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Renormalized Light Front Hamiltonian in the Pauli-Villars Regularization

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We address the problem of nonperturbative calculations on the light front in quantum field theory regularized by Pauli-Villars method. As a preliminary step we construct light front Hamiltonians in (2+1)-dimensional $\lambda\varphi^4$ model, for the cases without and with spontaneous symmetry breaking. The renormalization of these Hamiltonians in Pauli-Villars regularization is carried out via comparison of all-order perturbation theory, generated by these Hamiltonians, and the corresponding covariant perturbation theory in Lorentz coordinates.

Summary

In the present paper we have constructed the renormalized LF Hamiltonian for the $\lambda\varphi^4$ model in (2+1)-dimensional space-time.
We have found the explicit expression for the counterterm, necessary for the renormalization, using the PV regularization. To do this we compare the diagrams of the covariant perturbation theory in Lorentz coordinates with the analogous diagrams of the perturbation theory generated by the LF Hamiltonian which has also the cutoff in the momentum p_- ($|p_-| \geq \delta > 0$). We show that both perturbation theories can be described by the same set of diagrams, with the values of the compared diagrams coinciding in the limit $\delta \to 0$. Then we renormalize the LF Hamiltonian by the counterterm found in the calculation of the divergent part of the corresponding diagram in the covariant perturbation theory in Lorentz coordinates.

Furthermore we have taken into account the possibility of the spontaneous symmetry breaking in this model and obtained the LF Hamiltonians corresponding to two different vacua. We arrive at these LF Hamiltonians by considering the limit transition from the theories quantized on the spacelike planes approaching the LF. It is possible to describe the vacuum on these planes using the Gaussian approximation. The Hamiltonians obtained with this approximation still require UV renormalization. And the above-mentioned comparison of perturbative theories, generated by these LF Hamiltonians, and the covariant perturbation theory in Lorentz coordinates allows to renormalize both of these Hamiltonians in the PV regularization.

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