I. INTRODUCTION

The concept of a running coupling $\alpha_s(Q^2)$ in QCD is usually restricted to the perturbative domain. However, as in QED, it is useful to define the coupling as an analytic function valid over the full spacelike and timelike domains. The study of the non-Abelian QCD coupling at small momentum transfer is a complex problem because of gluonic self-coupling and color confinement. Its behavior in the nonperturbative infrared (IR) regime has been the subject of intensive study using Dyson-Schwinger equations and Euclidean numerical lattice computation, [1] since it is a quantity of fundamental importance. We will show that the light-front (LF) holographic mapping of classical gravity in anti-de Sitter (AdS) space, modified by a positive-sign dilaton background $\exp(+\kappa^2 z^2)$, leads to a nonperturbative effective coupling $\alpha_s^{AdS}(Q^2)$ which is in agreement with hadron physics data extracted from different observables, as well as with the predictions of models with built-in confinement and lattice simulations.

The AdS/CFT correspondence [2] between a gravity or string theory on a higher dimensional AdS space-time and conformal gauge field theories in physical space-time has brought a new set of tools for studying the dynamics of strongly coupled quantum field theories, and it has led to new analytical insights into the confining dynamics of QCD. The AdS/CFT duality provides a gravity description in a $(d+1)$-dimensional AdS spacetime in terms of a flat d-dimensional conformally-invariant quantum field theory defined at the AdS asymptotic boundary. [3] Thus, in principle, one can compute physical observables in a strongly coupled gauge theory in terms of a classical gravity theory.

Since the quantum field theory dual to AdS_5 space in the original correspondence [2] is conformal, the strong coupling of the dual gauge theory is constant, and its β function is zero. Thus, one must consider a deformed AdS space in order to have a running coupling $\alpha_s^{AdS}(Q^2)$ for the gauge theory side of the correspondence. We assume a positive-sign confining dilaton background to modify AdS space, a model that gives a very good account of meson and baryon spectroscopy and form factors. We use LF holography [4–8] to map the amplitudes corresponding to hadrons propagating in AdS space to the frame-independent light-front wave functions (LFWFs) of hadrons in physical $3+1$ space. This analysis utilizes recent developments in LF QCD, which have been inspired by the AdS/CFT correspondence. [2] The resulting LFWFs provide a fundamental description of the structure and