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Understanding Quantum Tunneling through Quantum Monte Carlo Simulations SERGIO BOIXO, SERGEI ISAKOV, Google Inc., GUGLIELMO MAZZOLA, ETH, VADIM SMELYANSKIY, Google Inc., ZHANG JIANG, Nasa Ames, HARTMUT NEVEN, Google Inc., MATTHIAS TROYER, ETH — The tunneling between the two ground states of an Ising ferromagnet is a typical example of many-body tunneling processes between two local minima, as they occur during quantum annealing. Performing quantum Monte Carlo (QMC) simulations we find that the QMC tunneling rate displays the same scaling (in the exponent) with system size, as the rate of incoherent tunneling. The scaling in both cases is $O(\Delta^2)$, where Δ is the tunneling splitting. An important consequence is that QMC simulations can be used to predict the performance of a quantum annealer for tunneling through a barrier. Furthermore, by using open instead of periodic boundary conditions in imaginary time, equivalent to a projector QMC algorithm, we obtain a quadratic speedup for QMC, and achieve linear scaling in Δ. We provide a physical understanding of these results and their range of applicability based on an instanton picture.

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