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Title: Majorana representation for adiabatic and superadiabatic processes in qutrits

Abstract:

Quantum algorithms are usually formulated using two-level systems (qubits). However, in recent years the idea that the use of three-level systems (qutrits) would expand the computational Hilbert space “for free” - that is, without having to add more physical components - has gained a renewed interest. Here we show that stimulated Raman adiabatic passage (STIRAP) and its superadiabatic version (saSTIRAP) have a natural geometric two-star representation on the Majorana sphere. In the case of STIRAP, we find that the evolution is confined to a vertical plane. A faster evolution can be achieved in the saSTIRAP protocol, which employs a counterdiabatic Hamiltonian to nullify the non-adiabatic excitations. We observe how, under realistic experimental parameters, the counterdiabatic term corrects the trajectory of the Majorana stars toward the dark state. We also introduce a spin-1 average vector and present its evolution during the two processes. We show that the Majorana representation can be used as a sensitive tool for the detection of process errors due to ac Stark shifts and non-adiabatic transitions. Finally, we show how to extend this representation to mixed states.

References: Shruti Dogra, Antti Vepsäläinen, and G. S. Paraoanu, Majorana representation of adiabatic and superadiabatic processes in three-level systems <https://arxiv.org/pdf/2003.09939.pdf>