PHY4905 Spring 2013

Homework B

Instructor: Yoonseok Lee

Submit only HW's. EX's are additional problems that I encourage you to work on.

(**a**.**b**) means problem number **b** of chapter **a** in *Introduction to Solid State Physics* (8th ed.) by Kittel.

Due February 1

EX: Is the reciprocal lattice of the reciprocal lattice is the original direct (crystal) lattice?

HW 1: (2.1)

HW 2: (2.2)

HW 3: (2.3)

HW 4: Show that the reciprocal lattice of the *bcc* lattice is an fcc lattice.

HW 5: Consider a 1-D monatomic crystal of N atoms whose primitive lattice vector is $\vec{a} = a\hat{x}$. As discussed in class, the total scattered radiation intensity is proportional to its lattice structure factor $|S|^2$:

$$S = \sum_{i=1}^{N} exp(-i\Delta\vec{k} \cdot \vec{R}_i),$$

where $\Delta\vec{k} = \vec{k} - \vec{k'}$ is the scattering vector is the lattice vector.

(a) Show that

$$|S|^2 = \frac{\sin^2 \frac{1}{2} N\Delta\vec{k} \cdot \vec{a}}{\sin^2 \frac{1}{2}\Delta\vec{k} \cdot \vec{a}}.$$

(b) The above function has main peaks at $\Delta\vec{k} \cdot \vec{a} = 2\pi n$ (n integer). Show that the hight of the main peak is N^2.

(c) The first zero around the $n = 0$ peak occurs at $\Delta\vec{k} \cdot \vec{a} = \epsilon$. Show that $\epsilon = 2\pi/N$. In other words, the width of the main peak decreases as the number of atoms increases.

(d) The first secondary peak appears at $\Delta\vec{k} \cdot \vec{a} = 3\pi/N$. For a large N, show that the intensity of the secondary peak is about 4% of the main peak intensity.

HW 6: (2.5)