Ultra-robust topologically protected edge states in quasi-1D systems

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Abstract

Topological materials yield robust edge states with potential applications in electronics or quantum technologies[1,2]. Yet, their simplest Su--Schrieffer--Heeger model covers only coupling disorders, leaving other types uncovered. Here, by studying a quasi-one-dimensional zigzag model with negative couplings, we show non-chiral edge states, which remain well localized in the simultaneous presence of dissipation and disorders in short- and long-range interactions, as well as in on-site energies, whose strengths are comparable with interactions in the system. To this end, we derive regularized values of the topological invariant via a novel approach. Our work hints on constructing topological phases even in the absence of usual symmetries.

References

[1] Z. Yue, M. Topological insulator materials for advanced optoelectronic devices. Advanced Topological Insulators. pp. 45-70 (2019)

[2] Xue, H., Yang, Y. & Zhang, B. Topological Valley Photonics: Physics and Device Applications. Adv. Photonics Res.. 2, 2100013 (2021)

Figures

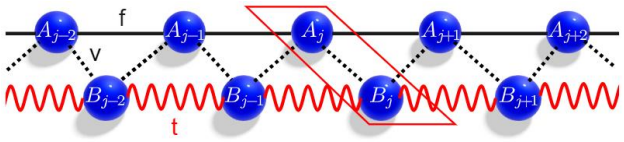

Figure 1: Quasi-1D zigzag structure with interacting chains *A* and *B* connected by strength $v > 0$ (dashed line). The coupling strengths between the sites within chain *A* is $f > 0$ (black line), while within *B* is $t < 0$ (red line). An elementary two-site unit cell is shown as a red frame.

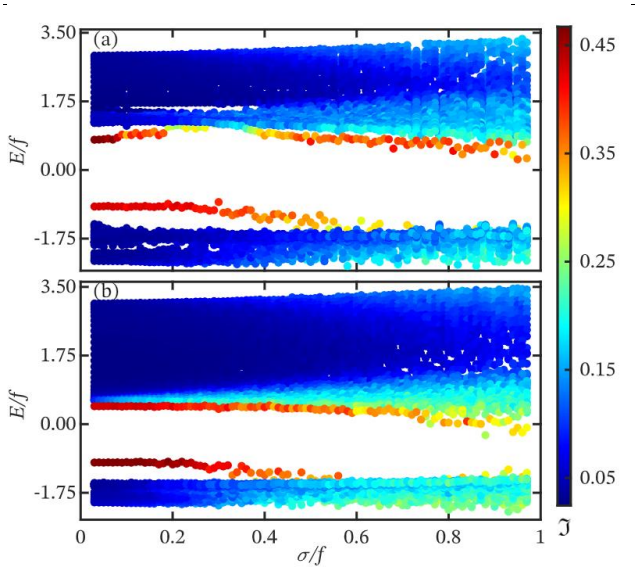

Figure 2: Our main result: robust topologically protected edge states in a zigzag system affected simultaneously by losses and disorders in next-neighbor and long-range interactions, and on-site energies; all quantified with strength σ. Remarkably, the edge states remain well localized for the disorders and losses comparable with the system interaction strength, $\sigma/f \leq 0.3$. The plot is computed for a chain of $N=60$ sites, $v/f=1$, (a) $t/f=-0.7$, (b) $t/f=-0.3$.