

Homework 7

Due 2/24/2011

1. [10 points] Kittel 6.9
2. [10 points] Kittel 7.2
3. [10 points] Consider the following matrix which is a generalization of the matrix that we considered in class. It is applicable to higher dimensions, and to the degenerate perturbation theory near the BZ boundary, not just at the BZ boundary (we assume $|\lambda_{\vec{k}} - \lambda_{\vec{k}+\vec{G}}| \ll |U_{\vec{G}}|$). This matrix is applicable near the BZ boundary that is the perpendicular bisector of $-\vec{G}$.

$$h = \begin{pmatrix} \lambda_{\vec{k}} + U_0 & U_{\vec{G}}^* \\ U_{\vec{G}} & \lambda_{\vec{k}+\vec{G}} + U_0 \end{pmatrix}$$

- a. Obtain eigenvalues of this matrix.
 - b. Show that the group velocity satisfies: $\vec{v}_{\vec{k}} \cdot \vec{G} = 0$ if \vec{k} is on the BZ boundary.
 - c. Explain why (b) means that a constant energy surface (e.g. the Fermi surface) would cut the BZ boundary at the right angle.
4. [20 points] Submit a paragraph, consisting of at least about 200 words, describing what you like to do for the presentation at the end of the course. The paragraph should (i) summarize roughly what you like to talk about, (ii) make connections to what we covered (or will cover) in class, (iii) have a key reference or two. I am open to discussions any time if you need help formulating your subject.