Notes of Topological Transition in a Non-Hermitian Quantum Walk

Taper

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Abstract

As suggested by the title.

Contents

sec:General

1 General

This paper discusses in general a model charaterised by the follwoing picture

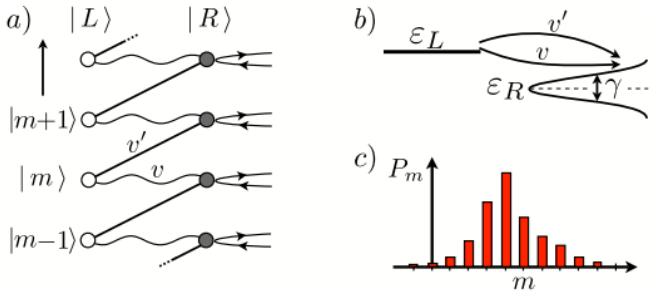

FIG. 1: Setup of the model. a) Each unit cell m contains two sites L (open circles) and R (filled circles), with each R-site connected to an external decay channel. Intracell (wavy lines) and intercell (straight lines) tunneling occur with amplitudes v and v', respectively. b) Energies of the L and R sites. Due to decay, the R-site energy obtains an imaginary part, $\tilde{\varepsilon}_R = \varepsilon_R - i\hbar\gamma/2$. c) Schematic distribution of local decay probabilities $\{P_m\}$ used to calculate the displacement (3).

Figure 1: Setup

The equation of motion is

$$i\hbar\dot{\psi}_m^L = \varepsilon_L\psi_m^L + v\psi_m^R + v'\psi_{m+1}^R \tag{1.0.1}$$

$$i\hbar\dot{\psi}_m^R = \tilde{\varepsilon}_R\psi_m^R + v\psi_m^L + v'\psi_{m-1}^L \tag{1.0.2}$$

where

$$\tilde{\varepsilon}_R = \varepsilon_R - i\hbar\gamma/2 \tag{1.0.3}$$

sec:I-can-get

1.1 I can get

$$|\psi\rangle = \sum_m |\psi_m^L\rangle + |\psi_m^R\rangle \tag{1.1.1}$$

$$\frac{\partial}{\partial t}\langle\psi|\psi\rangle = -\sum_m \gamma\,\langle\psi_m^R|\psi_m^R\rangle \tag{1.1.2}$$

(All leakage from "R" site!) (draft page 1 to 2)

Strange:

$$\sum_m P_m = 1 \tag{1.1.3}$$

(draft page 3)

sec:Result

1.2 Result

" we find that the average displacement of the particle during the course of its decay, $\Delta m = \sum_m mP_m$, is exactly quantized as an integer (0 or 1 unit cells), where P_m is the probability distribution for decay from different sites.
As in the case of the quantum Hall conductance, this quantization results from an underlying topological structure; in this case it is the winding number of the relative phase between two components of the Bloch wave function.
Using the topological origin of this phenomenon, we are able to show that the quantization is insensitive to parameters and is robust against certain types of noise and decoherence.
The topological transition, which is accompanied by the formation of a non-decaying dark state, leads to a prediction of threshold-like pumping of nuclear polarization, along with strong suppression of current due to the divergence of dwell time at the threshold "

" our motivation is to provide a simple model of nuclear spin pumping in spin-blockaded double quantum dots [9, 10, 11] in the presence of competing effects of the hyperfine and spin-orbital interactions, as in Ref.[11]. "

2 Anchor

sec:Anchor

References

1dwalk

[1] Topological Transition in a Non-Hermitian Quantum Walk, arXiv

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