One dimensional topological insulators with noncentered inversion symmetry axis

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Topological insulators (TIs) are materials with an electronic insulating bulk and conductive edge states, which are protected by the presence of certain symmetries in the model, meaning that they are robust against perturbations that respect these symmetries. This makes TIs very attractive for uses in quantum computation technologies, as evidenced by the large sums spent by the likes of Intel, Bell Labs or Microsoft in their research and development.

In one-dimensional (1D) TIs with inversion (I) symmetry, the eigenstates generate symmetric charge distribution in relation to the centered I-axis within the unit cell, as in the model of Fig. 1(a). In this paper, we studied a 1D TI [see Fig. 1(b)] belonging to a class of models for which the textbook topological characterization required some modifications, due to the fact that a noncentered I-axis within the unit cells originates a non-quantized topological invariant, which is problematic since it is from the quantized values of this invariant, directly correlated with the number of edge states, that one classifies the topology of any given model. As such, we derived a generalized version of this invariant that returns quantized values regardless of the position of the I-axis, enabling one to recover an unambiguous topological characterization of any 1D model with I-symmetry.

As for the model in Fig. 1(b), we further showed that the symmetry protecting the edge states is not the usual chiral symmetry $\hat{C}_1$, but rather an underlying "chiral-like" symmetry $\hat{C}_{1/2}$, depicted in Fig. 1(c), which provided protection against a more restricted set of perturbations. Finally, the noncentered I-axis in the unit cell was seen to imply a displacement of the inversion center of the bulk charge distribution with relation to the center of the chain, generating a shift in the polarization quantization, as shown in Fig. 2. A generalization of these results to 2D models with noncentered rotation axes is currently being considered.

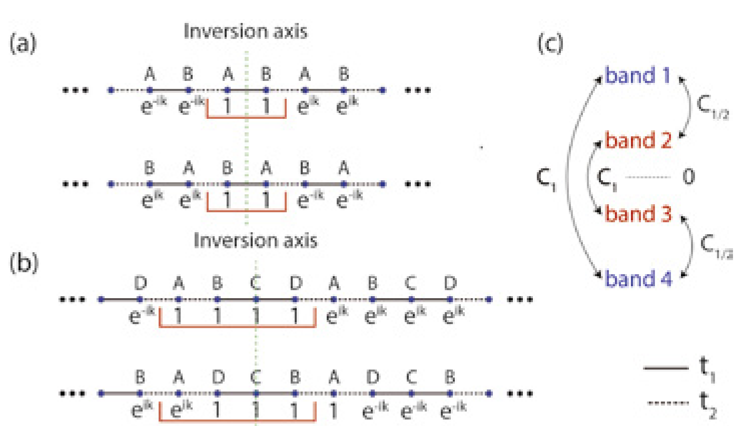

FIGURE 1
Examples of 1D models with (a) centered and (b) noncentered Inversion-symmetry axes within the unit cell, indicated in red. (c) Depiction of the action of the operators $\hat{C}_1$ and $\hat{C}_{1/2}$, on the band structure of the model shown in (b).

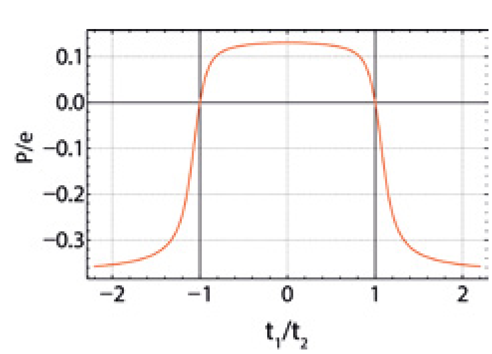

FIGURE 2
Polarization per unit length for the model in Fig. 1(b) with six unit cells and open boundaries, as a function of the ratio of the hopping parameters, showing the upward shift in the top and bottom plateaus in relation to *P*=0 and *P*=-0.5, respectively.