

Exercise-sheet 3 (November 3, 2017)

1 In-class exercises

1.1 Tight-binding model on square and honeycomb lattices

- (a) Calculate the dispersion relation for the tight-binding model on both square and honeycomb lattices (lattice constant a).
- (b) Find an expression for the density of states of the model on the square lattice.
- (c) Give an approximate expression for the dispersion of the model on the honeycomb lattice close to the point $K = (\frac{2\pi}{3a}, \frac{2\pi}{3\sqrt{3}a})$.

2 Homework - due date: November 10, 2017 (30 points).

2.1 Linear chain with next-nearest neighbor hopping (15 points)

Consider a linear chain of atoms with first- and second-neighbor hopping amplitudes t_1 and t_2 , respectively.

- (a) Determine the tight-binding band structure of the chain.
- (b) What's the number of minima of the dispersion?
- (c) Compute the DOS for $t_1 = 1/2$ and $t_2 = -t_1$.

2.2 Tight-binding model on a kagomé lattice (15 points)

- (a) Find the dispersion for the tight-binding model on a kagomé lattice (lattice constant a).
- (b) Plot the band structure of the model along the path $\Gamma - K - M - \Gamma$ with $\Gamma = (0, 0)$, $K = \frac{\pi}{a}(\frac{1}{3}, \frac{1}{\sqrt{3}})$ and $M = \frac{\pi}{a}(\frac{2}{3}, 0)$ in reciprocal space.