

Study of a Langevin-Equation-Based Solver for the Hubbard Model

Ken Yobisaka and Shintaro Hoshino

Department of Physics, Chiba University

Numerical methods for solving the effective impurity problem in dynamical mean-field theory (DMFT) [1] play a central role in the numerical study of strongly correlated electron systems. Existing impurity solvers, including continuous-time quantum Monte Carlo methods [2], have advantages and limitations that depend on the model and parameter regime. It is therefore important to explore complementary approaches. In this study, we focus on the complex Langevin method, a numerical approach based on stochastic processes.

The complex Langevin method has been applied to numerical calculations in particle physics and quantum many-body systems [3,4]. Langevin-type stochastic quantization has also been proposed for the two-dimensional Hubbard model [5], whereas its applicability to the effective impurity problem in DMFT remains insufficiently understood. We therefore investigate an approach that applies the complex Langevin method to the path-integral representation of the DMFT effective impurity problem for the single-orbital Hubbard model.

In this presentation, we examine the dependence of the numerical results on parameters such as temperature and the Langevin time step, and discuss the accuracy, convergence, and numerical stability of the method as an impurity solver. We also consider the conditions and challenges for obtaining reliable numerical results.

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