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Cite this article: Jeknić-Dugić J, Arsenijević M, Dugić M. 2016 Dynamical emergence of Markovianity in local time scheme. *Proc. R. Soc. A* **472**: 20160041.
http://dx.doi.org/10.1098/rspa.2016.0041

Received: 15 January 2016
Accepted: 11 May 2016

Subject Areas:
quantum physics, mathematical physics

Keywords:
Markovian processes, quantum dynamical maps, local time

Author for correspondence:
J. Jeknić-Dugić
e-mail: jjeknic@pmf.ni.ac.rs

Dynamical emergence of Markovianity in local time scheme

J. Jeknić-Dugić[1], M. Arsenijević[2] and M. Dugić[2]

[1]Department of Physics, Faculty of Sciences and Mathematics, 18000 Niš, Serbia
[2]Department of Physics, Faculty of Science, 34000 Kragujevac, Serbia

JJ-D, 0000-0002-4905-6457; MA, 0000-0003-4622-642X; MD, 0000-0002-4493-6009

Recently we pointed out the so-called local time scheme as a novel approach to quantum foundations that solves the preferred pointer-basis problem. In this paper, we introduce and analyse in depth a rather non-standard dynamical map that is imposed by the scheme. On the one hand, the map does not allow for introducing a properly defined generator of the evolution nor does it represent a quantum channel. On the other hand, the map is linear, positive, trace preserving and unital as well as completely positive, but is not divisible and therefore non-Markovian. Nevertheless, we provide quantitative criteria for dynamical emergence of time-coarse-grained Markovianity, for exact dynamics of an open system, as well as for operationally defined approximation of a closed or open many-particle system. A closed system never reaches a steady state, whereas an open system may reach a unique steady state given by the Lüders–von Neumann formula; where the smaller the open system, the faster a steady state is attained. These generic findings extend the standard open quantum systems theory and substantially tackle certain cosmological issues.

1. Introduction

Recently we pointed out the so-called local time scheme (LTS) [1] as a novel non-interpretational, minimalist approach to quantum foundations. In LTS, dynamics is a primitive that asymptotically defines local time for a single closed ('local') quantum system [1,2].

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