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Simulations of Thermal Quantum Annealing on the D-Wave Device TAMEEM ALBASH, University of Southern California, WALTER VINCI, University College London, ANURAG MISHRA, University of Southern California, PAUL WARBURTON, University College London, DANIEL LIDAR, University of Southern California — We report on classical and quantum simulations to model the open-system dynamics of the D-Wave programmable annealer as we increase the thermal noise level on the device. We consider three models for the device: (1) the evolution is described by a classical simulated annealer acting on the final-time Ising Hamiltonian; (2) the evolution is described by an O(3) model with a time-dependent Hamiltonian; (3) the evolution is described by a quantum adiabatic Markovian master equation with a time dependent Hamiltonian. We increase the thermal noise level by either decreasing the overall energy scale of the final-time Ising Hamiltonian or by increasing the total annealing time. Using a benchmark Ising Hamiltonian, we show that all three models give distinct predictions for the behavior of the system as the noise level on the device is increased. The only model that captures the results of the device over the entire range of noise levels studied is the quantum master equation, ruling out the two classical models considered here.

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