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Off-equilibrium Non-Gaussian Cumulants: criticality, complexity, and universality

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Non-equilibrium evolution of cumulants of critical fluctuations for space-time trajectories on the cross-over side of the QCD phase diagram will be discussed in detail. Memory effects are important. Utilizing a simple model of the space-time evolution of a heavy-ion collision, we demonstrate that, depending on the relaxation rate of critical fluctuations, Skewness and Kurtosis can differ significantly in magnitude as well as in sign from equilibrium expectations. Furthermore, we demonstrate that key features of the Kibble-Zurek framework of non-equilibrium phase transitions can be employed to extract the dynamics of critical cumulants for differing protocols—trajectories in the space of parameters in the vicinity of the QCD critical point. For a broad classification of crossover protocols, universal scaling functions are obtained for the cumulants that are insensitive to the parameters governing the protocols. As a consequence of this non-equilibrium universality, a map of the details of critical dynamics in heavy-ion collisions to the relevant Kibble-Zurek parameters is feasible and provides powerful model independent guidance in searches for the QCD critical point.

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