

Term Paper Guidelines
PHYS 798S
Spring 2016
Prof. Steven Anlage

Format: Follow the format of Physical Review A/B/E articles for references, sections, figures, etc. Include an abstract, introductory section (including a brief outline of the paper), and conclusions. This paper may pass as your "scholarly paper" requirement for the Physics Ph.D. program. The paper should be typed in LaTeX (or [REVTeX](#)) and double spaced, 12 pt type or larger. Style and clarity are important in all writing; have a friend proof-read your paper. Please have a native English speaker read and correct the paper. Figures can and should be used, but figures taken from other sources should be referenced. Please include a descriptive figure caption in your own words for all figures. Please have the figures integrated into the text, rather than collected together in a Figure section at the end of the paper. Don't forget to spell check the paper! The length of the paper should be somewhere between 10 and 20 pages.

Plagiarism: You must not steal other people's work. Verbatim copying of passages from other papers, published or unpublished or transparent paraphrasing of other work, is forbidden. You may use the results of other papers, but they must be referenced.

Content: Write an overview of your topic which can be read and understood by the other students in the class. Define terms, avoid the use of jargon, and put things in a logical order. This paper should introduce an intelligent newcomer to the topic. An exhaustive listing of all references in the field, or a repetitive unenlightening summary (in 2004, Smith made wiffnium, with a T_c of 102 K. In 2005, Jones made woofnium, with a T_c of 103 K, etc.) is not desirable. Also please do not choose a topic that is already well documented with wiki pages and review articles, if possible. An understandable discussion of key ideas, simple calculations and estimates, and anything else which indicates that you understand something about superconductivity and can explain it to beginning researchers in the field is desirable.

It is also important to focus the paper and go into quantitative detail on at least one or two aspects of the subject. For example, one should not simply mention a stream of results without any further discussion. Something should be discussed in depth, with quantitative and detailed analysis presented. Also avoid the use of qualitative statements such as "superconducting XYZ devices are clearly superior to normal metal XYZ devices." Give numbers and quantitative justification for all claims. Don't hesitate to introduce equations which illustrate the physics behind your arguments. If you write a paper on an experimental topic, be sure to include a discussion of theory relevant to the experiment. If you write on a theoretical topic, be sure to discuss experimental consequences of the theory.

Please give me three choices of topics in writing by early-March (anlage@umd.edu). To broaden your horizons a bit, choose paper topics that are not directly related to your research. I will assign topics no later than the end of March. Only one person should write on each topic, so please have more than one choice. If you want to write about a topic not on the list, please discuss it with me.

Bonus points will be awarded for anyone who develops a stand-alone "legacy product" that benefits future students and researchers. This could include, for example, code to calculate surface impedance (and 'surface Q' $Q_s = X_s/R_s$), tunneling conductance, and other quantities in BCS theory, or numerical solutions to common problems in Eliashberg theory or the Bogoliubov equations, the BTK model, time-dependent Ginzburg-Landau theory, etc. Another possibility is to create a thoughtful [PhET](#)-like interactive computer simulation/demonstration related to superconductivity. Consult with your instructor!

Please e-mail your paper by 14 April, 2016. A copy will be returned to you with comments, to be rewritten and returned on 5 May, 2016. The 5 May version will be graded.

