Oberseminar Analysis

Seminar der Abteilung für Analysis und des Lehrstuhls für Analysis und mathematische Physik

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Mesoscopic Quantum Dynamics and Bosonization of Noise

19.11.2025 - 11:00 – Raum 8.526

Abstract: Quantum systems that interact non-locally with an environment (or bath) serve as paradigms for exploring collective phenomena. These systems naturally arise in physical setups featuring long-range many-body interactions, and are experimentally realized in platforms such as Rydberg atom arrays, cold atoms in optical cavities, ion traps, and dipolar systems. They hold broad potential for applications in quantum computing and quantum sensing. In this work, we reveal an exact theoretical mechanism governing such non-locally and mesoscopically coupled systems. We demonstrate that the effect of general environments on the system exhibits a universal bosonic character. Specifically, the exact effect that environments have on the system, regardless of their microscopic details, is equivalently produced by the interaction with a reservoir of non-interacting bosonic modes. The emergent 'bosonization' of the environment results from the mesoscopic coupling in the thermodynamic limit and can be interpreted as a manifestation of the central limit theorem. While this effect has been observed in specific models before, we show that it is, in fact, a universal feature. - Joint work with Marco Merkli.

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