AKjDPG 1: Open Quantum Systems

Time: Sunday 14:00–15:40 Location: HS 3+4

Tutorial AKjDPG 1.1 Sun 14:00 HS 3+4

Solving Quantum Dynamics with QuTiP and HEOM — •Alexander Pitchford[1], Simon Cross[2], and Neill Lambert[3] — [1]Department of Mathematics, Aberystwyth University, Wales, UK — [2]Zurich Instruments, Zurich, Switzerland — [3]Theoretical Quantum Physics Laboratory, RIKEN, Wakoshi, Saitama, Japan

QuTiP, the Quantum Toolkit in Python, is an open source code library for the simulation of quantum dynamics, best known for its open quantum system solvers. We give an overview of the features of the core package and some of the associated 'family' packages.

We introduce the solvers, starting with unitary dynamics, then moving on to modelling interactions of the quantum system with its environment. We demonstrate solutions to the Lindblad master equation (LME), showing the effects of decoherence and dissipation on the ensemble through jump operators. We compare this with Monte-Carlo simulations and see how the random jumps converge to the deterministic solution with sufficient iterations.

LME assumes that interactions with the environment are Markovian in nature. The Hierarchical Equations of Motion (HEOM) provide an exact model of the effects of the environment on a quantum system. We describe how this is configured using auxiliary operators and solved as coupled differential equations. We compare QuTiP's HEOM solver with the LME solver and examine bath characteristics that exhibit Markovian noise.

Tutorial AKjDPG 1.2 Sun 14:50 HS 3+4

Non-Markovian Quantum Dynamics: Physical Concepts and Mathematical Methods Describing Memory in Open Systems — •Heinz-Peter Breuer — Physikalisches Institut, Universität Freiburg, Hermann-Herder- Straße 3, D-79104 Freiburg, Germany — EUCOR Centre for Quantum Science and Quantum Computing, University of Freiburg, Hermann-Herder-Straße 3, D-79104 Freiburg, Germany

The dynamics of open quantum systems is often approximated by means of a Markovian process in which the open system irretrievably loses information to its surroundings, expressing the memoryless nature of the dynamics. However, open systems out of equilibrium often exhibit a pronounced non-Markovian behavior distinguished by a flow of information from the environment back to the open system. This information backflow leads to the emergence of memory effects and represents the key feature of non-Markovian quantum dynamics. In the talk I will discuss fundamental physical concepts and mathematical methods used to characterize, to quantify and to model quantum memory effects in open systems.