



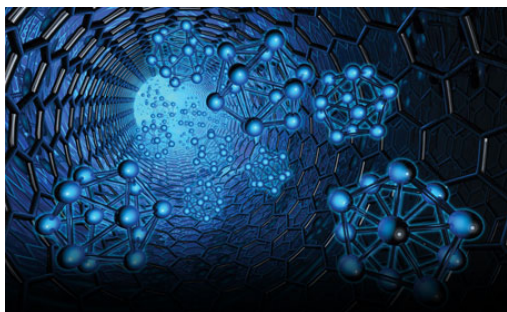
## the Carroll Research Group

Center for Nanotechnology and Molecular Materials  
Wake Forest University ♦ 501 Deacon Blvd ♦ Winston-Salem NC ♦ 27105

### ***Our Work***

The Carroll Research Group works at the interface of Materials Physics and Device Physics with an emphasis on nanoscale phenomena. Currently our research program addresses:

- **energy related technologies:** photovoltaics, thermoelectrics, high efficiency lighting, active coloration and signature modification,
- **biosensing and bioelectronics:** strain, pressure and gas sensing, analyte recognition enhancement based on self-gain sensing platforms, cyborgnetics (integration of sensors and living tissue)
- **advanced materials development:** metamaterial structures and new nanostructures.



The electrical, thermal, optical, and mechanical properties of macro-materials are typically dominated by internal heterogeneity. Grain boundaries, phase boundaries, occlusions/defects and compositional gradients can all have dramatic effects on the measured properties. Such effects are naturally occurring at the micron scale. However, when materials are constructed in which the heterogeneity occurs across nanometer length scales, vastly different properties can be obtained.

The work of the Carroll group:

- examines the origins of the macroscopic properties of nanocomposites, nanofilms, and matrix nanocomposites using fundamental models of nanoscale interactions as a foundation,
- develops new approaches to device applications based on the novel properties these matrix nanocomposites may express.

### ***Our Scientific Goals***

Our group is dedicated to the highest possible standards in the conduct, presentation, and reporting of our research. Our goal is to be always engaging in the national dialogue in nanosciences and the technologies developed from them. We strive to be at the forefront of new phenomenology, exploring new vistas and new paradigms, and continually embracing new directions. The hallmark of our work is the uncharted territory. Our vision is to challenge the conventional, and stimulate the development of new avenues of thinking

## Our Goals of Self-Actualization

To achieve the best in science we must achieve the best from ourselves. To do this we will:



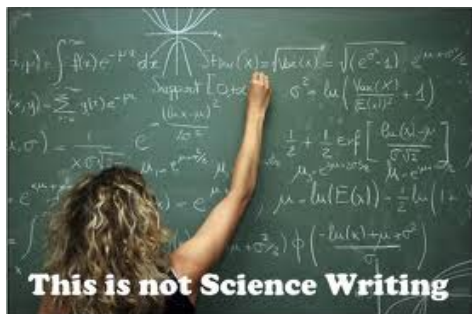
### *think like a scientist:*

- Demonstrate the ability to calculate and estimate outcomes, test a hypothesis theoretically based on current literature, fit data and present it graphically.
- Demonstrate a superior knowledge of current literature in the field and be able to comment on that literature coherently.
- Guard against biased skepticism and blind optimism. Be open to being wrong, be willing to accept other ways of looking at things, consider as a possibility that the majority of scientific thought may provide acceptable insights.
- Demonstrate the ability to come to conclusive statements regarding data and understand its broader implications in the scientific narrative.
- Clearly develop the ability to work independently, understanding next steps and how to ask questions scientifically.
- Take an interest in coworkers projects attend their talks.
- Demonstrate a knowledge of laboratory safety and basic biological impacts of their work.



