Precise calibration of quenched anisotropic lattices

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Anisotropic lattices, in which the temporal lattice spacing a_τ is finer than the spatial one a_σ, have become a convenient tool for various subjects in lattice QCD simulations. Among such applications, computations of heavy-light matrix elements are especially important for the extraction of an effect beyond the standard model from experimental data [1, 2]. Recent experimental progress requires theoretical predictions of matrix elements to a few percent level of precision. To achieve this precision on anisotropic lattices, systematic uncertainties in the calibration of anisotropy parameters must be controlled to sufficient level, say, 0.2%. The previous work by Klassen for the gauge field in quenched approximation at 1% accuracy [3] does not meet this condition.

We propose to calibrate the gauge anisotropy parameter through the hadronic radius r_0 which is defined as $r_0^2 F(r_0) = 1.65$, where $F(r)$ is the force between static quark and antiquark and determined from the static quark potential [4]. r_0 is frequently used to set the lattice scale via phenomenological identification $r_0 \simeq 0.5$ fm. Measuring r_0 in the spatial (coarse) and temporal (fine) directions, the renormalized anisotropy $\xi = a_\sigma/a_\tau$ is defined as the ratio of them. Recently, a high precision computation algorithm has been developed for computations of the static quark potential by Lüscher and Weisz [5]. This method is based on a multilevel scheme that exploits the locality of the theory and can exponentially reduce the statistical errors. One can then obtain a relation between γ_G, the bare anisotropy parameter in the gauge action, and ξ to high precision.

We apply the Lüscher-Weisz algorithm [5] to a computation of static potential on anisotropic lattices and verified that the above procedure successfully determine ξ at 0.2% accuracy [6]. At $a_\sigma \simeq 1$ GeV, we determine the bare anisotropy parameter γ_G which gives $\xi = 4$. Extended work to determine $\gamma_G(a_\sigma, \xi)$ in wide range of a_σ at $\xi = 4$ is in progress.

The simulation has been done on NEC SX-5 at Research Center for Nuclear Physics, Osaka University and Hitachi SR8000 at KEK (High Energy Accelerator Research Organization).

References

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