004.14816.

16. Tanaya Ray, Arun Kumar Pati, and Ujjwal Sen, *Estimating quantum coherence by noncommutativity of any observable and its incoherent part,* arXiv:2004.07729.

17. Shubhalakshmi S and Ujjwal Sen, *Noncommutative coherence and quantum phase estimation algorithm,* arXiv:2004.01419.

Conference/Workshops Attended:

1. *QMAT-2020*, SN Bose National Center for Basic Sciences, Kolkata, India, 07-11 Sep, 2020. Online.

2. *Young Quantum 2020*, Harish-Chandra Research Institute, Allahabad, India, 12-15 Oct, 2020. Online.