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Stable and unstable perturbations in universal scaling phenomena far from equilibrium

Thursday, 17 November 2022 15:30 (20 minutes)

We study the dynamics of perturbations around nonthermal fixed points associated to universal scaling phenomena in quantum many-body systems far from equilibrium. For an N -component scalar quantum field theory in 3+1 space-time dimensions, we determine the stability scaling exponents using a self-consistent large-N expansion to next-to-leading order. Our analysis reveals the presence of both stable and unstable perturbations, the latter leading to quasi-exponential deviations from the fixed point in the infrared. We identify a tower of far-from-equilibrium quasi-particle states and their dispersion relations by computing the spectral function. With the help of linear response theory, we demonstrate that unstable dynamics arises from a competition between elastic scattering processes among the quasi-particle states. What ultimately renders the fixed point dynamically attractive is the phenomenon of a scaling instability, which is the universal scaling of the unstable regime towards the infrared due to a self-similar quasi-particle cascade. Our results provide ab initio understanding of emergent stability properties in self-organized scaling phenomena.

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