Nonperturbative determination of the relativistic corrections to the static inter-quark potential at $O(1/m)$ up to 0.9 fm

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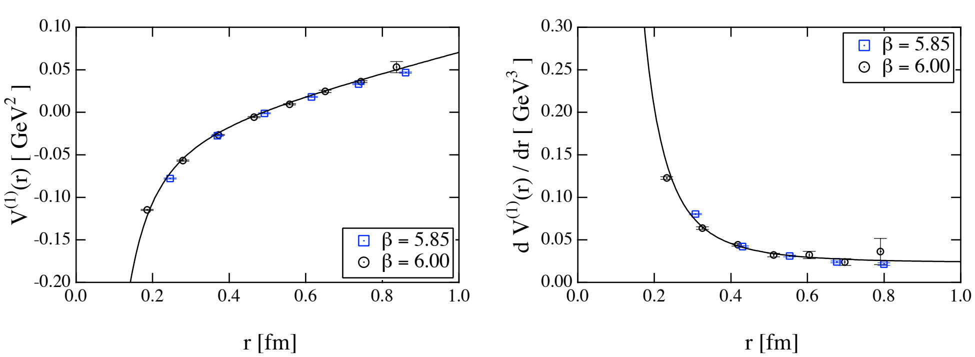
The effective field theory called potential nonrelativistic QCD (pNRQCD) provides us with a systematic framework to study the interquark potential. The potential is classified in powers of $1/m$, where m is the (heavy) quark mass. The static potential emerges as the leading-order contribution, followed by relativistic corrections. In pNRQCD, these corrections are expressed with the field strength correlators in the presence of heavy quark source [1]. A few years ago we reported the first result of the corrections at $O(1/m)$ (denoted as $V^{(1)}(r)$, where r is the q-$\bar{q}$ distance) from lattice QCD Monte Carlo simulation [2], up to 0.6 fm.

In this report we have further investigated the long-distance behavior of $V^{(1)}(r)$ up to 0.9 fm [3]. In the Figure we show $V^{(1)}(r)$ and its derivative $V^{(1)\prime}(r)$ corresponding to the force, evaluated at $\beta = 5.85$ ($a = 0.123$ fm) on the $18^3 24$ lattice and at 6.00 ($a = 0.093$ fm) on the $24^3 32$ lattice with the Wilson gauge action. The $1/m$ potential normalized at 0.5 fm and the force at different β values show a reasonable scaling behavior. The functional form of the $O(1/m)$ potential is not yet established nonperturbatively. We found that, if we include the data $r > 0.6$ fm, the $1/r$ function reported in Ref. [2] is not supported by the fit, while the perturbative $1/r^2$ function with the linear term can fit the data well.

Simulations have been performed on the NEC SX8 at RCNP, Osaka University.



References

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