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String-inspired Infinite Derivative Non-local QFT: Non-perturbative results

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Non-local quantum field theories have been studied recently as a promising approach to go beyond the Standard Model (e.g. see [1–3]). This approach is strongly motivated by string theory (p-adic string field theory) [4–6]. These theories have the properties of UV-completeness and (proposed as a direction of UV-completion the non-local infinite-derivative theories) are ghost-free (re-normalizable and predicts conformal invariance at the quantum level) [7]. They are able to rescue dark matter models [3], move trans-planckian processes to sub-planckian [8] and improve inflationary behaviour of the Higgs field [9]. On the same research avenues, we consider an infinite derivative scalar field theory and we show, by a technique devised by Bender, Savage and Milton [10], how to derive the set of Dyson-Schwinger equations in differential form. Then, we provide a method to solve them, assuming that non-local effects are small at low-energies and taking into account only the leading order solutions [11]. Local solutions for the scalar field theory, both for the classical and the quantum case have been recently obtained [12–15] and can be applied also to the solution of the Yang-Mills theory [16] and confinement studies can be accomplished with Kugo-Ojima criterion properly generalized [17]. It is seen that UV-limit is never reached in this case. In these studies, we just assume that they represent the local solutions to start from to get the corrections due to the non-locality. An immediate consequence of this approach is that the mass gap is obtained and the spectrum of the theory becomes computable. In any case, the mass gap is diluted and these theories become conformal in the UV-limit. By analogy, also the graviton propagator possibly would get a mass gap that is diluted in the UV-limit reaching a conformal limit.

Summary

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