6.730 PHYSICS FOR SOLID STATE APPLICATIONS

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PROBLEM SET 2

Issued: 2-10-99 Due: 2-17-99, at the beginning of class.

Readings:
PSSA Chapter 3
PSSA Chapter 4
Ashcroft and Mermin, Chapters 3
and Ashcroft and Mermin, Chapters 23

Problem 2.1 *2D electron gas* **SSS Exercises 7.2, 7.3, 7.4, 7.5 and 7.6. Also what is the temperature of the specific heat low temperatures for the systems in Exercise 7.6**

This problem is meant as a review of statistical physics and of finding the density of states for a free electron gas. You may want to review Chapters 20 and 24—26 of the 6.728 notes.

This problem also introduces you to programs in *Simulations for Solid State Physics* (**SSS**). To access these program on *athena*, type `add 6.730`, then the command `sommer`. Once the screen comes up, click onto *presets* and choose *sommer01*. One way to get a copy of the figures is to do a screen dump with `xdpr` or use `xv`. Go to `http://web.mit.edu/6.730/www/ST99/simulations.html for directions`. Answer the questions and either use the copy of the figures or make some simple hand sketches.

WARNING: There is one important caveat– do not run these simulations on a Sun Ultra 10— they completely lock up such machines, requiring a power cycle reboot, which is a Bad Thing to have to do—any other Sun model should be OK.

Problem 2.2 *Classical Limit of Fermi-Dirac Statistics* **PSSA Problem 3.1 parts a—d**

This problem shows how if one assumes the Boltzmann factor (Eqn. 3.77), then the classical results that we quote many times in class follow.

Problem 2.3 *2D Crystal Structure* **SSS Exercises: 2.1, 2.3, 2.4 and 2.5**

Please answer these questions with figures from the programs or make a simple hand sketches.

To access these program on *athena*, type `add 6.730`, then the command `bravais`. Once the screen comes up, click onto *presets* and choose *brav01*.

Problem 2.4 *2D Lattice Planes and Crystal Structure*

(a) **SSS Exercises: 2.6, 2.7, and 2.8.**. Answer the questions and submit a simple sketch.

Note that the primitive lattice vectors are $\mathbf{a_1} = 4\,\text{Å}\,\mathbf{i}_x$ and $\mathbf{a_2} = 4\,\text{Å}\,[\cos(60°)\mathbf{i}_x + \sin(60°)\mathbf{i}_y]$. The lattice vectors are not orthogonal, as they would be for a square lattice. Make sure you understand the difference between the lattice and the crystal structure.

(b) Go to preset 1. Now make the angle phi 90° so that you have a square lattice. Find the planes for $(1\,0)$, $(0\,1)$, $(1\,1)$ and $(1\,\overline{1})$. Submit a drawing.