Spatially Homogeneous Yang-Mills Theory: Instant and Light-Front Forms of Dynamics

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Abstract

Two different forms of relativistic dynamics, the instant and the light-front form, for the pure SU(2) Yang-Mills field theory in 4-dimensional Minkowski space are examined under the supposition that the gauge fields depend on the time evolution parameter only. The obtained under that restriction of gauge potential space homogeneity mechanical matrix model, sometimes called Yang-Mills classical mechanics, is systematically studied in its instant and light-front form of dynamics using the Dirac's generalized Hamiltonian approach. In the both cases the constraint content of the obtained mechanical systems is found. In contrast to its well-known instant-time counterpart the light-front version of SU(2) Yang-Mills classical mechanics has in addition to the constraints generating the SU(2) gauge transformations the new first and second class constraints also. On account of all of these constraints a complete reduction in number of the degrees of freedom is performed. In the instant form of dynamics it is shown that after elimination of the gauge degrees of freedom from the classical SU(2) Yang-Mills mechanics the resulting unconstrained system represents the ID_3 Euler-Calogero-Moser model with a certain external fourth-order potential, whereas in the light-front form it is argued that the classical evolution of the unconstrained degrees of freedom is equivalent to a free one-dimensional particle dynamics.

Keywords: Gauge theories, Yang-Mills mechanics, Hamiltonian reduction, Integrable systems.