1. INTRODUCTION

The physics of QCD exhibits different relevant excitations at distinct length (or momentum) scales. To give this notion a well-defined meaning, consider some characteristic length scale L_c of the order of 1 fm that crudely separates short- from long-distance physics. At short space-time distances ($r \ll L_c$) the relevant degrees of freedom are quarks and gluons, effectively unconfined due to asymptotic freedom, and their interactions are well described by perturbative QCD. The theory exhibits chiral symmetry and (approximate) scale symmetry. At large distances ($r \gg L_c$) on the other hand, we are in the regime of hadronic degrees of freedom and physical observable particles, whose non-perturbative interactions are known to be described well by chiral models. In between these two regimes, in the range $r \approx L_c$, our current knowledge is essentially limited to the understanding that there must be a rather sudden dynamical establishment of long-range order, i.e. some kind of "phase transition" from the unconfined, chiral- and scale-invariant phase of partons to the hadronic phase with massive physical states and broken symmetries.

The *dynamics* of this parton-hadron conversion and confinement mechanism has scarcely been studied yet, although QCD-inspired effective quark models that incorporate confinement phenomenology in some way have been exploited extensively to describe static hadron properties rather well [1]. This problem is particularly serious for attempts to describe the phenomenon of hadronization in high-energy QCD processes. The theoretical tools currently available for studying QCD are inadequate to describe the transformation from partonic to hadronic degrees of freedom as a dynamic process: perturbative techniques [2] are limited to the short-distance regime where confinement is not apparent, whilst effective low-energy chiral models [3] and QCD sum rules [4], that incorporate confinement, lack partonic degrees of freedom. On the other hand, common descriptions of parton fragmentation [5] are usually based on ad hoc prescriptions to simulate hadron formation from parton decays. In principle, lattice QCD [6] should be able to bridge the gap, but in practice dynamical calculations of parton-hadron conversion are not yet feasible.

The purpose of the present paper is to give a detailed documenation of our progress towards a consistent, fully dynamical formulation of the non-static properties of confinement, chiral symmetry breaking and hadron formation, as recently proposed in Ref. [7]. Aside from the aforementioned arguments, these issues are of great interest in the context