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Classical Ising Models Realised on Optical Lattices
MAURO CIRIO, G.K. BRENNEN, J. TWAMLEY, S. IBLISDIR, O. BOADA, Macquarie University — We describe a simple quantum algorithm acting on a register of qubits in d spatial dimensions which computes statistical properties of $d+1$ dimensional classical Ising models. The algorithm works by measuring scattering matrix elements for quantum processes and Wick rotating to provide estimates for real partition functions of classical systems. This method can be implemented in a straightforward way in ensembles of qubits, e.g. three dimensional optical lattices with only nearest neighbor Ising like interactions. By measuring noise in the estimate useful information regarding location of critical points and scaling laws can be extracted for classical Ising models, possibly with inhomogeneity. Unlike the case of quantum simulation of quantum hamiltonians, this algorithm does not require Trotter expansion of the evolution operator and thus has the advantage of being amenable to fault tolerant gate design in a straightforward manner. Through this setting it is possible to study the quantum computational complexity of the estimation of a classical partition function for a 2D Ising model with non uniform couplings and magnetic fields. We provide examples for the 2 dimensional case.

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