Physics 602, Spring 2008
Solid State Physics

Guidelines for Final Paper

(1) The topic may be either primarily theoretical or experimental. You are not expected to do original research, but you should read carefully on the topic, synthesize it, explain it, and work out the algebra and formalism where appropriate. Your topic should relate to the course material, preferably that of 602, or alternatively that of 601.

(2) It is all right if by chance you choose the same topic as someone else, but in this case you should work completely independently. Otherwise, feel free to discuss your insights and problems with others.

(3) Your paper topic should not be directly in the line of your thesis research. That is, if your thesis topic is about tunneling in superconductors, then tunneling in superconductors is not an appropriate topic. However, a related or complementary subject, such as vortices in superconductors or superfluidity in ^{3}He, would be appropriate.

(4) The tentative choice of topic is due in class on **Wednesday, April 16**. Please hand in a page with a tentative title, a short paragraph saying what you intend to cover, and a tentative list of references. If you find that you want to make a substantial change after this date, please discuss it with me.

(5) The length should be approximately 10-15 pages, double-spaced. (This may sound like a lot, but I think you will find that you fill pages pretty quickly once you really get started.)

(6) A few other guidelines:
   (a) The paper should be self-contained and understandable without having to refer to the cited references. This means you should define all symbols and quantities, explain any plots or figures, etc. (Figures should be enlarged enough so that everything in the figure is legible, axes should be labeled or explained in a caption, etc.) If you are talking about experiments, explain the experimental setup at least briefly.

Continued on other side...

(b) It is OK to copy some equations that appear in the cited papers, but please do not simply copy a whole string of equations. For example, if you find that the step from Eq. (8) to Eq. (9) is not so obvious to you, add one or two intermediate equations in your paper to explain it. Also, try as much as possible to add discussion explaining the physical meaning of the equations.

(c) A good measure of (a)-(b) is that your paper should be understandable to one of your classmates.

(d) I encourage you to editorialize. This means you should comment on which results you find surprising, which ones are important, which ones are doubtful, etc. Feel free to criticize the authors of some of the cited papers, to express different opinions of your own, to suggest alternate explanations, etc.

(7) Please do your best to polish the English in your paper. I will not give much weight to the quality of the English in grading the papers, as I prefer to focus on the physical content. However, in real life, the quality of the written English matters a lot!

(8) The paper is tentatively **due at 1:00 pm on Friday, May 9.** I prefer for you to send me an electronic version in PDF format as an attachment to an email, but you can give me a paper copy if you prefer.

(9) As I did last year, I will return the paper with some comments. You are encouraged to revise it and send it back to me, after which, if you agree, I will post it on the class web site (password protected, so that it is only visible to other students in the class). This way, you can read each other's papers. However, these last steps will be optional.

Physics 602 (2008)

Solid State Physics

Suggested Paper Topics

The following are just suggestions. By all means, pursue your own ideas as well. Also, feel free to consult me for ideas, references, etc.

Anderson localization; scaling theory of localization.
Carbon nanotubes, C_{60}, graphene sheets: electronic structure etc.
Charge-density (or spin-density) waves; Peierls instabilities.
d-wave superconductivity.
Density functional theory beyond LDA: gradient generalizations,
LDA+U, TDDFT, etc.
Electric polarization: Berry-phase theory.
Excitons.
Fermi liquid theory; application to heavy fermion systems; or to ^{3}He.
Ferromagnetic semiconductors; magnetic ferroelectrics; etc.
Gell-Mann & Bruekner paper.
"GW" quasiparticle theory.
^{3}He: comparison to the electron gas.
Heavy fermion systems.
High-T_c superconductivity (beware - a big topic! - pick a specific aspect).
Josephson effect. SQUIDs. Josephson circuits and qbits.
(See, eg, Physics Today Nov. 2005 p. 42.)
Kondo problem.
Magnetic interactions: superexchange, indirect exchange,
Dzyaloshinskii-Moria interactions, etc.
Neutron scattering in ^{3}He.
Neutron scattering in magnetic systems.
Polarons; Feynman's path-integral solution of the polaron problem.
Quantum hall effect (integral; fractional).
Spin waves in ferromagnetic and antiferromagnetic systems.
Strong coupling theory of superconductivity.
Superfluidity in ^{3}He.
Tunneling in superconductors.
Two-component superconductivity in MgB_2.
Vortices in superconductors, or in superfluid ^{3}He.