

Creating a Superconductor from a Topological Insulator

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- Attractively interacting electrons is the secret to superconductivity (Cooper pairs)
- Topological insulators are not conductive in the bulk but along the edges
- However, we can make a topological insulator superconductive in the bulk by creating attraction between the electrons of the insulator

Physical Model

$$H = -t \sum_{\substack{\langle i,j \rangle \\ \sigma=\uparrow,\downarrow}} \left(c_{i\sigma}^\dagger d_{j\sigma} + d_{j\sigma}^\dagger c_{i\sigma} \right) - t' \sum_{\substack{\langle\langle i,j \rangle\rangle \\ \sigma=\uparrow,\downarrow}} \left(c_{i\sigma}^\dagger c_{j\sigma} e^{i\phi} + c_{j\sigma}^\dagger c_{i\sigma} e^{-i\phi} \right. \\ \left. + d_{i\sigma}^\dagger d_{j\sigma} e^{-i\phi} + d_{j\sigma}^\dagger d_{i\sigma} e^{i\phi} \right) + U \sum_{i \in A} c_{i\uparrow}^\dagger c_{i\uparrow} c_{i\downarrow}^\dagger c_{i\downarrow} + U \sum_{j \in B} d_{j\uparrow}^\dagger d_{j\uparrow} d_{j\downarrow}^\dagger d_{j\downarrow}$$

- $U = 0 \Rightarrow$ Topological insulator (Haldane model)
- $U < 0 \Rightarrow$ Superconductor¹

¹Terms and conditions may apply

Seeing the transition

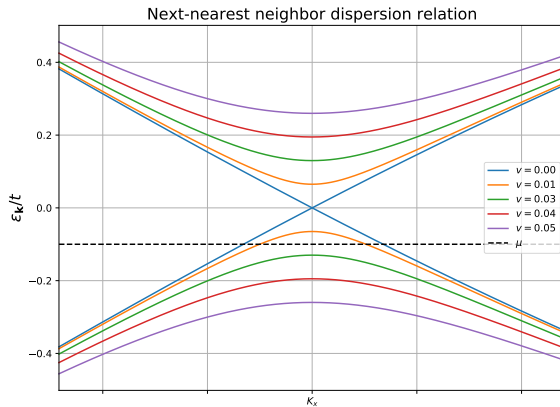


Figure: Electron energy as a function of k_x and $\nu \equiv t'/t$.