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Effects of Coloured Noise Environments to the Coherence Time of Open Quantum Systems

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The use of Stochastic Schrödinger Equations (SSE) to describe open quantum systems is a well-known class of methods, that can be used as an unravelling scheme of associated Quantum Master Equations and as a starting point to derive new ones. From the perspective of simulating quantum systems in Quantum Computers (QC), these methods are of great importance [Lloyd, S. (1996), Science, 273(5278); Hu, Z., Xia, R., Kais, S. (2020), Scientific Reports, 10(1)], as one can exploit stochastic averages to implement intrinsically contractive mappings since each trajectory is a unitary evolution of the system, and harnesses the need for repeated noisy measures in lieu of parallelization. Recent studies have shown the ability to engineer environmental effects, in particular concerning non-Markovian environments [Cialdi, S., Benedetti, C., Tamascelli, D., Olivares, S., Paris, M. G. A., Vacchini, B. (2019), Physical Review A, 100(5); Carmele, A., Parkins, S., Knorr, A. (2020), Physical Review A, 102(3)]. Such noises can be detrimental to or enhance the coherence time and the transport properties of the system [Butler, E. P., Fux, G. E., Ortega-Taberner, C., Lovett, B. W., Keeling, J., Eastham, P. R. (2024), Physical Review Letters, 132(6)]. Here, we present a theoretical description of different coloured noises-driven SSE starting from the model presented in [Barchielli, A., Pellegrini, C., Petruccione, F. (2010), Europhysics Letters, 91(2)], leading to non-Markovian quantum evolution in small model systems, and the associated QME. We show the differences between different interpretations, the differences with respect to the usual memoryless approximations and the effects on initial coherence time and stationary distributions.

Title

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