### *work like a scientist:*

- Develop a working relationship with other group members and with Prof. Carroll.
- Demonstrate superior laboratory skills using multiple laboratory techniques.
- Be able to address a problem experimentally, carry out investigations in a statistically significant manner, and interpret results correctly.
- Share in group laboratory activities.
- Work outside of the group in a collaborative exchange arranged by Prof. Carroll.



### *talk like a scientist:*

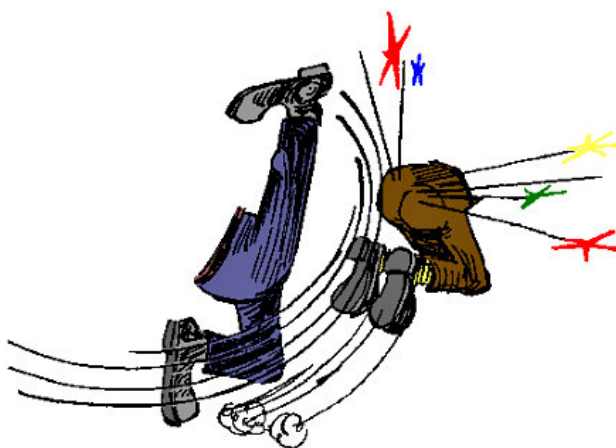
- Demonstrate the ability to communicate scientific findings and understanding in a clear and precise manner, both in written form and in presentations.
- Develop a significant CV with publications and presentations at meetings, along with a record of collaborative work.

## Rules/Expectations

To be a member of this research group, there is a set of rules/expectations by which we **ALL** abide.



**1. Prof. Carroll is large and in charge:** Group decisions, research directions, purchases, and other things are based on consultation with senior group members, but Prof. Carroll is ultimately responsible for implementing these decisions. If you have a problem you should come to Prof. Carroll first. If the problem can not be resolved together, then the next step is to go to the chair of the Physics department.



**2. Continuing membership in the group is conditional:** Every attempt will be made to help students and postdocs integrate into the group. But, sometimes the fit just isn't there. You must have:

- *Laboratory skill -*
- *Enthusiasm and dedication to research -*
- *Progress in research goals -*
- *Integration and service within the group -*
- *Academic performance and progress -*

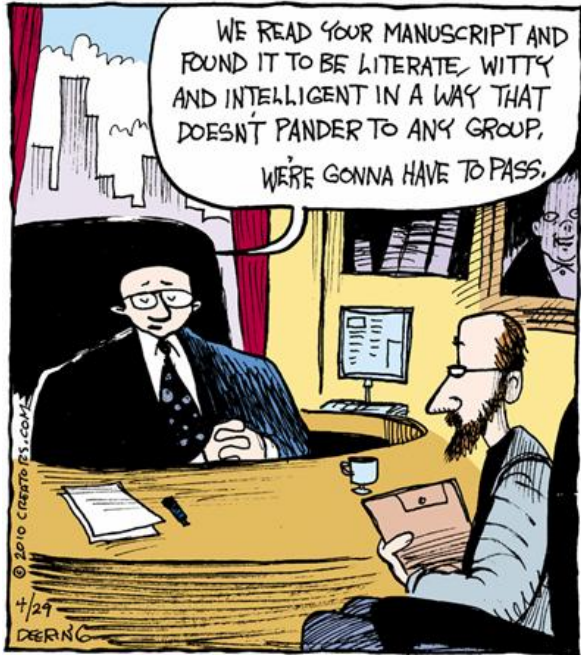
Group members not meeting expectations will receive a written evaluation outlining their disposition and be given an opportunity to discuss and fix the situation.



**3. Financial support from the group is not guaranteed:** Funds come from specific programs that are managed and reviewed. Continued funding is based upon:

- *Satisfactory completion of any course/academic responsibilities-*
- *Demonstrated excellence in laboratory work-*
- *Demonstrated service to the group-*
- *Progress on project assignments-*
- *Availability of funds-*

It is important to realize that our funding comes from people with expectations. Some of these expectations align with your thesis or publication imperatives, and some are deliverables for demonstration purposes, characterization of materials, etc. We try always to balance these expectations so that enough science is there to make it interesting. But that doesn't mean that the deliverables don't have to be met. Remember, even Dirac worked on transmission lines for the phone company. This is the nature of applied research funding.

