How Dissipation Affects Diabatic Quantum Annealing Shortcuts

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Abstract: We investigate two diabatic quantum annealing shortcuts for the maximum weighted independent set problem and show that dissipation significantly limits the advantage observed in the coherent regime.

Diabatic quantum annealing protocols have attracted considerable interest as possible shortcuts for quantum optimization, especially in settings where small spectral gaps and limited coherence times can make fully adiabatic strategies ineffective [1-3]. In this contribution, we study how dissipation affects two representative diabatic protocols for the maximum weighted independent set (MWIS), an NP-hard optimization problem naturally encoded in an Ising Hamiltonian: the sweep-quench-sweep (SQS) protocol, where a controlled quench is inserted between two quasi-adiabatic sweeps [2], and nonstoquastic diabatic quantum annealing (NS-DQA), where an XX catalyst reshapes the spectrum and can generate an additional avoided crossing [3].

Our main goal is to assess whether the advantage suggested by coherent dynamics survives in a more realistic open-system setting. To this end, we analyze small MWIS instances by solving a Markovian master equation with Lindblad terms describing dephasing and balanced gain-and-loss processes [4]. While the coherent dynamics still provides a useful reference, the central result is that dissipation strongly reduces the benefit of both diabatic shortcuts, creating an optimal annealing-time window: at short times, the dynamics still retains the imprint of the coherent diabatic transfer mechanism, whereas at longer times relaxation and decoherence increase the infidelity and progressively remove the performance gain [4,5].

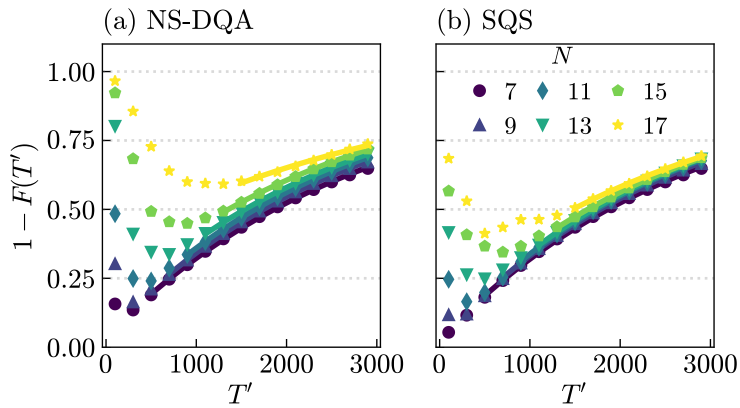

Fig. 1 Infidelity 1 - *F(T')* vs annealing time *T'* for the two different protocols with dephasing, plotted for increasing size *N*.

These results show that the performance of diabatic quantum annealing shortcuts cannot be evaluated reliably from closed-system dynamics alone. For realistic quantum optimization devices, open-system effects are not a secondary correction, but a central ingredient in determining whether diabatic protocols can offer a genuine advantage [1,4,5].

Example References

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