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Scattering Solutions of the Bethe-Salpeter equation in Minkowski and Euclidean spaces

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The solutions of the Bethe-Salpeter equation in Minkoswki space are mandatory for computing some physical quantities like elastic and transition form factors, scattering of-shell amplitudes etc. They are however plagued with the singularities of the free propagators, of the interaction kernel and of the amplitude itself making rather difficult its numerical computation. This difficulty was overcome in the 50's with the use of the "Wick rotation", which transforms the Minkowski into an Euclidean metric and allowed to obtain some observables invariant in this transformation. The Euclidean Quantum Field Theory is nowadays a basic ingredient in all the lattice calculations. We will see that this procedure is not always legitimate - at least in the original framework where its was formulated - without a detailed knowledge of the analytic structure of the Bethe-Salpeter amplitude in the complex momentum plane.

We will present two methods to obtain the Minkowski solutions for bound and scattering states. The first one is based on the Nakanishi integral transform and the projection of the Bethe-Salpeter equation into the Light Front. The second method is based on a careful analysis of the singularities and a direct solution of the original equation. In particular we will show the possibility to extract the scattering lenght from a purely euclidean solution. This approach is directly applicable in Euclidean Lattice calculations and provides a direct way to obtain the scattering length without making use of the Luscher formula.

Primary author: Dr CARBONELL, Jaume (CNRS/IPN Orsay)

Co-author: Dr KARMANOV, V. A. (Lebedev Institute Moscou)

Presenter: Dr CARBONELL, Jaume (CNRS/IPN Orsay)

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