

PHY 491 - 2013

Atomic, Molecular, and Condensed Matter Physics

Problem Set 12, The Last and The Easiest

1. For a one-dimensional crystal in the tight-binding approximation, assuming that the energy dispersion law is $E_{\mathbf{k}} = E_0 \cos ka$, find the density of levels per unit length. Make a plot. (5 pt)
2. Show that $\int d\mathbf{k} \partial_{\mathbf{k}} E_{m\mathbf{k}} = \mathbf{0}$, where the integration goes over the first Brillouin zone. Do not use the proof in the textbook, calculate the integral directly. (5 pt)
3. A simple type of a semiconductor photodetector is an intrinsic (small number of defects) semiconductor where light, when it is absorbed, creates electrons and holes. As a result the system, which is a dielectric “in the dark”, can become conducting, the effect of photoconductance. What is the threshold wavelength (in microns) of light that can be detected using such semiconductors as Ge and InSb? (5 pt)
4. Problem 2(a) to Ch. 10: for a cubic crystal with nearest neighbor coupling, consider in the tight-binding approximation the energy dispersion law $E_{\mathbf{k}}$ for the band formed from atomic p -levels, where the atomic wave functions have the form $x\phi(r), y\phi(r), z\phi(r)$. (5 pt)

You are supposed to get 20 points. The solution is due on December 6.