THE METHOD OF UNITARY CLOTHING TRANSFORMATIONS: VERTEX RENORMALIZATION IN THE OPERATORS OF NUCLEON-NUCLEON INTERACTION

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In the instant form of relativistic quantum dynamics for a system of interacting mesons and nucleons, where amongst the ten generators of the Poincar´e group (Π) only the Hamiltonian H and the boost operator B carry interactions, we have proposed [1] a constructive way of ensuring the relativistic invariance in field models with cutoffs in momentum space. Moreover, in combination with the method of unitary clothing transformations [2] the proposed approach enables us to get the interactions between the clothed particles (in particular, physical mesons and nucleons) simultaneously in the H and B. The derived interactions are hermitian and energy independent that do them helpful in practical calculations in nuclear physics. In addition they include recoil effects.

As an illustration we will show for the neutral pion and nucleon fields coupled via the pseudoscalar (PS) Yukawa-type interaction how the vertex renormalization problem can be considered in the framework of the method of unitary clothing transformations (UCT method). In the instant form of relativistic dynamic the total Hamiltonian and boost generators take on the same sparse structure in the Hilbert space of hadronic states [1]. The expression obtained by us for the charge shift in the first non-vanishing order (in the third order of the coupling constant) arises due to the cancellation of the vertex counterterm with the corresponding operators structure in these multiple commutators of the generator of the clothing unitary transformation. On the energy shell the derived expression is expressed via the three-dimensional integrals on certain Lorentz-covariant quantities, providing the momentum independence, and coincides with this one found within the Dyson-Feynman approach.

Along with it, we have developed off-energy-shell diagram technique in the UCT method which simplifies us to constructing of a new family of hermitian and energy-independent operators of relativistic interactions having the off-energy-shell structures in a natural way.

1. A.V.Shebeko, P.A.Frolov// Few Body Syst. 2012. V.52. P.125.
2. A.V.Shebeko, M.I.Shirokov// Phys. Part. Nuclei. 2001. V.32. P.31.