

NORTHERN ILLINOIS UNIVERSITY

PHYSICS DEPARTMENT

Physics 580 – Solid State Physics

Fall 2024

Problem Set #7

Problem Set Due: Tues, Nov.21, 2024

Read Kittel: Chapter 5

Problem 1: Singularity in density of states

- (a) From the dispersion relation derived in Chapter 4 for a monatomic linear lattice of N atoms with nearest-neighbor interactions, show that the density of modes is

$$D(\omega) = \frac{2N}{\pi} \cdot \frac{1}{(\omega_m^2 - \omega^2)^{\frac{1}{2}}}$$

where ω_m is the maximum frequency.

- (b) Make a plot of $D(\omega)$ for Part (a).

- (c) Suppose that an optical phonon branch has the form $\omega(K) = \omega_0 - AK^2$, near $K = 0$ in three dimensions. Show that

i. $D(\omega) = (L / 2\pi)^3 (2\pi / A^{\frac{3}{2}}) (\omega_0 - \omega)^{\frac{1}{2}}$ for $\omega < \omega_0$

ii. $D(\omega) = 0$ for $\omega > \omega_0$

Here the density of modes is discontinuous.

- (d) Make a plot of $D(\omega)$ for Part (c).