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Quark-antiquark potentials in nonperturbative models

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Many models have tried to explain some non-perturbative aspects of the strong interactions, in particular, the color confinement hypothesis of quantum chromodynamics (QCD), but actually, they do not fully explain it. In this work, we investigate some of these non-perturbative models for QCD with the purpose of testing its validity in the perturbative region of nuclear interactions where the perturbative predictions with quasi-free quarks are in agreement with the experimental data, as well as to explore its behavior in the infrared region. In particular, we focused on the calculations and analysis of the potentials between heavy quarks and antiquarks, since this observable might reveal the appearance of confinement properties in non-perturbative models through a linear growth at large and intermediate distances. We calculated the potentials associated with the Massive Gluon (Yukawa), Gribov-Zwanziger and Gribov-Zwanziger Refined models at tree level for the non-relativistic case. In addition, we have included the flux of the Renormalization Group in the QCD coupling constant, which allowed us to study the energy-scale dependence of the parameters of the potentials treated here. Our results indicate that, in the tree-level approximation, all potentials we have obtained can reproduce the perturbative result at high energies and some of them bring significant non-perturbative corrections. We also present one-loop corrections and discuss the two-loop modifications in the case of the Curci-Ferrari model.

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