

PHYSICS 880.06

Home Work Assignment # 1

9/27/2011

Due: Tue., Oct. 4, 2011.

Note: “A & M” = Ashcroft and Mermin

1. A & M Chapter 4, Problem 5(a).

2. A & M Chapter 4, Problem 6.

3. Show that it is impossible for a crystal to have five-fold symmetry.

Hint: One possible way is to exploit the fact that a periodic lattice cannot contain any vector less than a minimum length. Assume, if possible, that a crystal has five-fold symmetry, and show that this leads to a contradiction.

In view of the above theorem, it came as a great shock that D. Shectman *et al.* [Phys. Rev. Lett. **53**, 1951 (1984)] discovered five-fold symmetry in the diffraction pattern of certain Al-Mn alloys. D. Levine and P. Steinhardt [Phys. Rev. Lett. **53**, 2477 (1984)] provided the understanding of this observation in their theory of *quasicrystals*.

4. A & M Chapter 5, Problem 2(a,b).

5. (a) What are the known crystalline forms of carbon? Draw their crystal structures.

(b) Draw the crystal structures of the two best studied semiconductors: Si and GaAs. If you have a hard time drawing, write down the coordinates of atoms within a conventional cubic unit cell.

(c) What is a perovskite structure? Find a material that has this structure and draw its unit cell. Give examples of interesting perovskites.

(d) What is a kagome lattice? Draw a picture. Find an example of a material. Why is it interesting?

Term Paper:

Start thinking about your term paper. You have to write a 10 page paper on a topic of your choice in condensed matter physics. You will need to:

(i) Finalize your topic by October 11.

(ii) Have an outline and list of references by October 25.

(iii) Hand in the final report by December 1.

Please come and see me if you need ideas for topics.