Solid state physics (*winter term 2015/2016*)

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Exercise sheet 2

1. Miller indices in 2-Dimensions

Find the Miller indices of lattice planes shown in figure 1.

Hint: Define the pair of basis vectors (a, b) by yourself.

2. Structure factor of a diamond-lattice

The monoatomic diamond lattice (carbon, silicon, germanium, or grey tin) is not a Bravais lattice and must be described as a lattice with basis. The underlying Bravais lattice is face-centered cubic and the basis can be taken to be (0 0 0) and (¼ ¼ ¼).

1- Determine the structure factor of the diamond lattice.

2- Write a list of resulting structure factors for h, k and l $\epsilon\{0, 1, 2\}$ and discuss the result in terms of allowed diffraction reflections for the diamond lattice; i.e. extinction rules.

3. Zincblende and Wurtzite structures

In the zincblende structure, a view along a [111] direction reveals that the atoms of a given kind are stacked in the sequence …ABCABC…while maintaining tetrahedral bonds with those of the other kind. The undelying Bravais lattice is cubic. There is another arrangment that preserves the tetrahedral bond but stacks the atoms of a given kind in the sequence …ABABAB… This is the wurtzite structure, whose undelying Bravais lattice is hexagonal.

1- Give one example of each structure and plot it in 3D. Use different colors to place different atoms on the lattice.
2- Cadmium Selenide can grow in a Zinc-blende (cubic) but also in a wurtzite structure with 4 atoms in the unit cell placed at Cd: (0 0 0) (1/3 2/3 1/2) and Se: (0 0 3/8) (1/3 2/3 7/8). Calculate the structure factor of both di-atomic structures.

4. Reciprocal lattice

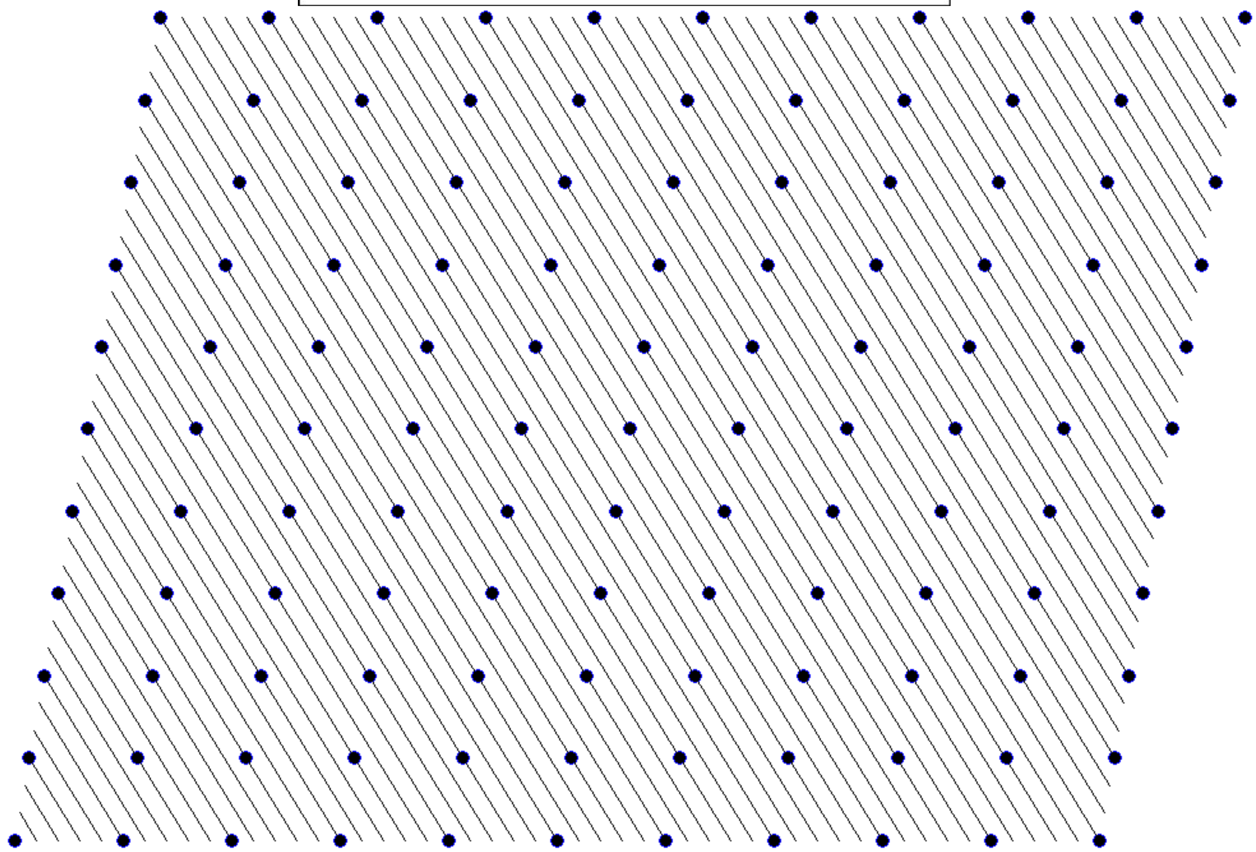
Prove that the reciprocal lattice primitive vectors defined in lecture satisfy:

