به نامِ خدا

دانش‌گاهِ صنعتیِ اصفهان – دانش‌کده‌یِ فیزیک

تصاویر فصل ۹

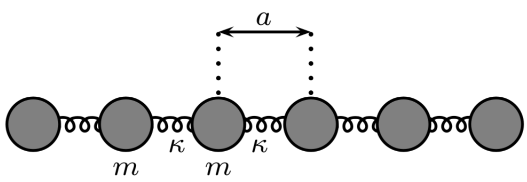
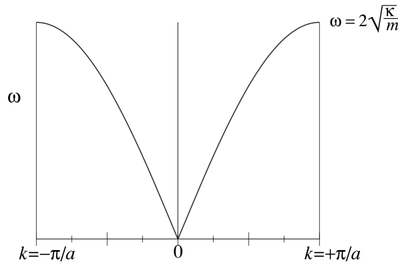


Fig. 9.1 The one-dimensional monatomic harmonic chain. Each ball has mass m and each spring has spring constant κ. The lattice constant, or spacing between successive masses at rest, is a.

Fig. 9.2 Dispersion relation for vibrations of the one-dimensional monatomic harmonic chain. The dispersion is periodic in $k \to k + 2\pi/a$.



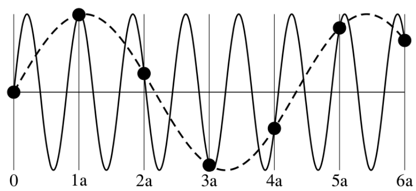


Fig. 9.3 Aliasing of waves. The dashed curve has wavevector k whereas the solid curve has wavevector $k + 2\pi/a$. These two waves have the same value (solid dots) at the location of the lattice points $x_n = na$, but disagree between lattice points. If the physical wave is only defined at these lattice points the two waves are fully equivalent.

- Normal modes are collective oscillations where all particles move at the same frequency.
- If a system is periodic in space with periodicity $\Delta x = a$, then in reciprocal space (k-space) the system is periodic with periodicity $\Delta k = 2\pi/a$.
- Values of k which differ by multiples of $2\pi/a$ (by an element of the reciprocal lattice) are physically equivalent. The set of points in k-space which are equivalent to $k = 0$ are known as the reciprocal lattice.

- Any value of k is equivalent to some k in the first Brillouin zone, $-\pi/a \leqslant k < \pi/a$ (in 1d).
- The sound velocity is the slope of the dispersion in the small k limit (group velocity = phase velocity in this limit).
- A classical normal mode of frequency ω gets translated into quantum-mechanical eigenstates $E_n = \hbar\omega(n + \frac{1}{2})$. If a mode is in the n^{th} eigenstate, we say that it is occupied by n phonons.
- Phonons can be thought of as particles, like photons, that obey Bose statistics.
