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On non-perturbative renormalization in the truncated Yukawa model

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In the framework of the Light-Front Tamm-Dancoff method, we applied the sector-dependent renormalization scheme to the quenched Yukawa model. A review of the results obtained in this way is given.
The Yukawa model incorporated spin is studied in the truncation N=3 (one fermion and two mesons), whereas the spinless Yukawa model is truncated up to a higher value N=4. The eigenvector equation is reduced to a linear system of integral equations for the Fock components. We use the Pauli-Villars regularization. The following results were found.
(i) The renormalization removes divergences: the results becomes stable relative to increase of the Pauli-Villars masses, like in the perturbation theory and in contrast to some other non-perturbative schemes. (ii) Comparison, in the scalar Yukawa model, of the N=3 and N=4 truncations shows the convergence of the (dominating) low Fock sectors and of the electromagnetic form factor relative to increase of truncation. This indicates that we are approaching to the true non-perturbative solution. (iii) In the N=3 truncation, the determinant of the system of equations for the Fock components vs. coupling constant α crosses zero at a critical value $\alpha = \alpha_c$. The non-renormalized solution obtains a pole ~$1/(\alpha - \alpha_c)$. The renormalization of coupling constant removes also this singularity: the renormalized wave functions becomes regular at $\alpha = \alpha_c$. These properties support the expectation that the Light-Front Tamm-Dancoff method complemented with the sector-dependent renormalization scheme can be an efficient tool in practical finding the non-perturbative solutions in field theory.

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