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(G*) Shuttling of Majorana zero modes in disordered and noisy topological superconducting wires

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Majorana-based quantum computing harnesses the non-Abelian exchange statistics of Majorana zero modes (MZMs) in order to perform gate operations via braiding. It is paramount that braiding protocols keep a given system within its ground state subspace, as transitions to excited states lead to decoherence and constitute a "diabatic error."Typical braiding protocols are envisioned on networks of superconducting wires where MZMs are shuttled by using electric gates to tune sections of a wire ("piano keys") between topologically trivial and non-trivial phases. The focus of our work is to further study the diabatic error, defined as the transition probability to excited states, as MZMs are shuttled using piano keys through a single wire. Previous work has established that the behavior of the error can be adequately captured by Landau-Zener physics [1] and that the use of multiple piano keys may be optimal in reducing the error in certain situations [2]. We extend upon these works and consider MZM transport through superconducting wires which are disordered and subjected to external noise. We numerically calculate the diabatic error for these cases and, in particular, we demonstrate how disorder and noise change the optimal piano key picture presented in Ref. [2].

[1] B. Bauer, T. Karzig, R. V. Mishmash, A. E. Antipov, and J. Alicea, SciPost Phys. 5, 004 (2018)
[2] B. P. Truong, K. Agarwal, T. Pereg-Barnea, Phys. Rev. B 107, 104516 (2023)

Keyword-1

Majorana zero modes

Keyword-2

Diabatic error

Keyword-3

Topological superconductivity

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