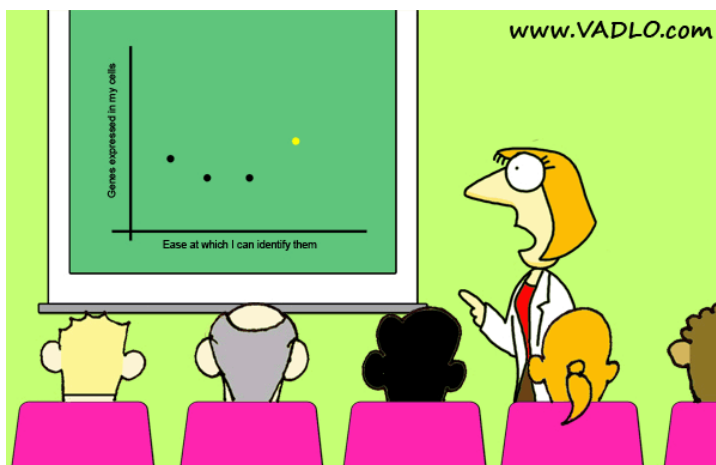


**4. If you don't publish it, patent it, talk about it - it doesn't count:** We define adequate progress in research as:

*Publication of results in acceptable journals - PhD. Candidates are expected to produce > 10 publications before graduation. > 5 of these should be first author. Postdocs and research staff are expected to publish no fewer than 4 papers per year of which two must be first author. All members of the group are expected to prepare one review article of their field for publication during their stay. This can be done in conjunction with other group members, but each student, postdoc, or research staff member must be able to show his/her significant contribution to the work. All publications **MUST** list funding source and Prof. Carroll as corresponding author unless specified otherwise. (See appendix for format)*

*Patenting of technology developments – in some outstanding cases, technologies developed within our labs can be patented and may lead to commercial products. Students are required keep appropriate notes and testament of dates for data when working on technology related projects. Approach to OTAM is always done in conjunction with Prof. Carroll.*

*Presentation of results at international level conferences – all graduate students and postdocs are expected to present research findings at one international level meeting per year. Only published work (or submitted work) may be presented and arrangements must be approved by Prof. Carroll. The Lab can offer travel support for funded programs and occasionally per diems.*



“Same graph as last year, but now I have an additional dot.”

**5. You must come to meetings and you must prepare:** All group members are required to attend general and team group meetings. Group members are expected to present progress updates at each meeting. Typically, one or two slides with data is expected each week. In consultation with Prof. Carroll you will also be occasionally asked to provide a topical overview (a few slides) of advanced issues in your thesis area. You should expect this once a month or so.





**6. You must work a full week:** All laboratory personnel are expected to provide a reasonable (40 hour) work-week. The laboratory operates from 8:00 am until 5:00 pm Mon. – Fri. and group members are expected to be at the labs during this period – at a minimum.

- *If you TA or are taking classes you must still make progress in your research and show up every day at the lab for some work time. A minimum of 10 hours per week research time is expected in the case of TA + classes. Otherwise a minimum of 20 hours per week is expected.*
- *Six weeks of leave with financial support (if receiving such support) per year is allowed. This includes sick leave, official University holidays, national and religious holidays. Excessive, unapproved leave, not health related, may result in a delay in graduation, or dismissal from the group.*
- *All leave schedules must be coordinated among other lab workers and approved by Prof. Carroll.*



