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A New Algorithm for Time Evolution of Quantum Trajectories
DOUGLAS MCNALLY, JAMES CLEMENS, Miami University — Quantum trajectory simulations are a Monte Carlo method which use ensemble averaging to generate wave function evolution for open quantum systems. Agreement with results from master equations increases with the number of independent realizations of the system evolution or "trajectories." It is often computationally preferable to use the Monte Carlo approach which requires averaging over many problems using a state vector, as opposed to using the master equation which requires solving a single problem using a density matrix. Past implementations of a quantum trajectories algorithm, such as mcsolve in the popular quantum optics package The Quantum Toolbox in Python (QuTiP), depend on high order differential equation solvers to obtain time evolution. The time evolution is given by the Schrodinger equation using a non-Hermitian effective Hamiltonian. Herein an alternate method which utilizes matrix diagonalization for trivial time evolution (matrix exponentiation) is presented and implemented in Python. This also allows the determination of the times at which a collapse or "quantum-jump" occurs to be done in advance using only a simple zero-finding technique and thus eliminating the need for high precision time intervals or backtracking. Agreement with existing implementations and master equation solutions is shown.

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