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Riemannian Manifold Hybrid Monte Carlo in Lattice QCD

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Critical slowing down presents a critical obstacle to lattice QCD calculation at the smaller lattice spacings made possible by Exascale computers. Inspired by the concept of Fourier acceleration, we study a version of the Riemannian Manifold HMC (RMHMC) algorithm in which the canonical mass term of the HMC algorithm is replaced by a rational function of the gauge-covariant, QCD Laplace operator. We have developed a suite of tools using Chebyshev filters based on the QCD Laplacian that provides the power spectra of both the gauge and fermion forces and determines the spectral dependence of the resulting RMHMC evolution of long- and short-distance QCD observables. These tools can be used to precisely tune the RMHMC mass term and to anticipate the resulting degree of Fourier acceleration that should be achieved.

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