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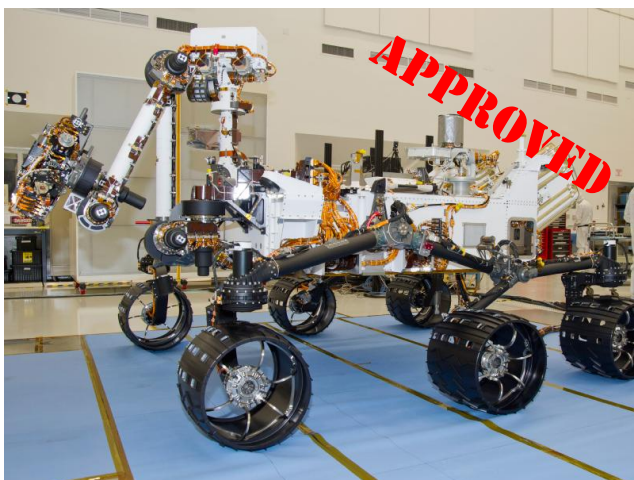
**7. No information may leave the lab:** It is the policy of the laboratory that no information of any type may leave the laboratory without the direct permission of Prof. Carroll. This policy extends to the submission of publication manuscripts, grants, white papers, or the writing of joint grants. All information and data collected by Carroll group members is property of the lab and Wake Forest University. It is *not* personal property. Any data, results, or experimental details released without Prof. Carroll's approval, in *any form*, including: email, written, oral presentation, conversations with campus or outside collaborators, etc. will result in immediate dismissal from the lab and forfeit of financial support *from the time of disclosure*. In certain extraordinary cases, blanket permission may be given to interact freely with group collaborators.



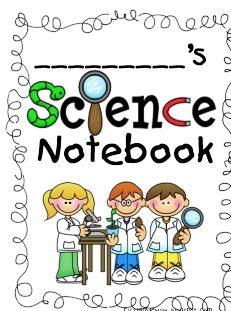
phillipmartin.info

**8. BE INTERESTED!** Group members are expected to interact with visitors and collaborators of the lab, as established by Prof. Carroll. Be courteous, punctual, and focused in your interactions. Respond to emails and calls right away. Discuss the scientific problems they are posing and find new approaches to help.

*In all cases it is Prof. Carroll who is responsible for establishing collaborations, providing initial correspondence and data, and arranging visits or exchanging information.*



**9. Only buy things with Prof. Carroll's permission:** All purchases and official travel must be approved by Prof. Carroll.



**10. Lab notebooks are VERY important:** Each researcher should keep a single notebook for all work performed in the laboratory. There will be occasional inspections of lab notebooks and notebooks remain the property of the Carroll

group. Originals must be turned in when you leave the group. *In the appendix there is a pretty extensive format for notebooks that is standard in laboratories across the world.*



**11. If you use our equipment and/or funding, you must agree to these rules.** Research Faculty and Research Staff are expected to abide by the rules of the group as fully participating group members. While it is recognized that such positions afford a greater level of independence; support from the group (through salary, use of non-centralize facilities, etc.) requires that the group's head (Prof. Carroll) be informed and involved in ALL activities relevant to the group and its facilities. This includes writing grants, publications, guiding students, establishing collaborations, etc. This is in keeping with the general operating

procedures of Wake Forest University and in general agreement with accepted practices at peer institutions.

**12. Graduate students must complete the Carroll Group Curriculum.** The Carroll Group has its own expectations as to the base of knowledge you carry with you. This will supply you with the background and language necessary to function within the group.

- Graduate students must complete the requirements of the graduate school for a PhD. in Physics. This should also include the two solid state physics courses offered by the Physics Department.
- Graduate students must complete the courses on electron microscopy and surface analysis offered at the NanoCenter. These are 1.5 credit hour special topics courses.

