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# Impact of mass renormalization on order parameter fluctuations near a phase transition

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Heavy ion collisions that aim to probe phase transitions and critical phenomena require robust predictions. In order to scan the QCD phase diagram and gain insight into the exact nature of these transitions and the conjectured critical point, numerical simulations are increasingly used.
Mapping a system onto a finite lattice, with discrete spatial steps, effectively cuts off the theory in the IR (through lattice size) and in the UV (through lattice spacing). The cutoff used to cure UV divergences, inversely proportional to the resolution, creates a lattice spacing dependence, most problematic when considering the behavior at continuum. We are mostly concerned with this sensitivity.
We consider a simplified Ginzburg-Landau effective potential, describing a phase transition. The time evolution of the order parameter from some small out-of-equilibrium condition to its value at the minimum of the potential, is governed by a Ginzburg-Landau-Langevin type equation. The dissipation term and the white additive noise in this relaxation equation, with no conserved charge, lead to the non-physical lattice spacing dependence.
We aim to cure, or at least alleviate, this lattice spacing sensitivity by adding an established counterterm, from a mass renormalization procedure, to our potential. We start by checking the validity of our approach by testing a simple unphysical quantity in the Gaussian limit.
We then choose 2 physical observables: the expectation value and the integrated variance of the order parameter.
In the Gauss approximation, no lattice spacing sensitivity is observed, as expected. Then performing the simulations after including the nonlinear terms, we confirm that the lattice spacing dependence of the mean is eliminated by the counterterm for all tested lattice spacing values, as previously discussed by various authors. However, for the integrated variance some lattice spacing dependence seems to persist. Preliminary results indicate that satisfactory results are only achieved for certain ranges of lattice spacing.
In the course of our study, we also discuss the possible influence and impications of the system volume and the chosen geometry on the results.

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