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New Avenues for Quantum Simulations In- and Out-of-equilibrium

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Quantum simulation using ultracold atoms and molecules has opened a new research field to probe quantum matter in- and out-of-equilibrium. In fermionic quantum matter, mixed two-dimensional systems boost the pairing energy of holes and have enabled us to observe first signatures of stripe phases in doped systems. In quantum dynamics, probing the full counting statistics of charge transfer allows one to explore quantum transport in fundamentally new ways. We test this for the cases of integrable and chaotic quantum dynamics, where for the latter case local subsystems eventually approach a thermal equilibrium state. Large subsystems, however, thermalize slower: their approach to equilibrium is limited by the hydrodynamic build-up of large-scale fluctuations. We show that large-scale fluctuations of isolated quantum systems display emergent hydrodynamic behaviour, expanding the applicability of macroscopic fluctuation theory to the quantum regime.

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