Eðlisfræði þéttefnis I

Dæmablað 6

Skilafrestur 9. October 2018 kl. 15:00

1. **Einnar atóma keðja – Monatomic chain** (15)

   Gera skal ráð fyrir einnar atóma keðju þar sem bæði er víxlverkun milli næstu granna og þar næstu granna. Táknum gormstuðul milli næstu granna með K_1 og milli þarnæstu granna með K_2, massa atómsins með M, og grindarfastann með a.

   (a) Rita skal hreyfijöfnur fyrir atómin og finna titringstíðni grindarinnar $\omega(k)$.

   (b) Hver er hljóðhraðinn fyrir þessa keðju ?

   Consider a monatomic chain which have both the nearest-neighbor and second nearest-neighbor interaction between atoms. Let us denote the nearest-neighbor spring constant by K_1, the second nearest-neighbor spring constant by K_2, the mass of the atoms by M, and the lattice constant by a.

   (a) Write down the equation of motion for the atoms and solve for the lattice vibrational frequencies $\omega(k)$.

   (b) What is the velocity of sound for this chain ?

   (Próf maí 2016)

2. **Atomic X-ray form factor** (15)

As a first step toward including the atomic form factor for X-ray diffraction, one can consider the Z electrons of an atom to be uniformly distributed in a sphere of radius r_0. Show that the form factor of a uniform sphere of radius r_0 can be written

$$f(\mathbf{G}) = 3Z \frac{\sin x_0 - x_0 \cos x_0}{x_0^3}$$

with $x_0 = |\mathbf{G}r_0|$.

3. **Phonon dispersion with alternating spring** (20)

Consider a one-dimensional chain of identical atoms. The springs between them alternate in strength between values K_1 and K_2.

(a) Find the vibrational frequencies as a function of wave number q. Study the low q limit and find the sound velocity.

(b) Discuss the physical meaning of the two branches. Sketch the way the atoms move in both cases !

(c) Discuss the dispersion and the normal modes for $K_1 \gg K_2$.

(d) Discuss the limit $K_1 \approx K_2$ and compare with the homogeneous chain where all springs are identical.