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Limitations of Nakajima-Zwanzig method

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Summary

Quantum correlations (including quantum entanglement) are now widely recognized as a fundamental ingredient in tasks related to quantum information and quantum computation [1, 2, 3]. Recently established rules about entanglement relativity and quantum correlations relativity [4, 5, 6] emphasize the role of "quantum structure": non-classical correlations are the matter of the system's structure (i.e. of the system's partition into subsystems). By "structure" here is meant a set of the degrees of freedom, while structures are mutually related by linear canonical transformation (LCT), which can target local or global degrees of freedom. Some of the LCT examples are: composite system's center of mass and the "relative (internal)" degrees of freedom, fine and coarse graining, permutation of degrees of freedom, exchange of particles etc [7].

Nakajima-Zwanzig projection method is one of the most used techniques for obtaining open system's dynamical equation, that carries all the possible information regarding the open system and its dynamics–so called quantum master equation [8, 9]. Open quantum system is a part of a whole composed of open system plus the environment. Having in mind that particles exchange between open system and environment is one example of LCT, and structure dependence of non-classical correlations, it is natural to ask how the projection method fits in this "LCT induced relativity".

It turns out, in contrast to classical intuition, that similar systems (e.g. where difference is due to adding/removing one or more particles) do not have similar dynamics. Projection method is of no use for deducing dynamics of the "new" structure on the ground of known master equation. In other words: the analysis of the new degrees of freedom should be started from the scratch.

This conclusion refers to finite- and infinite-dimensional quantum systems and to arbitrary kinds of system-environment splitting.

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