Physics 195b
Problem set number 19
Due 2 PM, Thursday, March 13, 2003

Notes about course:

- Homework should be turned in to the TA's mail slot on the first floor of East Bridge.

- Collaboration policy: OK to work together in small groups, and to help with each other's understanding. Best to first give problems a good try by yourself. Don't just copy someone else's work – whatever you turn in should be what you think you understand.

- There is a web page for this course, which should be referred to for the most up-to-date information. The URL: http://www.hep.caltech.edu/~fcp/ph195/

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- If you think a problem is completely trivial (and hence a waste of your time), you don't have to do it. Just write "trivial" where your solution would go, and you will get credit for it. Of course, this means you are volunteering to help the rest of the class understand it, if they don't find it so simple. . .

READING: Read the "Second Quantization" course note.

PROBLEMS:

88. Probability current of a charged particle in an electromagnetic field: Do Exercise 2 of the Electromagnetic Interactions course note.

89. The electric field in quantum mechanics: Do Exercise 3 of the Electromagnetic Interactions course note.

90. Two-level fermion system, second quantized: Do Exercise 1 of the Second Quantization course note.

91. We have been discussing superconductivity as an application of quantum mechanics. We considered a very simple model at first, in order to demonstrate the plausibility of the formation of Cooper pairs. The scanned notes are available as a link from the Ph 195 home page. The first seven pages are of present interest.

   (a) Try to make an estimate for how large the Cooper pair is, perhaps by evaluating $\langle r \rangle$ or $\sqrt{\langle r^2 \rangle}$.

   (b) Turn your estimate into a number, *e.g.*, comparing the size with the lattice spacing of the superconductor. You will no doubt need to make plausible estimates (guesses?) of unknown parameters.