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Complexity of commuting Hamiltonians for qubits on a square lattice

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Systems governed by Hamiltonians with commuting terms are very relevant in both condensed matter physics and in quantum information and complexity. They form the fixed points of renormalization flows and can thus be used to understand the structure of quantum phases. At the same time, they represent an interesting intermediate class between classical and general quantum Hamiltonians : All terms in the Hamiltonian can be diagonalized simultaneously, thus being "almost classical", but at the same time, these ground states can be highly entangled and exhibit e.g. topological order. In this talk, we will consider the computational complexity of Hamiltonians which are sums of commuting terms acting on plaquettes in a square lattice of qubits, and show that deciding whether the ground state minimizes the energy of each local term individually is in the complexity class NP. This is, if the ground states has this property, this can be proven using a classical certificate which can be efficiently verified on a classical computer. Different to previous results on commuting Hamiltonians, our certificate proves the existence of such a state without giving instructions on how to prepare it.

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