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Nonlinear Field Space Theory and Cosmology

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The concept of a field theory with nonlinear phase space has recently been introduced, inspired by nontrivial geometry of the particles' phase spaces appearing in several approaches to quantum gravity. In particular, it has been applied in the context of cosmological inflation, by considering a scalar field theory with spherical phase space, defined on the standard FRW background (i.e. general relativity itself is not modified). The scalar field Hamiltonian is assumed to correspond to the continuous XXZ Heisenberg model of a system of spins. For the homogenous cosmology the nonlinearity of the field phase space turns out to be relevant at late cosmological times, when it may lead to a recollapse of universe, while at early times there is a possibility of a bounce, avoiding the initial singularity. Quantum perturbations of the field have been studied in the linear approximation but taking into account the Lorentz symmetry breaking term in the field Hamiltonian. This leads to a correction to the ordinary amplitude of perturbations and a generalization of the Bunch-Davies vacuum state, while the inflationary spectral index remains unchanged in the leading order. The discussed framework is potentially able to bring cosmology and condensed matter physics closer together.

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