Field theory with compact phase space

Tomasz Trześniewski
Institute of Physics, Jagiellonian University

Abstract

The generalization of field theory to the case of fields with nonlinear phase space has recently been proposed, inspired by nontrivial geometry of the particles' phase spaces that appear in several approaches to quantum gravity. The potential usefulness of such a framework was first explored by constructing a prototype scalar field with the spherical phase space [1, 2], which is also equivalent to the phase space of spin [3, 4]. After the quantization, it leads to a variety of predictions familiar from the quantum gravity research, including deformation of the operator algebras, corrections to the uncertainty relation and shift of the vacuum energy. Moreover, in the context of cosmological inflation, a similar model was considered [5] as the matter field on the background of FRW spacetime. Using the analogy with spin, the field Hamiltonian is there adapted from the Heisenberg model. The preliminary study was devoted to both the homogenous case and quantum perturbations of such a test field. It turns out that the nonlinearity of the field phase space becomes relevant for late times in the evolution of universe and then it can lead to a recollapse, and possibly it also affects the early times, leading to the effect of a bounce. The presented framework might hopefully bring quantum gravity, cosmology and condensed matter physics closer together.

References

[1] J. Mielczarek and T.T., *The Nonlinear Field Space Theory*, Phys. Lett. B **759**, 424 (2016) [arXiv:1601.04515 [hep-th]].

[2] T.T., *Nonlinear Field Space Theory and Quantum Gravity*, Acta Phys. Pol. B Proc. Suppl. **10**, 329 (2017) [arXiv:1701.06865 [hep-th]].

[3] J. Mielczarek, *Spin-Field Correspondence*, Universe **3**, 29 (2017) [arXiv:1612.04355 [hep-th]].

[4] J. Bilski, S. Brahma, A. Marcianò and J. Mielczarek, *Klein-Gordon field from the XXZ Heisenberg model*, Int. J. Mod. Phys. D **28**, 1950020 (2018) [arXiv:1708.03207 [hep-th]].

[5] J. Mielczarek and T.T., *Nonlinear Field Space Cosmology*, Phys. Rev. D **96**, 043522 (2017) [arXiv:1704.01934 [gr-qc]].