Universität Bielefeld Fakultät für Physik

Physikalisches Kolloquium

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Simulation on/of quantum computers

A quantum computer is a device that performs operations according to the rules of quantum theory. There are various types of quantum computers of which nowadays the two most important ones considered for practical realization are the gate-based quantum computer and the quantum annealer. Practical realizations of gate-based quantum computers are currently limited in size to about ten qubits while quantum annealers with more than 2000 qubits are commercially available.
In the gate model quantum computer, a universal quantum computer, a computation (or quantum algorithm) consists of a sequence of quantum gate operations (unitary transformations) that changes the internal state of the quantum computer. Quantum annealing is a technique for finding the global minimum of a quadratic function of binary variables by exploiting quantum fluctuations. Its main potential targets are combinatorial optimization problems featuring a discrete search space with many local minima.
We present results of simulating on the IBM Quantum Experience device with 5 qubits and the D-Wave 2X quantum annealer with more than 1000 qubits. Simulations of both types of quantum computers are performed by first modeling them as a zero-temperature quantum system of interacting spin-1/2 particles and then emulate their dynamics by solving the time-dependent Schrödinger equation.

K. Michielsen, M. Nocon, D. Willsch, F. Jin, T. Lippert, H. De Raedt, "Benchmarking gate-based quantum computers", https://doi.org/10.1016/j.cpc.2017.06.011
K. Michielsen, F. Jin, and H. De Raedt, "Solving 2-satisfiability problems on a quantum anneale" (in preparation)

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