Possible Topics

Vortex Glass - Vortex Liquid - Vortex solid phase transitions

Exotic vortex phases - Bose glass, hexatic phase, etc.
 Critical behavior of superconductors (heat capacity, thermal expansion, penetration depth, etc.)
 p-wave and d-wave pairing in superconductors and superfluids
 SQUID ground state wavefunction pairing symmetry experiments
 Spin-charge separation, Charge fractionalization, Visions
 Spin fluctuation pairing mechanism in HTS and pnictide superconductors
 Andreev reflection, bound states at surfaces of unconventional superconductors
 Time-reversal symmetry breaking states in superconductors
 Nonlinear Meissner Effect
 Pseudogap phenomenon in HTS - stripe phase
 Neutron spectroscopy of collective modes in HTS
 The Electron-Phonon mechanism in superconductors (including the isotope effect)
 Coexistence of antiferromagnetism and superconductivity in HTS and other superconductors
 Coexistence of ferromagnetic and superconducting order
 S/F/S Josephson junctions, spin-triplet proximity effect
 The Proximity Effect, superconductor/ferromagnet proximity coupling
 C₆₀ superconductors, field-effect in C₆₀ films
 Superconductivity in carbon nanotubes and graphene
 Superconductivity and topological insulators
 Nano-scale superconductivity, proximity effect
 MgB₂ superconducting properties and/or applications
 Leggett mode in multi-band superconductors
 Kosterlitz-Thouless transition in superconducting thin films
 Quasi-1D superconducting films grown on carbon nanotubes
 Hubbard model and HTS pairing mechanism
 SO(5) theory of antiferromagnetism and HTS
 Superconducting X-ray detectors
 Mesoscopic superconductors - Andreev scattering, Andreev billiards
 Infrared and Optical properties of superconductors - The sum rule in HTS
 Rotating superconductors and the London moment
 The Bernoulli Effect in superconductors
 Electric Field Effect in superconductors
 High Field (>30 T) properties of HTS. Fulde-Ferrell-Larkin-Ovchinnikov State
 HTS and MgB₂ Wire production
 HTS Tape coating methods (Rabbits, IBAD, etc.)
 Vortex imaging techniques (neutrons, magnetic force microscopes, SQUID microscopes, etc.)
 Classical superconducting computers
 Quantum superconducting computers (a focused topic)
 Superconducting kinetic inductance single-photon detectors
 Transition edge sensors
 NMR measurements in superconductors
 Ultrasonic attenuation in unconventional superconductors
 Magnetic and non-Magnetic impurities in HTS
 Angle-Resolved Photoemission spectroscopy (ARPES) of the Fermi surface and energy gap in HTS
 High-field quantum oscillation measurements in cuprates and other superconductors
 STM and tunneling spectroscopy of superconductors
 Marginal Fermi Liquid theory of HTS
 Organic superconductors
 Transport properties of HTS with $H > H_{c2}$
 Hall Effect in LTS and HTS
 Nernst Effect above T_c in the pseudogap region
 Fluctuation diamagnetism above T_c in the pseudogap region
 Theory of and Evidence for a Quantum Critical Point in the HTS phase diagram
 Room temperature superconductivity – where is it? What would it look like? Do we already have it?
 Practical utility of room temperature superconductors
 Extremely low-level measurements using SQUIDs

Superconductivity in the presence of spin imbalance
Superconducting experiments and detectors operating in earth orbit and beyond.
Superconductivity in the gravity-Probe B experiment
Using metamaterial structures to modify the superconducting pairing interaction
Hydrogen-based superconductivity

Some Previous Term Paper Titles:

Transport Properties of the Electron-doped Superconducting Cuprates
Superconductors for Wireless Applications
Imaging Techniques for Vortices in Superconductors
Scanning Tunneling Microscopy and Scanning Tunneling Spectroscopy on Superconductors
Extremely Low-Level Measurements Using DC SQUID
Report on Rapid Single Flux Quantum (RSFQ) Logic
Proximity Effects of Superconductors
Infrared and Optical Properties of Superconductors
Extremely Low Level Measurements Using SQUIDS
Kosterlitz-Thouless Transition in Two-Dimensional Superconductors
Manifestations of the Casimir effect in superconductors

Superconductors in Rotation
Superconductors in the presence of weak inertial and gravitational fields
The pseudogap of the angle resolved photoemission spectroscopy and the resonating valence bond model in
high temperature superconductors
Thermally-Driven Melting of the Vortex Lattice
Quantum phase transition: in cuprate superconductors
High- T_c Superconductors and the Hubbard Model
Models for the proximity effect
Chaos and Nonlinear Dynamics in Josephson Junctions
Vortex Imaging Techniques
Magnetic Levitation with Superconductors
Andreev Reflection