represent the particle excitations of the scalar long-range χ field. These "pre-hadronic" excitations must then convert into physical hadronic states $-$ either excited gluonic states, or, via coupling to the U field, quark-antiquark meson excitations $-$ and subsequently decay into low-mass hadrons.

4.1 General concept

As stressed in Sec. 2, the phenomenological color-singlet function χ represents the effect of the long-range order of the non-perturbative vacuum, so that the formation of a color-neutral parton cluster - or bubble - can be interpreted as a domain structure immersed in the medium of the non-perturbative vacuum. In quantum field theory such stable field configurations arise as *classical* soliton solutions of the equations of motion [9, 26]. On the other hand, it is well known that QCD exhibits the so-called 'preconfinement' property [27] already on the perturbative level, which is the tendency of the gluons and quarks produced in parton cascades to arrange themselves in color-singlet clusters with limited extension in phase space. It is therefore natural to suppose that these clusters, or bubbles, are the basic 'pre-hadronic' units out of which hadrons arise non-perturbatively.

Thus, the kinetic evolution of the system develops in three stages: parton multiplication, parton-cluster conversion, and cluster decay into hadrons. It is clear that in this approach the conversion process is a local, microscopic mechansim, that proceeds earlier or later at different points in space, depending on the local density of partons and their nearest-neighbour separation L, as defined by eq. (3). Thus, in order to trace the full dynamics, it is necessary to follow the evolution of the particle distributions in real time using the kinetic framework of Sec. 3. In accord with the above picture, we will now proceed in several steps, starting from the master equations (34) and (35): (i) employ a separation of a coherent (mean) field part and a contribution from quantum excitations for the composite fields χ and U, (ii) fix a specific, ghost-free gauge for the gluon fields that is most convenient for our purposes, (iii) treat the evolution of the high-momentum quarks and gluons perturbatively in the presence of the coherent field χ.

(i) According to our interpretation of oscillations about the minimum of the potential at χ_0, U_0 as physical excitations of the coherent fields χ and U, we separate in a standard way [28] the classical field configuration at the minimum of $\mathcal{V}_{\chi=\chi_0}$ in Fig. 2, from the quantum