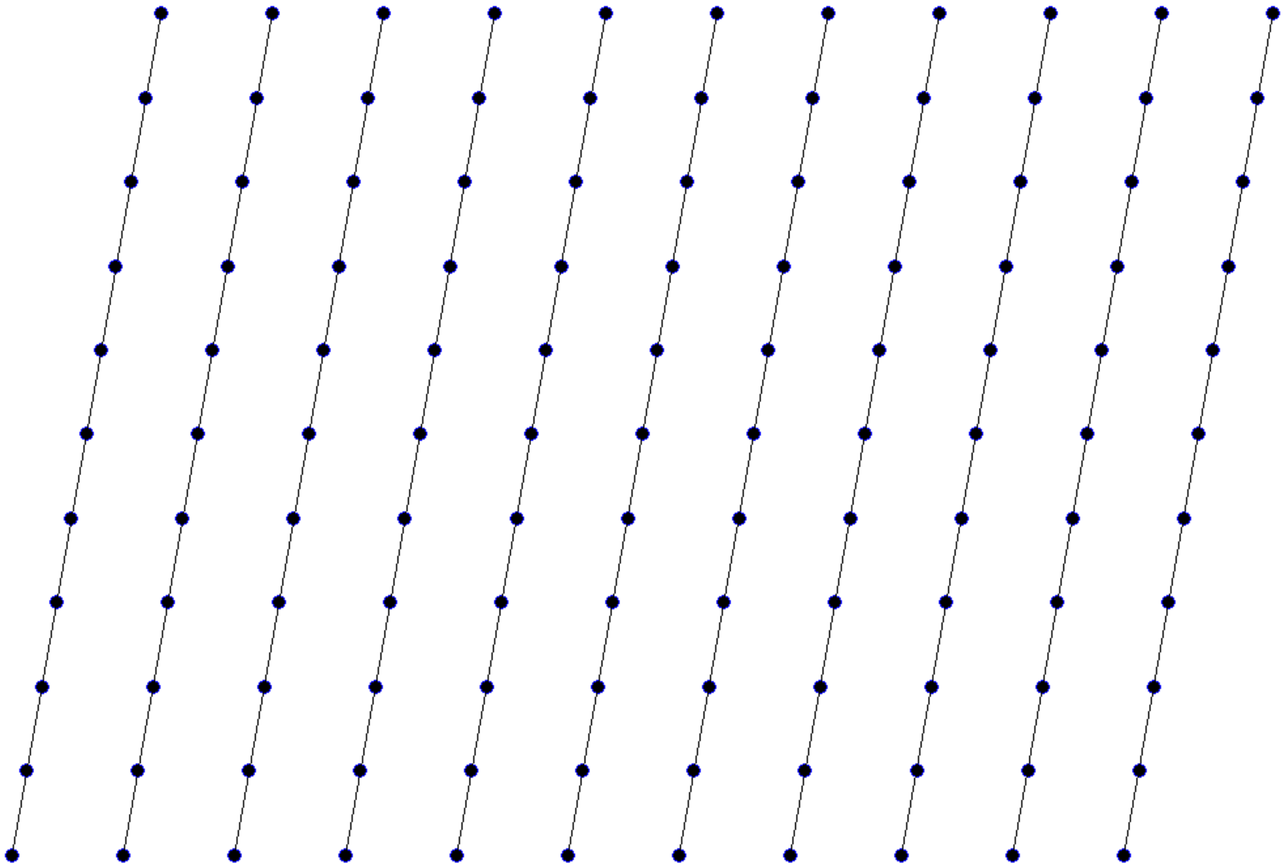
$$b_1.(b_2 \times b_3) = \frac{(2\pi)^3}{a_1.(a_2 \times a_3)}$$

