Hamiltonian simulation, entanglement and universal quantum computers

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What quantum systems can be used to simulate other quantum systems? Recently there has been much active research into the simulation of complex quantum systems interacting via Hamiltonian dynamics [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]. In particular it has been shown that all fixed two-body entangling Hamiltonians across a connected network of n qudits are equivalent up to local unitaries [2]. Thus it follows that two-body entangling Hamiltonians and local unitaries provide a universal set of gates for quantum computation [1]. It has also been shown that there exist dynamical equivalence classes between different many-body Hamiltonians, some of which do not allow universal quantum computation.

This work provides important insight into the relationship between universality and entanglement in quantum computers and the understanding of quantum control mechanisms.

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