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Renormalizing Lattice Spacing Dependence

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Heavy ion collisions that aim to probe phase transitions and critical phenomena require robust predictions for fluctuation observables. Today, a major challenge preventing the systematic study of event-by-event stochastic dynamical models for critical fluctuations in heavy-ion collisions is the lattice spacing dependence of physical observables. It arises from discretizating such models, which effectively cuts off the UV modes.
In this presentation, we show the first systematic renormalization of this unphysical lattice spacing dependence in fluctuation observables. In order to study fluctuation dynamics of trajectories near the QCD critical point in heavy ion collisions, we take a stochastic relaxation equation of the chiral field, in the framework of model A in the Hohenberg-Halperin classification, with a Ginzburg-Landau effective potential. We show the noise-induced lattice spacing dependence in the variance and kurtosis of chiral fluctuations. We then introduce an appropriate lattice counterterm to cure this unphysical sensitivity for evolutions not too far from equilibrium. In addition, lattice renormalization recovers expected physics near the critical point during dynamics: a large but finite correlation length and non-zero values of the kurtosis. Finally, we comment on the prospect of extending this approach to stochastic hydrodynamics.

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