



Official guide to the

## Carroll Research Group

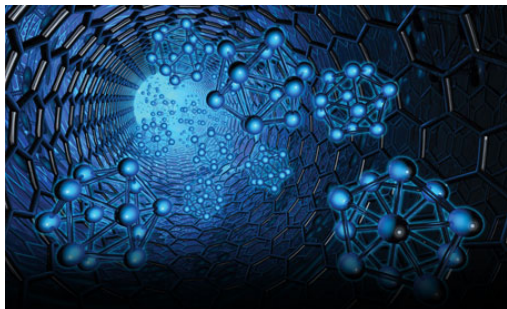
Founding members of  
The Center for Nanotechnology and Molecular Materials  
Wake Forest University • 501 Deacon Blvd • Winston-Salem NC • 27105

### *Our Work*

The Carroll Research Group works at the interface of Materials Physics and Technology Physics with an emphasis on nanoscale phenomena. Currently our research programs address:

- **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. Our work: 1) examines the origins of the macroscopic properties of nanocomposites, nanofilms, and matrix nanocomposites using fundamental models of nanoscale interactions as a foundation, and 2) develops new approaches to technology/device applications based on the novel properties these matrix nanocomposites may express. A key component of our intellectual directive is to answer questions of critical need in human society.

### *Our Goals as a Group*

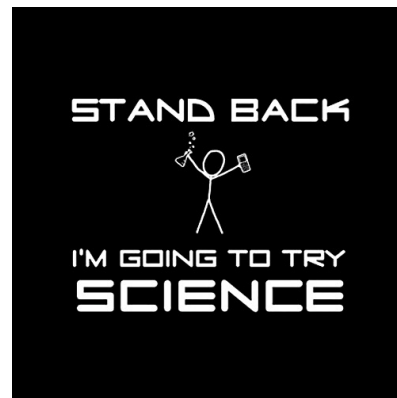
Our group is dedicated to the highest possible standards in the conduct, presentation, and reporting of our research. Our goal is to be always engaging in the national dialogue in nanosciences and the technologies developed from them. We strive to be at the forefront of new phenomenology, exploring new 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 this end, all members of the group agree to embrace the following tasks:

### *think like a scientist:*

1. Demonstrate the ability to calculate and estimate outcomes, test a hypothesis theoretically based on current literature, fit data and present it graphically.
2. Demonstrate a superior knowledge of current literature in the field and be able to comment on that literature coherently.
3. 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.
4. Demonstrate the ability to come to conclusive statements regarding data and understand its broader implications in the scientific narrative.
5. Clearly develop the ability to work independently, understanding next steps and how to ask questions scientifically.
6. Take an interest in coworkers projects attend their talks.
7. Demonstrate a knowledge of laboratory safety and basic biological impacts of their work.



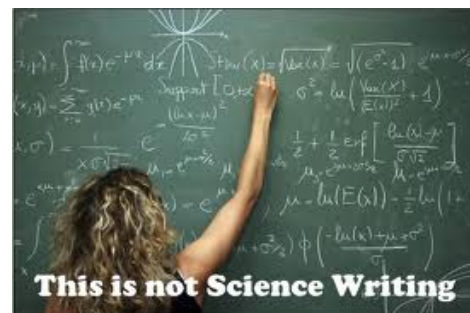
### *work like a scientist:*

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



### *talk like a scientist:*

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

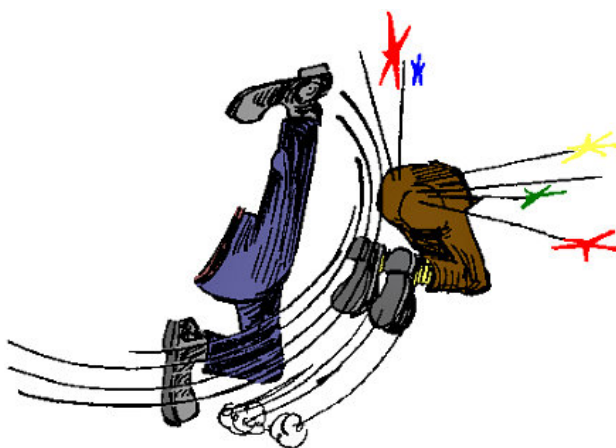


## Rules/Expectations

Our group is relatively loose, with each member being an equal portion of the whole. There aren't as many rules as in some other groups you may know, but there are a few rules/expectations by which we **ALL** abide. To be a member of the group you must agree...



