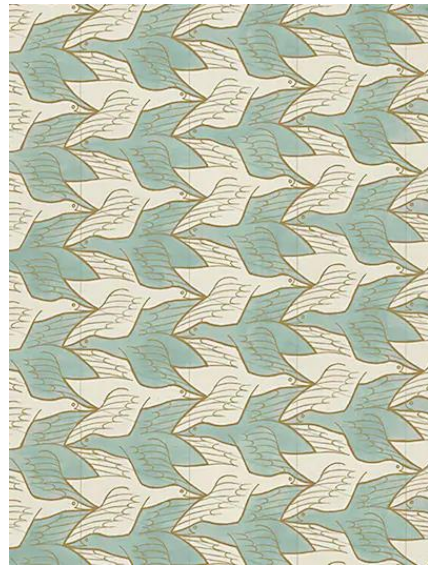


Solid state physics

Problems 2

Deadline: 11. October 2020. 24:00

- 1) Find the fundamental translation vectors of the following 2D structures. Construct the elementary cell and the Brillouin Zone.



- 2) Investigate the phonon modes of the diamond crystal. How many optical and acoustic modes are there?
- 3) Plot the dispersion relation of the 1D phonons (Eq. 3.5) in the first Brillouin-zone. What is the maximal value of the frequency of phonons? How can we derive the sound velocity?
- 4) Show that the spatial probability density for one-dimensional free electrons is constant. Show that it has the periodicity of the corresponding Bravais lattice for Bloch electrons.

- 5) Show that the dispersion (Eq. 4.10) for the s-band in the tight-binding model (bound state approximation) can be approximated by a parabolic dispersion in the vicinity of $k=0$, as in the nearly free electron model. (b) Calculate the effective mass in this case, and discuss the result.
- 6) What is the physical interpretation of the vector \mathbf{k} for an electronic state in a solid?
- 7) Do the Bloch wave functions have the periodicity of the lattice?
- 8) Plot the dispersion relation of a nearly free electron (Eq. 4.13). Due to the Bragg reflection convert every wavenumber into the first Brillouin-zone.