results from the gauge-fixing constraint in eq. (5), e.g., in covariant gauges $\xi_a^\nu(A) = (1/\alpha)\partial^\nu\partial_\mu A_a^\mu$. Note that in general there are additional equations of motion involving the ghost fields coupled to the gluon fields, however, since we will later choose a ghost free gauge, these decouple and are irrelevant here.

It is evident from the above equations and the form of the potential $V(\chi, U)$, eq. (11), that in the short-distance limit when $\langle\chi\rangle = 0$ and $\kappa_L(\chi) = 1$, the system of equations decouples and reduces to the usual Yang-Mills equations. Similarly, in the long-wavelength limit, one has $\langle\chi\rangle \to \chi_0$, $\langle U\rangle \to U_0$, and $\kappa_L(\chi) \to 0$, so that the dynamics in this case is completely described by the equations for the effective fields χ and U. A very important point is that the U field does not couple directly to the quark or gluon fields. By construction [14], the dynamics of the quark condensate field U is solely driven by the gluon condensate field χ. As a consequence, the equation for U is readily solved, once the solution for χ is known. It is important to realize that the interplay between the χ field and the quark and gluon fields, ψ and A, is the crucial element of this approach. From a phenomenological point of view, this implies that the transformation of parton to hadron degrees of freedom proceeds first by formation of scalar color-singlet states which subsequently decay into pseudoscalar excitations (Sec. 4).

3.2 Real-time Green functions and microscopic kinetics

The central role in the following is played by the *real-time Green functions* in the 'closed-time-path formalism' (for an extensive review, see [21]). This formalism is the appropriate tool to describe general non-equilibrium systems, and its particular strength lies in the possibility of studying the time evolution of phenomena where initial and final states correspond to different vacua, as we are addressing here. In [19] it is shown how one obtains a dynamical formulation which systematically incorporates quantum correlations and describes naturally the transition from the perturbative QCD regime to the non-perturbative QCD vacuum. The real-time Green functions are defined as the two-point functions that measure the *time-ordered correlations* between the fields at space-time points x and y (as before we suppress the spinor indices for the fermion operators):

$$
\begin{aligned}
i\, S_{ij}(x,y) \;&:=\; \langle\, T\, \psi_i(x)\, \overline{\psi}_j(y)\, \rangle \\
i\, D_{ab}^{\mu\nu}(x,y) \;&:=\; \langle\, T\, A_a^\mu(x)\, A_b^\nu(y)\, \rangle
\end{aligned}
$$