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Relativistic studies of three-body systems within the Bethe-Salpeter approach

The influence of relativistic effects on the stability of three-body systems is of great interest.
From a general point of view, understanding the interaction in terms of the fundamental degrees of freedom is very important for nuclear and particle non-perturbative physics. Since that is a very difficult problem, simple models are of great value for understanding the crucial qualitative features of the solution with more realistic kernels.
As an attempt towards such studies, we have explored [1] the bound system of three scalar bosons interacting through a zero-range interaction. The binding energies and amplitudes have been computed by solving for the first time the Euclidean Bethe-Salpeter equation for the Faddeev component of the two lowest states.

It is well-known that in the non-relativistic approach the binding energy of this system is not bounded from below, what is known as Thomas collapse. As it was discovered in the light-front dynamics (LFD) [2,3], the relativistic repulsion prevent the Thomas collapse in the non-relativistic sense.

We discuss the impact of higher Fock components on three-body systems, and thus effective three-body forces, by comparing the Euclidean Bethe-Salpeter solutions with the ones computed within LFD. In the present calculations we consider three-body systems in which two of the particles can form a bound state, and in addition, the so-called "Borromean" systems, where no two-body bound state exists. The latter kind of systems were not treated in previous works [2,3] and our results show that these papers were not treating the true ground state. Both of these regimes are discussed in detail. We show that the Thomas collapse is also prevented in the Bethe-Salpeter approach by the relativistic repulsion at small distances. Further counterparts of other well-known phenomena in non-relativistic physics, as the popular Efimov physics, is also briefly discussed.

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