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A local-time-induced unique pointer basis

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There is a solution to the problem of asymptotic completeness in many-body scattering theory that offers a specific view of the quantum unitary dynamics which allows for the straightforward introduction of local time for every, at least approximately closed, many-particle system. In this approach, time appears as a hidden classical parameter of the unitary dynamics of a many-particle system. We show that a closed many-particle system can exhibit behaviour that is characteristic for open quantum systems and there is no need for the 'state collapse' or environmental influence. On the other hand, closed few-particle systems bear high quantum coherence. This local-time scheme encompasses concepts including 'emergent time', 'relational time' as well as the 'hybrid system' models with possibly induced gravitational uncertainty of time.

1. Introduction

A solution to the problem of asymptotic completeness in the many-body scattering theory offers a specific view of the quantum unitary dynamics. The important work of Enss [1,2] opened the door for new methods in solving the problem. On this basis, the later elaboration due to Kitada [3,4] allowed Kitada [5–7] to introduce the notion of local time, that is a dynamics generated by the Hamiltonian of the local system that can serve as a (local) 'clock'.

The notion of local time or 'multi-time' is not a new idea. Mainly motivated by relativity, a separate time coordinate for every particle in a composite system has been introduced (e.g. [8,9] and references therein). It is also shown that the 'timeless' Wheeler–DeWitt equation:

$$H(x)|\Psi\rangle = 0, \tag{1.1}$$

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