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Exact solution studies of local and non-local Yang-Mills theories

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Local exact solutions for the scalar field theory, both for the classical and the quantum case have been recently obtained [1{3] by a technique devised by Bender, Savage and Milton [4]. This permits to derive the set of Dyson-Schwinger equations in a fully differential form. These methods can be applied also to the exact solution of the Yang-Mills theory [5] and corresponding confinement studies [6]. It is also possible to get a significant agreement for the spectrum of the theory [7] and to prove confinement in 2+1 dimensions [8].

Non-local quantum field theories have been studied recently as a promising approach to go beyond the Standard Model (e.g. see [9-11]). This approach is motivated by p-adic string field theory [12-14]. These theories have the properties of UV-completeness and have been proposed as a direction of UV-completion the non-local inifinte-derivative theories, and are ghost-free, re-normalizable and predicts conformal invariance at the quantum level [10, 15]. They are able to rescue dark matter models [11], move trans-planckian processes to sub-planckian [16] and improve inflationary behaviour of the Higgs field [17]. Along these same research avenues, we consider an infinite derivative non-local Yang-Mills theory and we show and we derive the set of Dyson-Schwinger equations in differential form till the 2P-correlation functions. 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 [19] as we already show for the scalar field case [18]. The argument about confinement, put forward in [6], is then extended to this non local case [20]. It is seen that UV-limit is never reached in this case and the theory confines in the IR, the coupling running to infinity, without the appearance of a Landau pole. In these studies, we just assume that one has a proper local solutions to start from to get the corrections due to the non-locality. An immediate consequence of this approach is that the a mass gap is obtained and the spectrum of the theory becomes accessible analytically. In any case, the mass gap is diluted in the UV.

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