Homework 3

Phys 155, Winter 2008, UCSC

Due Jan 31

Each problem is 5 points. For problems from H&H, please note that solutions are included in the textbook. However, use those solutions simply as a guide, if necessary. If you do, your answers should show clear evidence (your own words, logic, details, diagrams, etc.) for your own understanding.

1. H&H, 11.7

2. Elastic wave equation

   (a) Show that equation (2.7) reduces to the following continuum elastic wave equation, if the wave length is much longer than the lattice constant. [Note that under this condition the lattice constant can be taken as an infinitesimal, dx, of the differential calculus.] Verify that v is the same as (2.13) (or (2.14)).

   $$\frac{\partial^2 u}{\partial t^2} = v^2 \frac{\partial^2 u}{\partial x^2}$$

   (b) Generalize this solution to the case of diatomic chain, (2.15) and (2.16) or my lecture note, and show that the same form of wave equation is obtained with the correct velocity, as given in page 44, $v = a\sqrt{\frac{K}{2(M+m)}}$, where a is the lattice constant (note that the distance between adjacent atoms is half of that).

3. [Peierl's transition] Problem 2.2 of H&H with a modification at the end: When plotting dispersion curves, plot these two cases together (i) $K_1 = K_2 = K$ (this should be the same as the mon-atomic chain except for the periodicity doubling), (ii) when K_1 and K_2 differ (by a small amount). In the case of (i), indicate where the two branches – acoustic and optical – meet.