QuTiP: An open-source Python framework for the dynamics of open quantum systems.

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QuTiP: An open-source Python framework for the dynamics of open quantum systems â˜†

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Abstract

We present an object-oriented open-source framework for solving the dynamics of open quantum systems written in Python. Arbitrary Hamiltonians, including time-dependent systems, may be built up from operators and states defined by a quantum object class, and then passed on to a choice of master equation or Monte Carlo solvers. We give an overview of the basic structure for the framework before detailing the numerical simulation of open system dynamics. Several examples are given to illustrate the build up to a complete calculation. Finally, we measure the performance of our library against that of current implementations. The framework described here is particularly well suited to the fields of quantum optics, superconducting circuit devices, nanomechanics, and trapped ions, while also being ideal for use in classroom instruction.

Program summary

Program title: QuTiP: The Quantum Toolbox in Python

Catalogue identifier: AEMB_v1_0

Program summary URL: http://cpc.cs.qub.ac.uk/summaries/AEMB_v1_0.html

Program obtainable from: CPC Program Library, QueenÊ¼s University, Belfast, N. Ireland

Licensing provisions: GNU General Public License, version 3

No. of lines in distributed program, including test data, etc.: 16â€‰482

No. of bytes in distributed program, including test data, etc.: 213â€‰438

Distribution format: tar.gz

Programming language: Python

Computer: i386, x86-64

Operating system: Linux, Mac OSX, Windows

RAM: 2+ Gigabytes

Classification: 7

External routines: NumPy (http://numpy.scipy.org/), SciPy (http://www.scipy.org/), Matplotlib (http://matplotlib.sourceforge.net/)

Nature of problem: Dynamics of open quantum systems.

Solution method: Numerical solutions to Lindblad master equation or Monte Carlo wave function method.

Restrictions: Problems must meet the criteria for using the master equation in Lindblad form.

Running time: A few seconds up to several tens of minutes, depending on size of underlying Hilbert space.

Keywords

Open quantum systems; Lindblad master equation; Quantum Monte Carlo; Python

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[a†]   This paper and its associated computer program are available via the Computer Physics Communications homepage on ScienceDirect (http://www.sciencedirect.com/science/journal/00104655).

[1]   These authors contributed equally to this work.

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