

Internal Webinar

Asymptotic TCL4 Generator for the Spin-Boson Model: Analytical Derivation and Benchmarking

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In open quantum systems, accurately modelling system-environment interactions beyond the weak-coupling limit remains a challenging problem. The spin-boson model serves as a fundamental testbed for such studies, as it captures essential decoherence and dissipation effects across a wide range of physical systems.

In this talk, I will present our recent work titled “Asymptotic TCL4 Generator for the Spin-Boson Model: Analytical Derivation and Benchmarking.” This work provides an analytical derivation of the complete fourth-order time-convolutionless (TCL4) generator for a generic spin-boson model, valid up to fourth order in the system-environment coupling parameter, under the assumption that the environmental spectral density is an odd function of frequency. Applying this framework to a semiconductor double quantum dot system, we show that higher-order corrections can significantly modify the dynamics and we report that the widely used second-order TCL equation tends to overestimate non-Markovianity across a broad parameter regime. Furthermore, our analytical results are benchmarked with numerically exact Hierarchical Equations of Motion (HEOM) results, demonstrating very good agreement.

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