

Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

A method to efficiently simulate the thermodynamic properties of the Fermi-Hubbard model on a quantum computer PIERRE-LUC DALLAIRE-DEMERS, FRANK WILHELM-MAUCH, Saarland University — Many phenomena of strongly correlated materials are encapsulated in the Fermi-Hubbard model whose thermodynamic properties can be computed from its grand canonical potential. In general, there is no closed form expression of the grand canonical potential for lattices of more than one spatial dimension, but solutions can be approximated with cluster perturbation theory. To model long-range effects such as order parameters, a powerful method to compute the cluster's Green's function consists in finding its self-energy through a variational principle. This opens the possibility of studying various phase transitions at finite temperature in the Fermi-Hubbard model. However, a classical cluster solver quickly hits an exponential wall in the memory (or computation time) required to store the computation variables. Here it is shown theoretically that that the cluster solver can be mapped to a subroutine on a quantum computer whose quantum memory scales as the number of orbitals in the simulated cluster. A quantum computer with a few tens of qubits could therefore simulate the thermodynamic properties of complex fermionic lattices inaccessible to classical supercomputers.

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Date submitted: 06 Nov 2015

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