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Overcoming Ergodicity Problems of the HMC Method using Radial Updates

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Despite its many advantages, the sensible application of the Hybrid Monte Carlo (HMC) method is often hindered by the presence of large - or even infinite - potential barriers. These potential barriers partition the configuration space into distinct sectors, which leads to ergodicity violations and biased measurements of observables.
In this work, we address this problem by augmenting the HMC method with a multiplicative Metropolis-Hastings update in a so-called "radial direction" of the fields, which enables jumps over the aforementioned potential barriers at comparably low computational cost. The effectiveness of this approach is demonstrated for the Hubbard model, formulated in a non-compact space by means of a continuous Hubbard-Stratonovich transformation. Our numerical results show that the radial updates successfully resolve the ergodicity violation, while simultaneously reducing autocorrelations.

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