List of changes

Title:
We changed the title to “A Short Introduction to Topological Quantum Computation” in order to have a unique title that is not confused with Pachos's book.

Abstract:
We have revised the abstract to more clearly communicate the contents and the intended audience.

Contents:
After deliberating on the optimal structure of the review, we decided move Section 5 (“Manifestations of anyons...”) to be a subsection of Section 2. In this way it does not interrupt the flow of the discussion that progresses from anyons models (Sec 3) to quantum computating with them (Sec 4) to the example (Sec 5).

We also revised the titles of the Sections 5.1-5.5 to better reflect their content.

Section 1:
As suggested by referee 1, we have added a sentence to the first paragraph to immediately introduce the key concepts of a degenerate protected subspace and adiabatic transport to manipulate the states within it.

We have also added two new paragraphs. The first explains the intended audience of the present review and puts our work in the context of other reviews/books on topological quantum computation. The second new paragraph explains the structure of the review.

Section 2:
We have completely revised the three paragraphs before Sec 2.1. Without going deeper into the mathematics, our intention here is to make clear the difference between SPT order and intrinsic topological order and clarify that the first requires defects of some type to support anyons, while the latter does not. In the third paragraph we also now anticipate the concepts of topological entanglement entropy and topological degeneracy that arise in intrinsically ordered systems and which are explained in Section 2.2.

Section 2.2:
This section is the old Section 5. The first paragraph explains the scope and purpose of the section.

Section 2.2.1:
Throughout this section we make it clear that when talking about excitations we refer to intrinsically ordered systems where anyons are massive excitations, but that similar manifestations of protected degeneracies apply also to SPT states with defects. We also try to anticipate the discussion ahead and connect the protected degenerate subspaces and Berry phases to encoding and processing of quantum information that is described in the following sections.

Section 2.2.2:
This section has now been shortened and we explicitly mention that the concepts of topological entanglement entropy and topological degeneracy only apply to intrinsic topological states. Regarding the nature of topological degeneracy, we no longer discuss how it depends on the anyon model, but only give references. After all, our intention is just to introduce the reader to these two

concepts that appear often in the literature, but that do not directly feature in topological quantum computation.

In the same spirit, we now define how entanglement entropy of a system is calculated, but omit the details how it depends on the anyon model via the total quantum dimension. We also no longer talk of “topological twists” when extracting the full data.

We also made the decision to drop the paragraph related to edge states and their relation entanglement spectrum in order to cut unnecessary concepts that are not directly relevant to quantum computation.

Section 3.1:
Regarding pentagon and hexagon equations, we now mention explicitly that their role is to classify possible consistent anyon models, but refrain from talking about them any deeper since their solutions can be looked up from literature for all anyon models of interest. We don’t feel that discussing them in depth provides any significant understanding of anyons from the point of view of quantum computation.

Section 3.3:
We now give as eq. (16) the fusion rules for few different numbers of Fibonacci anyons to show how the dimensionality of the fusion space grows and why it implies a lack of tensor product structure.

To clarify this key difference to Ising anyons that do have a tensor product structure, we also added the fusion rules for many Ising anyons as eq. (18).

Section 4.3:
We have revised the paragraphs discussing the challenge posed by finite temperature to topological quantum computation. We omit any discussion about “ill-defined statistics” and merely state the results from the given references that discuss Abelian anyon based quantum memories. Any discussion about temperature in nanowires is deferred to Section 5.4.

Section 5.2:
We have clarified how the microscopic properties of the wire, such as fermion parity conservation, relate to the Ising anyon model and how they are used in the protected encoding of the Majorana qubit.

Section 5.3:
We thought how to expand and provide more details about the calculation of braid evolutions in the wire network, but in the end decided that providing any of the mathematics behind the braiding calculations does not serve the purpose here. Our aim is merely to justify that topological quantum computation is indeed possible in nanowire arrays along the principles outlined in Section 4. We have revised the section though the make all our statements clearer and we now also explicitly point to references where details how braiding and measurement is carried in a particular realization of nanowire arrays could be carried out.

Furthermore, we added a paragraph to describe how the general measurement protocol of Section 4.3 is to be carried out in nanowire arrays.

Further revisions:
Proof-reading to catch typos

We have added all the suggested references as well as few other that we came across.

Improved inter-connectedness by referring back and forth to different sections.