Topological Order and Noise

Emergence of Majorana Zero Mode

Yusheng Zhao

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Outline

Noise in Quantum Computer

- Quantum Computing has advantage over Classical
- Noise is the archenemy
- Solution: store information non-locally
- "If a physical system were to have quantum topological (necessarily nonlocal) degrees of freedom, which were insensitive to local probes, then information contained in them would be automatically protected against errors caused by local interactions with the environment." - A. Kitaev

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Note

- Quantum Computers could solve some problems more efficiently compared to classical computers. For example, Shor's algorithm is able to factor large integers N, in $\mathcal{O}(log(N)^2 loglog(N)$ time. Meanwhile, the best known classical algorithm is $\mathcal{O}(e^{1.9log(N)^{1/3}loglog(N)^{2/3}}$.
- However, this technology is plagued by noise. Roughly speaking, noise is like a little daemon who flips the abucus that you use to do calculation. The source of those noise come from unwanted physical interaction. or even badly calibrated actions.
- For the purpose of this talk, we focus on unwanted physical interaciton.
- This gives us an idea. Since all known physical interactions are local, could be store our information non-locally to alleviate the effect of noise?

Kitaev's Toy Model

Topological Order

- Where the hell did it emerge?

Physics and Computation

- "Information is Physical" - R. Landauer
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Note

- Information is physical, meaning that the effecacy of the computation relies very much so on the system that realizes it. Computation is not merely something on the paper. It's very much so related to the physical world.
- Topological degree of freedom is calculated from the system-wide point of view. Therefore, it could not be probed locally hence it's immune to local error.

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