

Coherent quantum annealing with parity constraints

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Quantum annealing aims at solving optimization problem using the quantum adiabatic theorem. In the spin glass paradigm of quantum annealing, an optimization problem is encoded in the interactions of a fully connected Ising spin model. The ground-state of the spin model encodes the optimal solution of the problem. Finding this state is a hard problem on classical computers and quantum annealing aims at efficiently preparing the ground state using adiabatic state preparation. However, the infinite range of the spin-spin interactions limits the scalability of a direct implementation of the fully connected spin glass.

Parity constraint based quantum annealing [1] has been recently introduced as an alternative to the spin glass paradigm of quantum annealing. In this architecture, an optimization problem is encoded in local fields that act on an extended set of qubits in a constraint subspace. The constraints are problem independent 4-body interactions acting uniformly on all plaquettes of a square lattice. The parity scheme allows one to implement quantum annealing protocols with the focus on coherent dynamics in various platforms, including Transmons, Rydberg atoms and ions in surface traps. I will also outline opportunities in applications such as training of a restricted Boltzmann machine.

[1] W. Lechner, P. Hauke and P. Zoller, *Science Advances* **1**, e1500838 (2015).