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# Application of Unitary-Scaling Decomposition in Nuclear Magnetic Resonance

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In quantum development, dynamical maps are central objects used to describe the behaviour of many quantum systems. While special kinds of mappings attract great interests, such as unitary evolution describing the dynamics in close systems and the Lindblad-type dynamical maps in Markovian open systems, a general formulation of the dynamical map has been rarely investigated. We introduce a unitary-scaling decomposition of a mapping on a finite dimensional state space, composing of a unitary evolution and a real-positive semi-definite matrix, called a scaling matrix, corresponding to the system's dissipative behaviour. We show that the formulation covers the Lindblad dynamics where the Markovian property is assumed, and it constitutes a building block for the beyond-Lindblad dynamics of finite dimensional systems. In order to demonstrate the formulation, in this presentation, we apply the unitary-scaling decomposition to quantum information processing in nuclear magnetic resonance (NMR), which employs the Lindblad dynamics for a two-level system. We also show that, the dynamical map in NMR can be decomposed as a product of the unitary and scaling matrices, which can be constructed from elementary gates in quantum information processing. We believe this formulation and the application in NMR demonstrate that the dynamics in a real situation can be simulated by another quantum system of the same dimension, and the unitary-scaling decomposition is a useful tool in processing information.

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