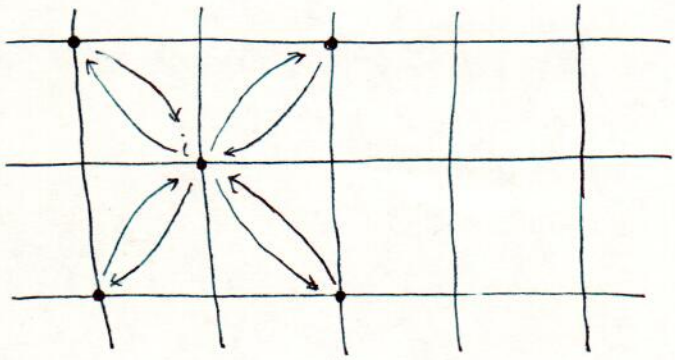
2017 / 1 / 2 (월).

사각격자에서 대각성분끼리 hopping 을 고려하면 $\sim \cos k_x \cos k_y$ 항이 나오는 예.

$$\sum_i \Big(-t' C_i^\dagger C_{i+\hat{x}+\hat{y}} - t' C_i^\dagger C_{i-\hat{x}-\hat{y}} - t' C_i^\dagger C_{i-\hat{x}+\hat{y}} - t' C_i^\dagger C_{i+\hat{x}-\hat{y}}$$

$$- t' C_{i+\hat{x}+\hat{y}}^\dagger C_i - t' C_{i-\hat{x}-\hat{y}}^\dagger C_i - t' C_{i-\hat{x}+\hat{y}}^\dagger C_i - t' C_{i+\hat{x}-\hat{y}}^\dagger C_i \Big) \quad \cdots (1)$$



Fourier transformation

$$\sum_i (-t') \sum_{\vec{k},\vec{k}'} C_k^\dagger e^{-i\vec{k}\cdot\vec{r}_i} C_{k'} e^{i\vec{k}'(\vec{r}_i+\hat{x}+\hat{y})}$$

$$= -t' \sum_i \sum_{k,k'} C_k^\dagger C_{k'} e^{-i\vec{r}_i(\vec{k}-\vec{k}')} e^{i\vec{k}'(\hat{x}+\hat{y})}$$

$$= -t' \sum_k e^{i\vec{k}\cdot(\hat{x}+\hat{y})}$$

$$\therefore \quad -t' \sum_k C_k^\dagger C_k \left(2e^{ik_x} e^{ik_y} + 2e^{-ik_x} e^{-ik_y} + 2e^{-ik_x} e^{ik_y} + 2e^{ik_x} e^{-ik_y} \right)$$

↑ 2 due to the first line and the second line of Eq. (1).

$$\rightsquigarrow 8 \cos k_x \cos k_y$$