Háskóli Íslands
Raunvísindadeild
Eðlisfræði

Haust 2014

Eðlisfræði þéttefnis I

Dæmablað 3

Skilafrestur 16. September 2014 kl. 15:00

1. **Interplanar separation**

   Consider a plane hkl in a crystal lattice.

   (a) Prove that the reciprocal lattice vector $\mathbf{G} = h\mathbf{b}_1 + k\mathbf{b}_2 + l\mathbf{b}_3$ is perpendicular to this plane.

   (b) Prove that the distance between two adjacent parallel place of the lattice is $d(\text{hkl}) = 2\pi/|\mathbf{G}|$.

   (c) show for a simple cubic lattice that $d^2 = a^2/(h^2 + k^2 + l^2)$.

2. **Hexagonal reciprocal lattice**

   (a) For a hexagonal lattice with primitive lattice vectors $\mathbf{a}_1 = a(1, 0, 0), \mathbf{a}_2 = a(1/2, \sqrt{3}/2, 0), \mathbf{a}_3 = c(0, 0, 1)$ calculate the primitive vectors of the reciprocal lattice using the standard construction shown in class. What type of lattice is the reciprocal lattice ? What is its angle of rotation with respect to the original lattice ?

   (b) Using the reciprocal lattice vectors, calculate the volume of the first Brillouin zone. Draw a careful diagram of the first Brillouin zone in reciprocal space.

3. **Structure factor of diamond lattice**

   The diamond structure is described in your text. The basis consists of eight atoms if the unit cell is taken as the conventional cube.

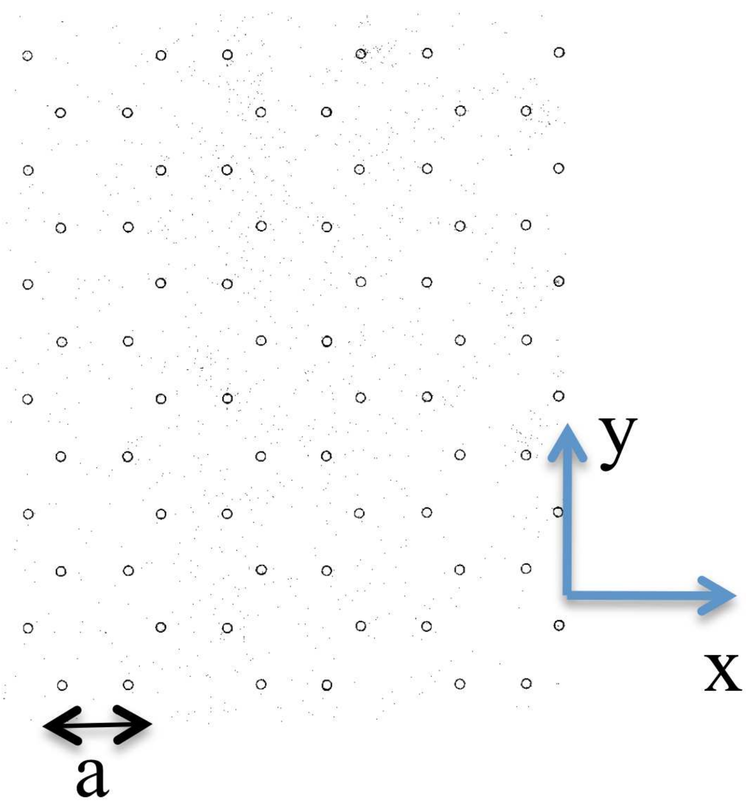
(a) Find the structure factor S of this basis.

(b) Find the zeros of S and show that the allowed reflections of the diamond structure satisfy $h + k + l = 4n$, where all indices are even and n is any integer, or else all indices are odd.

4. **Graphene (honeycomb)** (10)

(a) Indicate whether graphene structure (below) is a Bravais lattice. If it is, give two primitive vectors; if it is not, describe it as a Bravais lattice with as small as possible a basis.

(b) Using the following grid, draw primitive vectors and a primitive cell for the Bravais lattice. Calculate the area of the primitive cell.



5. **Miller indices** (10)

Find the Miller indices for the following planes:

(a) A plane parallel to both $\mathbf{a}_1$ and $\mathbf{a}_3$,

(b) The plane containing the points $3\ \mathbf{a}_1$, $2\ \mathbf{a}_2$, and $1/2(\mathbf{a}_1 + \mathbf{a}_2 + \mathbf{a}_3)$,

(c) A plane that contains a cube edge and cuts two other cube edges of the same cube at their midpoints, in a simple cubic lattice.