- Graduate Students have three texts they should complete through self-study over the course of their first four years. These texts should be read throughout and ALL the problems presented should be worked. They are:
  - Ibach and Lüth *Solid State Physics*,
  - Israelachvili *Intermolecular & Surface Forces*,
  - Roth and Carroll *One Dimensional Metals* (read only)

A complete working knowledge of all topics covered in these texts will be assumed at the end of the fourth year. Prof. Carroll will be available for discussions and help with problems as you go. But it is important to realize this as a minimum of knowledge in our field. Forming study groups for these self-study components is encouraged. Senior graduate students are expected to help tutor and discuss with junior graduate students. You should keep Prof. Carroll informed of your progress.



Yes, this is a lot of additional work – when added to the classes you must take for the PhD. And, the topics in these works are not typically covered in our Solid State classes. Also, it doesn't substitute for reading current literature. But remember, you are becoming a specialist in an area in which more than 70% of practicing physicists work. It is important to know the main features of the work that has come before. So make it a habit – each night – to cover some of these texts and become adept at solving the problems in them. When you go for your first interview as a postdoc – you will be really glad you know about the breadth and depth of this fascinating field of study.

You will also be surprised at just how much this elevates the quality of your work now! Making contextual links to the rest of the field is essential to being a truly mature thinker.



## **Appendix:**

**Publications** must follow the procedure here:

- *Give referencing, excellent clear writing, and precision a top priority in each manuscript.*
- *Construct a full manuscript in the format of the target journal. This should be complete with images, references, etc. Have coworkers check English and grammar before handing it to Prof. Carroll.*
- *After Prof. Carroll has approved the manuscript, the manuscript must be then submitted to all co-authors for approval. They are to be given one week for reply. This should be explained clearly and politely in the email using the phrase "I would like to submit by (date)..."*
- *If corrections are submitted, they are to be made and the manuscript (with support information) returned to me for final approval.*
- *Submit the manuscript and inform all co-authors.*
- *When reviews are returned begin on corrections and a response immediately.*
- *After Prof. Carroll's approval submit response to co-authors with a timeline for submission to the journal.*
- *Resubmit.*
- *The review process takes time, so be patient. Each two months that a paper has been out for review, please send a polite reminder to the editor regarding the manuscript's status. This is YOUR responsibility.*

It is important to realize that publishing a paper represents a serious commitment to your colleagues. Remember, your colleagues and co-authors trust you to perform the steps above in a serious and professional manner.

### **Patent applications and filings (if applicable)**

Patent applications must be cleared through Prof. Carroll before OTAM is approached.

### **Presentation of results at national level conferences**

All members are expected to present new research results at a minimum of one professional meeting per year. To submit an abstract to a meeting, it must first be cleared through Prof. Carroll. Once accepted, YOU are responsible for arranging travel and accommodations. Generally, the lab will cover travel and lodging in some form for funded programs.

Presentations should be practiced in front of the group before you go. Posters must be approved.



## Lab Notebooks Format

The cover should show:

- Your name.
- The laboratory name "NANOCENTER, Carroll Group".
- The department address
- Your phone number and email address
- The date you started in the laboratory.

Your laboratory notebook should contain a credible record of everything you have done. This is your documentation of your data and should be complete.

- It should show the time and date you started any experiment.
- When any experiment is interrupted or stopped you should have a sentence explaining the situation and the reason as well as the time.
- You should do the same thing when you leave the lab for the day.

This is a working notebook and everything should be written in ink. You should write on every page, or alternatively use only front page and leave all back pages blank. Make your choice and stick to it. Fill in every page. If you want to start a new page for any reason, put an X through the blank region. Do not use white out. If you need to make a correction draw a single line through the wrong material and initial it. It should be legible under the line. It is perfectly reasonable to tape figures, diagrams, or sections of relevant articles into your lab book. This book is to allow you to go back many months from now and understand what you did from that information.

Information that should be included in your laboratory notebook :

- Objectives
- Questions
- References to publications, or part of an article itself
- Drawings of apparatus, circuit diagrams
- Data
- Calculations
- Graphs
- Interpretations
- Conclusions
- New ideas.
- Experimental Improvements

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