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# Variational counterdiabatic driving of the ferromagnetic p-spin model

In adiabatic quantum computation, the goal is to find the ground state of a many-body Hamiltonian starting from the simple ground state of a transverse field potential. A fast evolution time renders the system robust against decoherence and thermal noise but can cause diabatic transition towards excited states. Adding a counterdiabatic (CD) potential to the original Hamiltonian can suppress Landau-Zener excitations and drive the system towards the correct target state.

The exact general form of the CD driving operator, derived by Berry [1], is useless for all practical purposes as it cannot be implemented on physical processors. On the other hand, Sels and Polkovnikov [2] have shown that there exists a variational formulation of the CD problem that allows one to build approximate, experimentally-viable CD operators. For many-body systems, this can be done using a series expansion of the CD operator, the nested commutator (NC) ansatz, that
can be easily engineered using Floquet pulses [3].

We tested the variational approach to CD driving for the ferromagnetic p-spin model [4]. Despite its apparent simplicity, this model is often used to benchmark the performance of quantum annealing. In our work, we show that the NC ansatz can be successfully used to improve the
annealing performances of this fully-connected system, although its efficiency is bound to decrease in the thermodynamic limit. In addition, we show that it is possible to use another ansatz for p = 3, which we named cyclic ansatz (CA), that allows us to have optimal fidelity even for extremely short dynamics, independently of the system size. We analyze generalized p-spin systems to get a further insight into our ansatz.

[1] M. V. Berry, "Transitionless quantum driving", Journal of Physics A, 42, 36 (2009)
[2] D. Sels and A. Polkovnikov, "Minimizing irreversible losses in quantum systems by local counterdiabatic driving", PNAS May 16, 114 (20) (2017)
[3] P. W. Claeys, M. Pandey, D. Sels, and A. Polkovnikov, "Floquet-Engineering Counterdiabatic Protocols in Quantum Many-Body Systems", Phys. Rev. Lett. 123, 090602 (2019)
[4] G. Passarelli, V. Cataudella, R. Fazio, and P. Lucignano, "Counterdiabatic driving in the quantum annealing of the p-spin model: A variational approach", Phys. Rev. Research 2, 013283 (2020)

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