May 31, 2024

1 A switch to more analytics

I switched over from a complete brute-force numerical method to using SymPy to obtain the inner products, which in hindsight I should have done earlier.

The eigenvectors are found to be

$$\begin{bmatrix} -\frac{k}{k_x+ik_y} \\ 1 \end{bmatrix}, \qquad \begin{bmatrix} \frac{k}{k_x+ik_y} \\ 1 \end{bmatrix} \tag{1}$$

with corresponding eigenvalues

$$-v_F k, \qquad v_F k \tag{2}$$

where $k^2 = k_x^2 + k_y^2$

Over the summation, from what I understand I am to consider the eigenvectors of the same hamiltonian at a single point in k-space. The first quantity I computed was:

$$\frac{f(E_n) - f(E_{n'})}{E_n - E_{n'}} = \frac{4k_y^2}{k^2} \tag{3}$$

Where I'm only considering opposing eigenvalues.
Then:

$$\langle n| v_x |n'\rangle \langle n'| v_x |n\rangle = \pm \frac{\left(1 + e^{\frac{v_F k}{T}}\right)^{-1} - \left(1 + e^{-\frac{v_F k}{T}}\right)^{-1}}{2v_F k} \tag{4}$$

I put these together to numerically obtain the plots I attached to the email, which are probably