Homework #7 Feb 20, 2016

Problems (HH= Hook & Hall)

#1 Assuming a 1-d crystal with hoppings t for nearest neighbors and t' for second neighbors, calculate the tight binding energy dispersion, following the method used in class.
#2 Plot the resulting spectra of #1 for t=1 and t'=1,.5,0,-.5,-1. What is the difference as t' is changed from 0?

#3 For the triangular lattice write down the 6 nearest neighbor vectors η's in terms of the unit vectors **x** and **y.** (You may assume the lattice constant is 1). Using these vectors, calculate the tight binding energy dispersion as a function of kx and ky assuming a hopping t between nearest neighbors. Locate the maximum and minimum of the dispersion (assuming t=1).

#4 The important material Graphene occurs in the graphite structure, also known as the honeycomb lattice. Verify that this can be thought of as a triangular Bravai lattice plus a basis of two sites.

Write down the nearest neighbor vectors for each of the basis vectors.

How would you set up a 2x2 matrix to compute the tight binding bands of this system? (See supplemental paper titled Graphite band structure paper***.pdf on the website for guidance after trying the problem yourself. I do not expect you to complete this calculation, but it would get you thinking correctly about semiconductors and other complex applications of the tight binding theory)