Anomalous fluctuations in many-body systems

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概　要

　One-dimensional models are a theoretical playground for the investigation of strongly interacting many-body dynamics that have in recent years become experimentally realizable. While mean-field methods and other standard approaches are not applicable, they can often be investigated with techniques of integrability and generalized hydrodynamics that have revolutionized our understanding of their large-scale behavior. Fluctuations around hydrodynamic values display remarkable robustness and have recently been observed to be anomalous, indicating additional processes besides normal diffusion.

　We study a family of cellular automata with ballistically propagating charged particles and stochastic scattering. By mapping the dynamics to a "vacancy-dressed" stochastic six-vertex model we derive the exact anomalous distribution of the charge current. Building on macroscopic fluctuation theory, we also give a hydrodynamic description of the model's anomalous fluctuations. Linear degeneracy arising from charge inertness allows for simultaneous contributions from convective and normal diffusion.

　Similar phenomenology of dynamical criticality is observed in equilibrium spin current fluctuations in the easy-axis and isotropic regimes of the XXZ spin chain. The easy-axis regime supports the non-Gaussian distribution of the charged single-file class despite not manifestly satisfying a kinetic constraint. We argue anomalous fluctuations instead arise due to linear degeneracy of the vacuum polarization in the quasi-particle description. At the Heisenberg point the spin structure factor matches that of the Kardar-Parisi-Zhang universality class while spin fluctuations are anomalous but distinct from those of the KPZ class.

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