Contribution ID: **242** Type: **Talk**

On the condition for correct convergence in the complex Langevin method

Tuesday, July 26, 2016 5:30 PM (20 minutes)

The complex Langevin method (CLM) is a promising way to perform the path integral with a complex action based on a stochastic equation for complexified dynamical variables. It is known, however, that the CLM gives wrong results in some cases, while it works, for instance, in finite density QCD in the deconfinement phase or in the heavy dense limit. In this talk, we revisit this issue starting with a finite Langevin step-size. We find that there is a subtlety in taking the zero step-size limit, although the previous argument used a continuous time from the beginning. Also there is a subtlety in using the time-evolved observables, which play a crucial role in the argument. These subtleties require that the probability distribution of the drift term should be suppressed exponentially at large magnitude. We demonstrate our claim in some examples including chiral Random Matrix Theory and show that our criterion is indeed useful in judging whether the results obtained by the CLM are trustable or not.

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Session Classification: Nonzero Temperature and Density

Track Classification: Nonzero Temperature and Density