Suppose the primitive vectors are constructed from the b_i in the same manner as b_i are constructed from the a_i. Prove that these vectors are just the a_i themselves; i.e. show that:

$$2\pi \frac{b_2 \times b_3}{b_1.(b_2 \times b_3)} = a_1, \quad etc.$$

Please return on 04/11/2015





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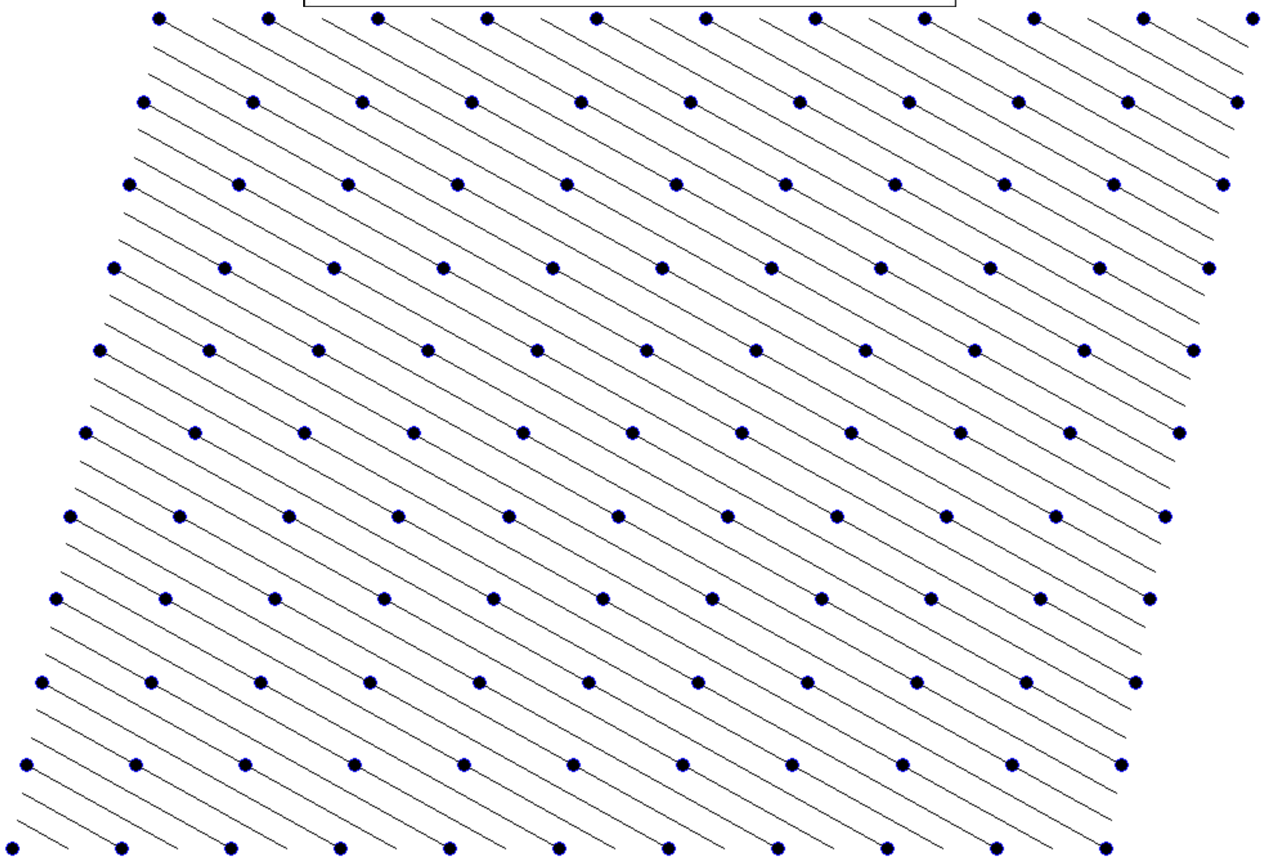

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