Stuttgarter Physikalisches Kolloquium

Fachbereich Physik, Universität Stuttgart
Max-Planck-Institut für Festkörperforschung
Max-Planck-Institut für Intelligente Systeme

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Dienstag, 30. April 2024	16:15 Uhr	V57.02

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Quantum reaction-diffusion dynamics

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Abstract

A recurrent challenge in physics is the understanding of collective behavior in many-body systems, which leads to the emergence of phases and phase transitions. Ongoing progress in the control of cold atomic gases continuously offers new opportunities for probing and understanding these phenomena in tailored quantum matter.

In this talk I will discuss how these advances put us into position to explore the impact of quantum effects on emergent collective many-body phenomena far from equilibrium. I will focus mainly on two instances: the contact process [1], which is a simple model for epidemic spreading, and fermionic lattice gases featuring two-body annihilation [2]. In both settings the introduction of non-classical effects, such as coherence, appears to alter emergent collective dynamical behavior. This manifests in a change of static and dynamical critical exponents, which can in principle be probed on lattice quantum simulators with Rydberg and ground state atoms. The particular challenge is (also for theory) that an unambiguous identification of these signatures requires the study of large quantum many-body systems over long times.

[1] F. Carollo, E. Gillman, H. Weimer and I. Lesanovsky, Critical behavior of the quantum contact process in one dimension, Physical Review Letters 123, 100604 (2019)

[2] G. Perfetto, F. Carollo, J.P. Garrahan and I. Lesanovsky, Reaction-limited quantum reaction-diffusion dynamics, Physical Review Letters 130, 210402 (2023)