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REAL-TIME DESCRIPTION OF PARTON-HADRON CONVERSION AND CONFINEMENT DYNAMICS

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Abstract

We propose a new and universal approach to the hadronization problem that incorporates both partonic and hadronic degrees of freedom in their respective domains of relevance, and that describes the conversion between them within a kinetic field theory formulation in real time and full 7-dimensional phase space. We construct a scale-dependent effective theory that reduces to perturbative QCD with its scale and chiral symmetry properties at short space-time distances, but at large distances ($r \gtrsim 1$ fm) yields symmetry breaking gluon and quark condensates plus hadronic excitations. The approach is applied to the evolution of fragmenting $q\bar{q}$ and gg jet pairs as the system evolves from the initial 2-jet configuration, via parton showering and cluster formation, to the final yield of hadrons. The phenomenological implications for $e^+e^- \to hadrons$ are investigated, such as the time scale of the transition, and its energy dependence, cluster size and mass distributions. We compare our results for particle production and Bose-Einstein correlations with experimental data, and find an interesting possibility of extracting the basic parameters of the space-time evolution of the system from Bose enhancement measurements.

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