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Collective disispative tunneling during quantum annealing on D-Wave II device[1] VADIM SMELYANSKIY, NASA Ames Research Center, SERGIO BOIXO, ALIREZA SHABANI, SERGEY ISAKOV, Google, MARK DYKMAN, Michigan State University, VASIL DENCHEV, Google, MOHAMMAD AMIN, ANATOLY SMIRNOV, D-Wave Systems, MASOUD MOHSENI, HARTMUT NEVEN, Google — We develop theory based on NIBA Quantum Master Equation to describe the multiqubit tunneling in the evolution of a programmable quantum annealer. We describe D-Wave II performance in the non-convex problems realized by frustrated networks of qubit clusters with strong intra-cluster coupling. We show that the collective effect of the environment is suppressed near the avoided crossing leading to coherent tunneling in that region. In a later stage of the annealing z-magnetizations of qubit clusters increase steeply as a manifestation of the spontaneous symmetry breaking giving rise to a substantial polaronic effect. Transition to the final solution state proceeds via tunneling of one of the qubit clusters as a whole, accompanied by the reorganization of the environmental degrees of freedom and absorption of the residual energy from the qubit system. Transition rate decreases exponentially fast with time after avoided crossing leading to the freezing of the portion of population in the local minimum. We used noise parameters from the single qubit MRT experiments taken on the same device. Model predictions for multiqubit quantum annealing on the above problems are in a very close correspondence with the data collected on D-Wave II device without using any fitting parameters.

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