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A quantum Ising machine based on parametrically driven nonlinear oscillators

Quantum annealing exploits quantum fluctuations to solve combinatorial optimization problems that can be encoded into the couplings of Ising Hamiltonians. Protecting these machines against decoherence remains an outstanding challenge. In this talk I will introduce a new paradigm for quantum annealing which relies on continuous variable states. In this approach, quantum information is encoded in two coherent states that are stabilized by parametrically driving a nonlinear oscillator. I will show that a fully connected Ising problem can be mapped onto a network of such resonators. I will also outline an adiabatic annealing protocol during which the oscillators in the network evolve from vacuum to coherent states representing the ground state configuration of the encoded problem. Numerical simulations indicate substantial resilience to photon loss in this system. Finally, I will discuss realizations of these ideas in superconducting circuits. This continuous variable annealer provides new direction for exploring quantum phase transitions and non-stoquastic dynamics.