Tasks for local chern number computation

We will follow the following paper

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Task set I :-

1) Consider $L \times L$ square lattice system with periodi-e boundary condition (PBC). Vary $L = 20$ to $L = 60$, in steps of 4. This way we will collect data for 11 system size.

2) Now for [redacted] each value of L, compute the local chern number (LCN) at each site. Store this data set [redacted] for each [redacted] L. So we will have 11 such data set.

3) Execute step 2 for the following 6 values of $\frac{m}{t_0} = -1.5, -1, -0.5, 0.5, 1, 1.5$

$\Rightarrow$ Then we finally have 66 data set, on which we will now perform data analysis.

Task sit II :-

1) Bin count the number of sites that produces the correct LCN, say $C = 1$ for example, within the tolerance rang δ. So for each 66 data set do bin counting for

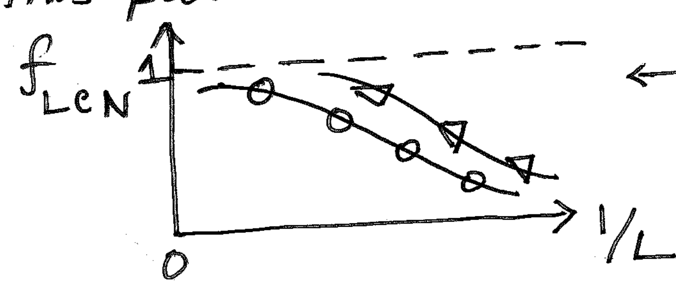
$$1 - \delta \leq C \leq 1 + \delta$$

for $\delta = 0.1, 0.3, 0.5, 0.7, 0.9$
(5 values of δ).

2) Then compute the follow quantity

$$f_{LCN} = \frac{\text{No. of sites yielding LCN between } 1-\delta \text{ \& } 1+\delta}{L^2 \text{ (Total number of sites)}}.$$

Next we will plot $\left(\frac{1}{L} \text{ vs } f_{LCN}\right)$ for 11 chosen values of L, 6 chosen values of m/t_0, and for 5 chosen values of δ, altogether yielding $11 \times 6 \times 5 = 330$ data points. This plot should qualitatively look like



← total 30 curves each curve containing 11 data point.

<u>Conclusion</u>:- ~~#~~ From the scaling of ($\frac{1}{L}$ vs. f_{LCN}) we will show that in the thermodynamic limit ($1/L \to 0$), $f_{LCN} \to 1$ asymptotically, confirming that the LCN becomes site independent & gives the correct chern number ~~in~~ even in the limit $\delta \to 0$.

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Once this tasks are executed and complete on a square lattice QAHI, we will set out to demonstate a similar outcome on Projected Topological Branes (PTB).

To proceed, we now consider PTB of different thickness in the following way. In our notation we can vary the thickness of PTB ~~#~~ by keeping

x_{down} : fixed $\qquad x_{up}$: varied.

say ~~$x_{up,j}$~~ we characterize a PTB by these two parameters (x_{down}, $x_{up,j}$) for $j = 1, 2, 3, 4, 5$. We choose $x_{up,j}$ values such that the percentage of sites enclosed by PTB has a minimum value of 10% (approx) and a maximum value of 20% (approx).

Then we repeat all the steps, we did for 2D square lattice crystal. So now we will have

11 (depending on the linear dimension of the parent crystal)

× 6 (depending on the value of m/t_0)

× 5 (depending on the value of δ)

× 5 (depending on the value of $x_{up,j}$).

= 1650 data points.

We will characterize PTB by its width, defi-ned as $\Delta x_j = x_{up,j} - x_{down}$. Then plot f_{LCN}, introdued on page 2 as a function of $1/L$ for various L, $\frac{m}{t_0}$, δ, Δx_j proving that in the thermodynamic limit $f_{LCN} \to 1$, i.e., all the sites gives correct value of LCN.

We perform this calculation with PBC.