Response to Referee Report

We have made several changes to the manuscript that we believe address the referee's very helpful comments.

1. *I suggest that the authors go through their paper from the standpoint of a general PRC reader, who is very interested in relativistic few-body physics, but not only in the approach of Ref.[3]. For example, some readers may be interested in approaches based on relativistic field theory, like the Bethe-Salpeter equation, or other covariant approaches based on Green functions and Feynman diagrams. The present paper should be brought into a form which is interesting and useful also for those more general readers.*

   We have added a brief discussion in the introduction regarding the choices that one can make when implementing the constraints of Lorentz invariance in quantum theories, including field theory and Bakamjian-Thomas constructions, and their respective connections in practice to the requirement of cluster separability. As noted in the introduction, implementations of field theory that depend upon truncations (such as ladder approximations to the Bethe-Salpeter equation or other integral equations driven by subsets of Feynman diagrams) do not automatically satisfy cluster separability and would need to be studied on a case-by-case basis. Such studies go beyond the scope of this paper.

2. *If one works through the paper from this perspective, first of all one still finds problems with the notations: For example, the 2-body mass eigenvalue is called λ_{12} in Eqs.(2.1) - (2.4), but in (2.7) and below it is denoted as λ. More importantly, it is not clear why it is necessary to introduce new symbols (b_1, b_2, b_3) for the single-particle momenta in Eq.(2.9). The momenta $p_{12} = p_1 + p_2$ and p_3 used in (2.5)-(2.8) do not refer to a particular frame, so it would be helpful if the authors could simply continue to use (p_1, p_2, p_3) instead of (b_1, b_2, b_3). In order to clarify the second change of variables in Eq.(2.9), it would be helpful to indicate this change of variables like it was done in Eq.(2.5) for the first change if variables. There are several other places where new notations can be avoided, for example the symbol M^0_{12} in Eq.(2.9), which should be simply $2m$, because the authors consider 3 particles with equal mass m.*

   We have made several thorough edits that fix several inconsistencies of notation. Two specific points:

   - The momenta (b_1, b_2, b_3) are distinct from (p_1, p_2, p_3), and are calculated in different ways. This difference is now explicitly identified in the text preceding Eq. (3.12) of the new version of the manuscript.
   - We have replaced the notation M^0_{12} by M_k in Eq. (3.16). The non-interacting mass of the two-body is not $2m$ (the non-relativistic version) but rather the sums of the one-body energies in a frame where the total momentum of the two-body system vanishes.

3. *Second, the generally interested reader is left alone with conceptual problems: For example, the term [Tensor-Product (TP) Model] used in Sect. II A is unclear. The properties (2.2) and (2.3) seem so general and reasonable that one should not consider them as model assumptions. In an approach based on relativistic field theory and Green functions, these properties would follow almost trivially from the relevant Feynman diagrams. Is it really necessary to use BT Representations in Sect. II C, which fail to satisfy those properties? It seems that there are many ambiguities in those representations, because it is necessary to introduce additional constraints like A and B in Sect. II E which in general lead to different results. It is very important to provide stronger and more general motivations to discuss those models.*

   We agree that Tensor Product (TP) should refer to a representation rather than a model, and have corrected the text accordingly. We have also strengthened the point that, for more realistic systems than the simple four-body model that we developed, one cannot simply write down a TP result that is both Poincaré invariant and cluster separable. If that we true, then indeed there would be no point in using the BT construction. It is only because the model is so simple that we can write down a TP result and then compare the BT solutions to it. This comparison has never been made in a quantitative way for a specific case until now.

   As noted above, a full field theory involving products of propagators manifestly satisfies cluster separability. However, approximate schemes such as those involving three-dimensional reductions of a Bethe-Salpeter equation, no longer involve products of propagators with completely independent four-momenta, and cluster separability is no longer manifestly satisfied. Such schemes must demonstrate separability - either exactly, or to the extent that it is satisfied approximately. In short, the separability requirement is easy to write down, and in certain cases (exact field theories) is trivially satisfied, but for many realistic calculations involving strong interactions, the requirement is non-trivial.

   The ambiguities to which the referee refers have to do with the comparison between a BT calculation and a TP result. One manifestation of the cluster separability problem for BT constructions without the Sokolov restoration is that the full set of momenta do not quite match between the calculations. Thus one must choose (constrain) a set of momenta for comparison purposes. We present what we believe are natural choices, and they are spelled out for the specific cases of instant, front and point forms. The point form is somewhat distinct from the instant and point forms because states are labeled with velocities rather than momenta, and we found two possible choices from which one could make a BT vs TP comparison. We note here that for the instant- and front-form calculations, as well as one of the point-form calculations, the BT-TP difference is of order 10^{-3}. The main conclusion of the paper is that the *impact* of the violation of cluster separability is quantititatively small.

We hope that with these revisions the paper will be suitable for publication.