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A precise α_s determination from the R-improved QCD Static Energy

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The strong coupling α_s is the most important parameter of Quantum Chromodynamics (QCD) therefore it is essential to determine it with high precission. This work presents an improved approach for extracting α_s comparing the numerical results of lattice QCD simulations to the perturbative expansion of the QCD static energy. We apply R-improvement to its 3-loop fixed-order prediction, enabling the subtraction of the u=1/2 renormalon and the corresponding summation of large logarithms. We also perform resummation of large ultra-soft logs to N^3LL accuracy using renormalization group equations. A new and more flexible parametrisation of the renormalization scale has been implemented, allowing us to extend perturbation theory to distances of the order of 1 fm. Perturbative uncertities are estimated randomly varying the parameters that specify the renormalisation scale. We have designed a highly optimised algorithm to evolve α_s based on the perturbative definition of Λ_{QCD}, which makes scanning over the strong coupling when minimising the χ^2 function very efficient. We also combine Lattice data from different simulations into a single dataset, simplifying the fitting procedure. Using this approach, we determine the strong coupling with a precision comparable to that of the world average

Abstract

The strong coupling α_s is the most important parameter of Quantum Chromodynamics (QCD) therefore it is essential to determine it with high precission. This work presents an improved approach for extracting α_s comparing the numerical results of lattice QCD simulations to the perturbative expansion of the QCD static energy, applying R-improvement and resumming large ultrasoft logs at N^3LL accuracy. A flexible renormalization scale parameterization allows us to extend perturbation theory to distances up to 1 fm. Through an optimized algorithm, we achieve efficient α_s determination with precision comparable to that of the world average.

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