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Exponentially Biased Ground-State Sampling of Quantum Annealing Machines with Transverse-Field Driving Hamiltonians

While obtaining the ground state of a spin-glass benchmark instance represents a difficult task, the gold standard for any optimization algorithm or machine is to sample all solutions that minimize the Hamiltonian with more or less equal probability. In my talk I will present our latest results [Phys. Rev. Lett. 118, 070502] on the performance of the D-Wave 2X quantum annealing machine on systems with well-controlled ground-state degeneracy. More precisely, I will show that while naïve transverse-field quantum annealing on the D-Wave 2X device can find the ground-state energy of the problems, it is not well suited in identifying all degenerate ground-state configurations associated with a particular instance. Even worse, some states are exponentially suppressed, in agreement with previous studies on toy model problems [New J. Phys. 11, 073021 (2009)]. These results suggest that more complex driving Hamiltonians are needed in future quantum annealing machines to ensure a fair sampling of the ground-state manifold.