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Multigrid low-mode averaging for Wilson fermions

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We develop a generalization of low-mode averaging in which the number of low quark modes of the Dirac operator required for a constant variance reduction can be kept independent of the volume by exploiting their local coherence. Typically in lattice QCD simulations, the benefit of translation averaging quark propagators over the space-time volume is spoiled by large fluctuations introduced by the approximations needed to estimate the average. For quark-line connected diagrams at large separations, most of this additional variance can be efficiently suppressed by the introduction of hierarchical subspaces, thanks to the reduced size of the coarse grid operators that act within the subspaces. In this work, we investigate the contributions to the variance of the isovector vector current correlator with $N_f = 2$ non-perturbatively $O(a)$ -improved Wilson fermions on lattices approximately of size $L = 2, 3$ and 4 fm. The numerical results obtained confirm that the variance decreases as the volume is increased when a multigrid decomposition is used with a fixed number of low modes. While the proposed decomposition can be applied to any quark propagator, it is expected to be especially effective for quark-line connected diagrams at large separations, for example, the isovector contribution to the hadronic vacuum polarization or baryonic correlators.

Parallel Session (for talks only)

Algorithms and artificial intelligence

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