Title:	Algorithmic approach to simulate Hamiltonian dynamics and an NMR simulation of quantum state transfer
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Keywords:	Algorithmic approach Coupling parameters Hamiltonian dynamics
Issue Date:	2012
Publisher:	American Physical Society
Citation:	Physical Review A - Atomic, Molecular, and Optical Physics, 85 (3), art. no. 030303
Abstract:	We propose an iterative algorithm to simulate the dynamics generated by any n-qubit Hamiltonian. The simulation entails decomposing the unitary time evolution operator U (unitary) into a product of different time-step unitaries. The algorithm product-decomposes U in a chosen operator basis by identifying a certain symmetry of U that is intimately related to the number of gates in the decomposition. We illustrate the algorithm by first obtaining a polynomial decomposition in the Pauli basis of the n-qubit quantum state transfer unitary by Di Franco that transports quantum information from one end of a spin chain to the other, and then implement it in nuclear magnetic resonance to demonstrate that the decomposition is experimentally viable. We further experimentally test the resilience of the state transfer to static errors in the coupling parameters of the simulated Hamiltonian. This is done by decomposing and simulating the corresponding imperfect unitaries.
Description:	Only IISERM authors are available in the record.
URI:	http://pra.aps.org/abstract/PRA/v85/i3/e030303 (http://pra.aps.org/abstract/PRA/v85/i3/e030303) 10.1103/PhysRevA.85.030303 (10.1103/PhysRevA.85.030303)
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