

# Eðlisfræði þéttfnis I

## Dæmablað 6

Skilafrestur 11. October 2016 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 ?

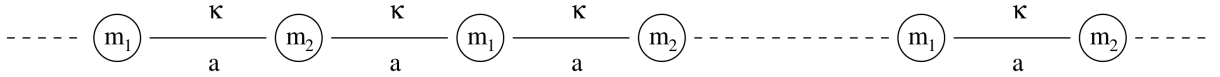
Consider a monatomic chain which have both the nearest-neighbor and second nearest-neighbor interaction between atoms. Let us denote the nearest-neighbor spring constant by  $K_1$ , the second nearest-neighbor spring constant by  $K_2$ , the mass of the atoms by  $M$ , and the lattice constant by  $a$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

- (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. Normal modes of a one dimensional diatomic crystal (20)

Consider a straight chain of atoms with alternating mass  $m_1$  and  $m_2$  and interatomic distance  $a$ . Nearest neighbors interact through a spring of constant  $\kappa$ .



- Establish the dispersion relation for the normal modes of the chain.
- Discuss the cases  $m_1 = m_2$  and  $m_1 \gg m_2$  making use of reduced and extended zone representations.

## 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  $K_2$ .

- Find the vibrational frequencies as a function of wave number  $q$ . Study the low  $q$  limit and find the sound velocity.
- Discuss the physical meaning of the two branches. Sketch the way the atoms move in both cases !
- Discuss the dispersion and the normal modes for  $K_1 \gg K_2$ .
- Discuss the limit  $K_1 \approx K_2$  and compare with the homogeneous chain where all springs are identical.