Hidden Gauge model for the $\pi\rho$-system

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The properties of ρ-mesons interaction with pions are investigated within a renormalizable non abelian vector meson dominance model of hidden gauge type [1]. The model is gauge invariant and besides the coupling of the ρ-mesons to the pions contains three and four rho-meson vertices and corresponding ghost contributions. The ρ-meson mass is generated using of the Higgs-Kibble mechanism for spontanouos symmetry breaking. The details of the model can be found in [2].

The self consistent approximation is derived from a variational principle using the functional of Luttinger and Ward [3], which due to Baym [4] leads to an approximation which fulfills the conservation laws for the expectation values of conserved quantities, if the conservation law is given by Noether's theorem with a symmetry group realized linearly on the fields.

The generating functional for the self-energies can be depicted as the sum over all two-particle irreducible closed diagrams with at least two loops and lines representing the selfconsistent Green's functions [2,5]. One obtains the selfconsistent scheme by opening each of these lines, leading to self-energy skeleton diagrams expressed in terms of the self consistent Green's functions. Further on the variational principles tells us that the Green's functions and the self energies are connected by the usual Dyson-equation, which leads to a closed system of self consistent equations for the Green's functions.

Using the spectral representation for the Green's functions, one is able to formulate a renormalized coupled set of integral equations [6]. The renormalization is done in the physical scheme in vacuum quantum field theory, giving masses and coupling constants fitted to data on the electromagnetic form factor of the pion.

The figures below show the one-loop perturbatively and selfconsistently calculated results for the vacuum quantum field theory.

The diagram on the left hand side shows the selfconsistently calculated selfenergy for the ρ-meson as a function of the invariant mass s. The change compared to the perturbative one-loop result is such small that it cannot be seen graphically. Nevertheless the π-self energy is modified by the selfconsistent calculation, compared to the perturbative result. The main reason for that behaviour is that the threshold has been move from the perturbative value of $(m_\pi + m_\rho)^2$ down to the is selfconsistent position at $s = (3m_\pi)^2$. This can be understood inspecting the contribution from the perturbative three-loop diagram which are implicitely contained in the selfconsistent resummation scheme. Further more the finite width of the ρ-meson smoothes the π-self energy compared to the sharp edged perturbative calculation.

The small effect on the selfconsistent solution for the ρ-self energy compared to the pertubative result can be explained by the fact that the pion mass is small compared to the ρ mass and its on-shell properties remain untouched in the physical renormalization scheme.

Presently the properties of this dynamical model are studied within this self consistent approximation at finite temperature. Interesting in this respect are the medium modifications of the vector-meson self energies in general, i.e. the change of their mass and width, as a function of temperature, i.e. the pion density, and the consequence on di-lepton production rates from the electromagnetic decay of vector mesons.

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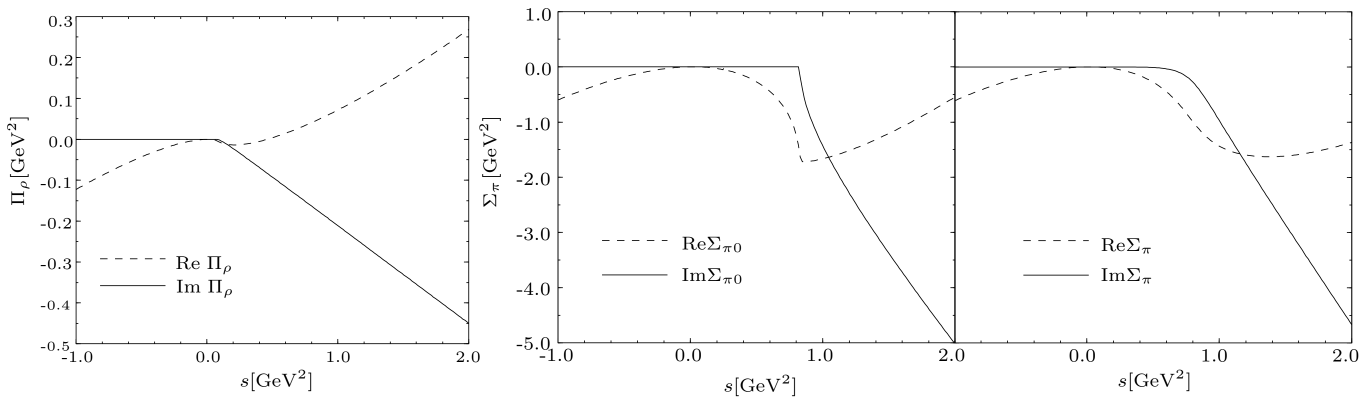

Figure 1: Perturbative and selfconsistent ρ- and π-self energy.