Solutions of the Bethe-Salpeter Equation in Minkowski space: a comparative study

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The numerical investigation of the Bethe-Salpeter Equation for a bound system, composed by two massive scalars exchanging a massive scalar, has been carried out in ladder approximation, and using a form of the Bethe-Salpeter amplitude inspired by the Nakanishi perturbation-theory integral representation approach[1]. Such an integral representation has been proposed for exactly describing the multi-leg transition amplitudes, corresponding to a given S-matrix, in terms of suitable weight functions, that depend upon real variables. In literature [2,3,4] there exist two different eigenequations for determining the Nakanishi weight functions: i) one has been obtained by imposing a uniqueness theorem of the weight function, assumed still valid within the Bethe-Salpeter framework, that is intrinsically non perturbative, and ii) the other has been devised by using a Light-front formalism that leads to the exact relation between the valence component of the interacting state and the Bethe-Salpeter amplitude. The outcomes of our quantitative studies show that a remarkable agreement, in particular for the eigenvalues of the two equations above mentioned, has been achieved, numerically confirming that the Nakanishi uniqueness theorem for the weight functions, demonstrated in a perturbative analysis of the multi-leg transition amplitudes, can be safely extended to a non perturbative framework. Moreover, both probabilities and Light-front momentum distributions for the valence component, have been calculated and discussed.

The approach based on the uniqueness theorem has been applied to the scattering states[4], allowing a first calculations of the scattering lengths, corresponding to different masses of the exchanged boson, within the Nakanishi-inspired approach. Preliminary results will be presented .

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