The Complexity of the Local Hamiltonian Problem on Restricted Geometries

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The local Hamiltonian problem is QMA-complete, even on a square lattice. The problem's complexity remains robust across a range of geometric configurations. Specific families, like the Fermi-Hubbard model, retain this intractability on triangular lattices but not so on bipartite lattices.

Using such ideas, results for the guided local Hamiltonian problem can be strengthened to additional geometries. It is established that the Fermi-Hubbard model is BQP-hard for the guided local Hamiltonian problem.

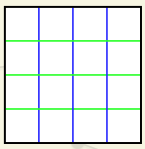


Fig. 1: Square Lattice

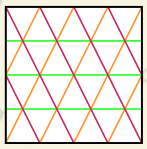


Fig. 2: Triangular Lattice

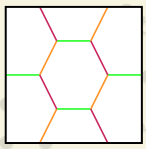
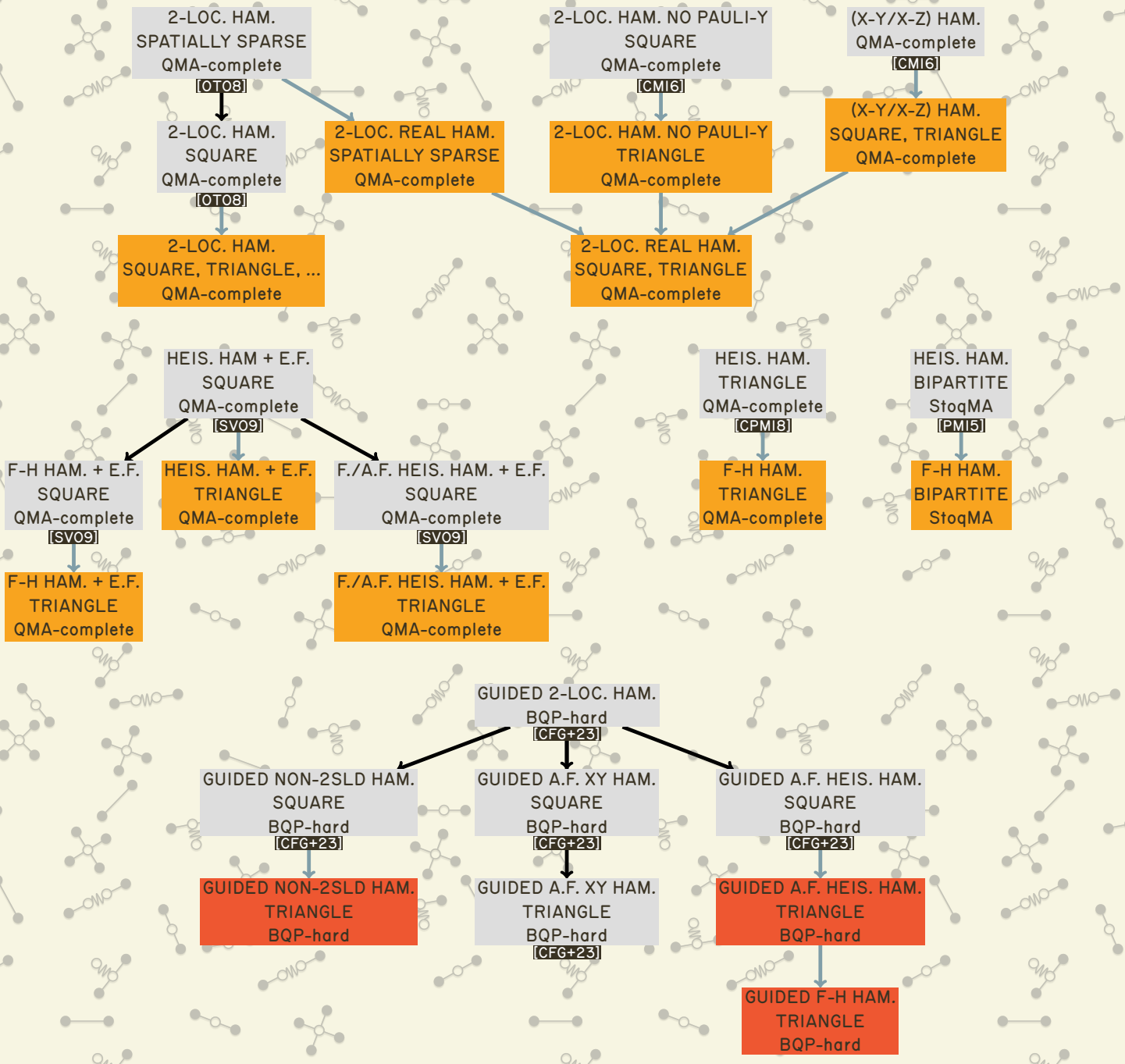


Fig. 3: Hexagonal Lattice



Local Hamiltonian Problem: given a local Hamiltonian, determine if the ground state energy is below a or above b, promised one is true and with $b - a = O(1/\text{poly}(n))$

Guided Local Hamiltonian Problem: given a local Hamiltonian and a semi-classical encoded state that is promised to have overlap δ with the true ground state. The problem is to determine whether the ground state energy is below a or above b, promised one is true.

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