Abstract

Quantum computers have been shown to provide an exponential advan- tage over their classical counterparts in solving certain problems like prime factorization of a large integer, computing discrete logarithms etc. However, the physical realization of quantum computers to solve these problems is still a daunting challenge. This serves as a motivation to build universal quantum simulators that can in princile simulate any quantum evolution (unitary dynamics) generated by some Hamiltonian; natural or unnatural. In this thesis I’ve studied an algorithmic approach proposed by Ashok et al. [PhysRevA.85, 030303 (2012)] to product decompose the desired unitary operation asa product of small unitary gates : U = Um Um−1 · · · U1. Then I’ve used this algorithm to find the product decomposition of the unitary evolution generated by the XY Hamiltonian for 3-qubit and 4-qubit cases in both the open and closed chain for different time intervals. Although the product decomposition that I’ve obtained is inefficient but it shows certain structural symmtery that can be used along with the fact that the eigen-states of the XY Hamiltonian are W states to suitably modify the algorithm and extract some general result. The algorithm is also shown to have some serious draw-backs when the correlations among different particles in a quantum system are strong.