Service de Physique de l'Univers, Champs et Gravitation

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Sujet de mémoire

Exotic gauge-invariant equations of motion

A massless particle of arbitrary spin can be described by a field $\varphi_{\mu_1 \cdots \mu_s}$ generalising the vector potential A_μ and the linearised metric $h_{\mu\nu}$. The form of the equations of motion can then be fixed uniquely by requiring invariance under a suitable generalisation of the gauge symmetry $\delta A_\mu = \partial_\mu \lambda$ of the vector potential.

However, for values of the spin $s \geq 2$, there exist different ways to generalise the gauge symmetry $\delta A_\mu = \partial_\mu \lambda$. For instance, in Minkowski space one can obtain field equations describing either a single particle of spin s [1] or a multiplet of particles of spin s, $s-2$, $s-4$, ... [2]. In space of constant curvature (de Sitter or Anti de Sitter) one has even more options for writing gauge-invariant equations of motion, and this corresponds to the existence of so-called partially-massless particles [3].

In the search for the correct equations of motion for partially-massless fields, it has been noticed the existence of two different field equations enjoying the same gauge symmetry [3]. One has been eventually proved to describe partially-massless fields, while the other, even if it displays some nice properties (as for instance, the absence of signals propagating at a speed faster than that of light), was "abandoned". The "wrong" equation of motion, however, recently re-appeared in a completely different context, as an equation characterising the global symmetries of fields of arbitrary spin in a Minkowski background [4].

The goal of the project is to extend the analysis of [3] to fields of arbitrary spin and clarify the spectrum propagated degrees of freedom (essentially, identify which particles are described by such equation and understand the expected problems with unitarity). The main technique will be the rewriting in Hamiltonian form of the equations of motion (see e.g. [5]), which makes manifest the number of propagating degrees of freedom. Further development may include the study of other, alternative gauge-invariant equations of motion in Minkowski space with higher-derivative kinetics terms as, for instance, those discussed in [6].

Prerequisites: courses of General Relativity and Quantum Field Theory 1

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References

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