

Physics 617 Problem Set 2 Due Mon, Feb. 6

(1) Ashcroft-Mermin #4.5

(2) [a] For the simple cubic lattice of cube edge a , show that the lattice planes indexed by Miller indices (h, k, l) are separated by,

$$d = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$$

[b] For the tetragonal lattice, with perpendicular cell edges $a, a,$ and c , find the corresponding relationship for d in terms of the Miller indices.

(3) X-ray scattering for GaAs: The GaAs zincblende structure is similar to the diamond structure, except that the basis consists of two different atoms. Consider the atomic form factors for Ga and As to be f_{Ga} and f_{As} , respectively. Show that the structure factor, S_K , has four* different values, depending upon the reciprocal lattice vector, K . Find expressions for S_K in terms of f_{Ga} and f_{As} .

*There are three different values if f_{Ga} and f_{As} are both real. Imaginary components are non-zero when x-ray scattering includes an inelastic component. This is important when the x-ray is near resonance with a core-state transition, although in practice the imaginary parts are small and sometimes neglected.

(4) In the handout on x-ray scattering, in figure 3 the visible x-ray reflection lines are shown schematically for the simple cubic, BCC, and FCC lattices. The highest-order reflections shown are: (311) for SC, (332) for BCC, and (440) for FCC. In each case find the next visible reflection line.