

# Physics 602 Term Paper - Due May 4, 2010

Instead of a final exam in 602, I would like you to learn a little bit about a topic not covered in class, and write a short paper about it. I do not want an elaborate paper with lots of equations or detailed descriptions of experimental apparatus, but rather a short, concise exposition ( $\sim 10\text{--}15$  pages) presenting some fundamental physical ideas in the area chosen, that I can read and understand in about an hour. You should include a short bibliography of the works you used in preparing the paper. There are many possible topics you might choose, and I would suggest something that interests *you*. Some suggestions:

- High  $T_c$  superconductors
- Critical Phenomena
- Carbon nanotubes, graphene sheets, etc.
- Density functional theory beyond LDA
- Time dependent density functional theory
- Magnetic materials
- Ferroelectric materials
- Modern theory of polarization - Berry phase
- Superfluid  $^3\text{He}$
- Superfluid  $^4\text{He}$
- Colossal magnetoresistance
- Kondo problem
- Spin waves
- Dislocations and structural defects
- Surface states
- Weak localization
- Quantum dots
- Surface structure and reconstruction
- Quantum Hall effects
- Josephson effects
- Heavy Fermion compounds

- Modern electronic structure methods
- Neutron scattering
- Scanning tunneling microscopy
- Maximally localized Wannier functions
- Dynamical mean field theory (DMFT)
- GW quasiparticle theory
- Polarons
- Magnetic interactions: superexchange, indirect exchange, etc.
- Charge density or spin density waves; Peierls instabilities
- Multiferroics
- Atomic force microscopy (AFM)
- Angular resolved photoelectron spectroscopy (ARPES)

Many of these are almost fields in themselves, so you will need to choose sub-areas. The choice is by no means limited to the above – they are just examples. Choose something that interests you. I will be happy to discuss your choice personally with any of you who would like that.

Your paper should not be directly in the line of your thesis research. For example, if your thesis topic is tunneling in superconductors, then your paper should not be on tunneling in superconductors. However, a related or complementary topic, such as vortices in superconductors would be appropriate. This brings up another caveat. Since in the above example, we will already already covered in class some material on vortices in in superconductors, if you were to choose that topic, you would be expected to go beyond what was covered in class, and not to regurgitate that material.

It is possible that two students may choose the same or similar topics. That is OK, but you must work completely independently.

I will not base your grade on your mastery of the English language, but I do expect the paper to be printed neatly in large (12pt, i.e., this size) type and formatted so that it is easy to read, and to have been run through a spell checker. Take notice, however, that the ability to write clearly in English is *very important* to a successful career in physics. For this reason, please try your best to polish the English in your paper.

Your paper is due on **Tuesday, May 4 at 1 PM**. I would prefer to receive it in PDF format, but MS Word is OK. If both of these formats are difficult for you, please discuss it with me well in advance. Please **email** your paper as an attachment to me: langreth@physics.rutgers.edu. I will scan the graded paper and email it back to you; please indicate the the email address you want me to use for this on the *cover page* of your paper.