Abstract:

The so-called sign problem is obstructing efficient simulations of finite density QCD and other problems with a complex action. The complex Langevin equation (CLE), which replaces the complex density with a positive measure on complexified field space, was proposed long ago as a general solution to this problem. However, progress was hampered by various difficulties, such as instabilities (runaways) and, more worrisome, convergence to an incorrect limit. I will review the formal justification of the method, pointing out where the formal arguments may go wrong. The difficulties are inherent in the structure of the stochastic dynamics of the CLE: in all interesting cases there exist repulsive fixed points, that may lead to large excursions and slow decay of equilibrium measures. While the problem of instabilities appears to be eliminated by using an adjusted step size, convergence to incorrect solutions remains a serious problem. We have developed a set of practical tests for correctness of simulations. The strength of the tests is successfully studied in simple examples; work on more realistic models is in progress.