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Optimal quantum annealing in p-spin model KOSTYANTYN KECHEDZHI, QuAIL NASA Ames Research Center Mail Stop 269-3, Moffett Field, CA 94035 and USRA RIACS, 615 National ave, 94043 Mountain View CA, VADIM SMELYANSKIY, QuAIL NASA Ames Research Center Mail Stop 269-3, Moffett Field, CA 94035 — In this work we are looking to understand the physical mechanisms of quantum speedup in quantum annealing devices. We consider a simplified Hamiltonian that can be addressed analytically using a semiclassical approximation. The Hamiltonian models a typical potential barrier that can trap the system in a metastable state and thus prevent it from reaching the ground state. This situation is common in complex optimization problems such as a spin glass. The model we consider consists of Ising spins forming a fully connected graph with interaction energy proportional to a product of p individual spin operators (p=2 would correspond to the pair interaction in, for example, a ferromagnet). At $p > 2$ this model demonstrates 1st order phase transition associated with exponential scaling of the quantum annealing computation time with the system size. We analyze the characteristics of the potential barrier that determine the efficiency of quantum annealing. We also identify the optimal regime for quantum annealing.

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