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Progress on stabilisation of complex Langevin for real-time simulations of non-abelian gauge theories

Complex actions lead to highly oscillatory weight functions in the calculation of ensemble averages, which is known as the numerical sign problem and renders modern standard techniques such as Hybrid-Monte-Carlo (HMC) integration inappropriate for these calculations. The complex Langevin (CL) method proposes to resolve this issue by introducing a fifth artificial Langevin time and complexifying the fields of the theory.
We present our current work on the simulation of real-time SU(2) Yang-Mills theory by complexifying the gauge group to SL(2,C) and specifying complex time-contours based on the Schwinger-Keldysh formalism. It is known that for this application the CL process suffers from numerical instabilities and problems with convergence. We lay out our recent progress on improving stabilisation techniques and present results from real-time simulations obtained with our numerical framework. We further review how combinations of modern stabilisation techniques such as gauge cooling and dynamical stabilisation can be used to mitigate the convergence issues but also discuss their limitations.

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