**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 cannot 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 -*

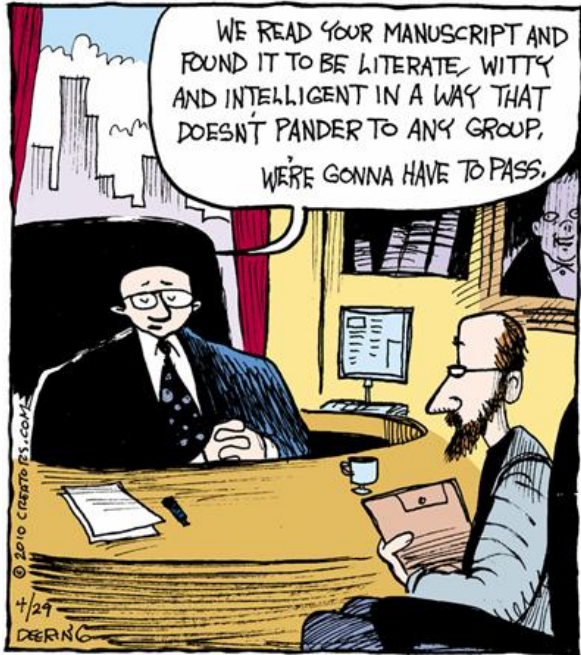
Group members not meeting expectations will receive a written evaluation outlining their disposition and be given an opportunity to discuss and fix the situation.



**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.

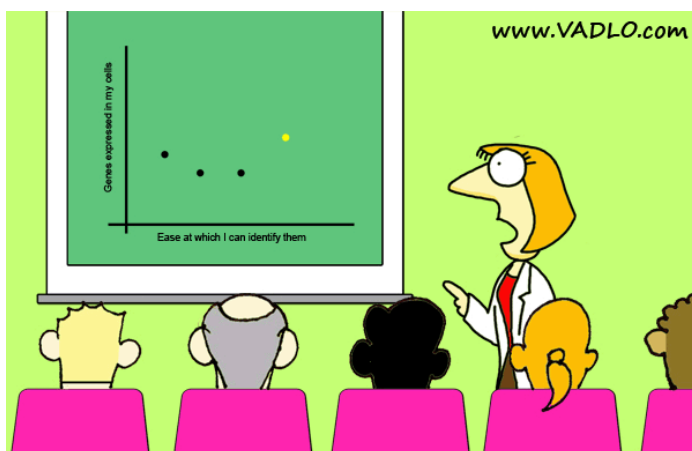


**4. If you don't publish it, patent it, talk about it - it doesn't count:** We define adequate progress in research as:

*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 – 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 WFU is always done in conjunction with Prof. Carroll. **All intellectual property developed in our labs belongs to WFU and WFU will seek assignments for management from all staff/students/undergraduates of our group** – but they usually share the proceeds, so this is a good thing!*

*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 occasionally.





**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, loss of pay, or dismissal from the group.*
- *All leave schedules must be coordinated among other lab workers and approved by Prof. Carroll.*



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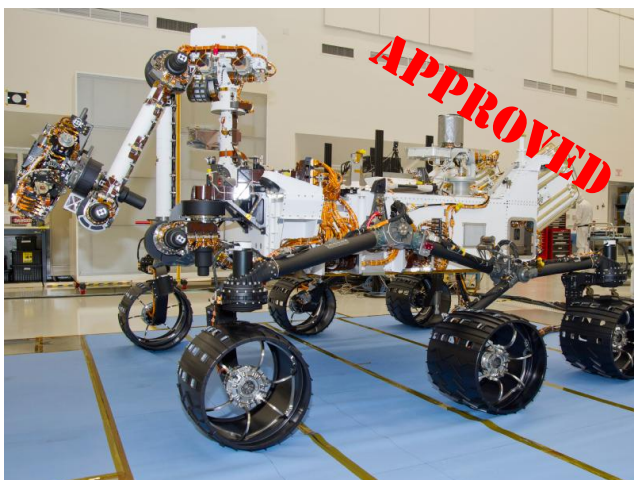
**7. No information may leave the lab:** It is the policy of the laboratory that no information of any type may leave the laboratory without the direct permission of Prof. Carroll. This policy extends to the submission of publication manuscripts, abstracts, grants, white papers, or the writing of joint 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.



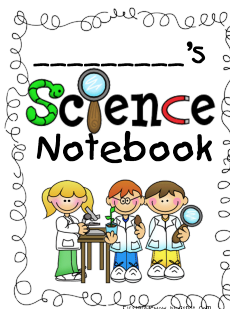
phillipmartin.info

**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

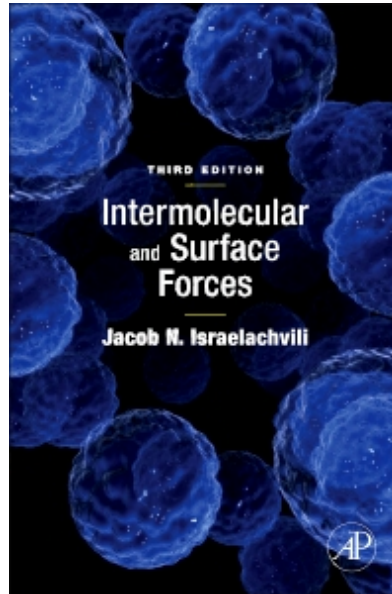
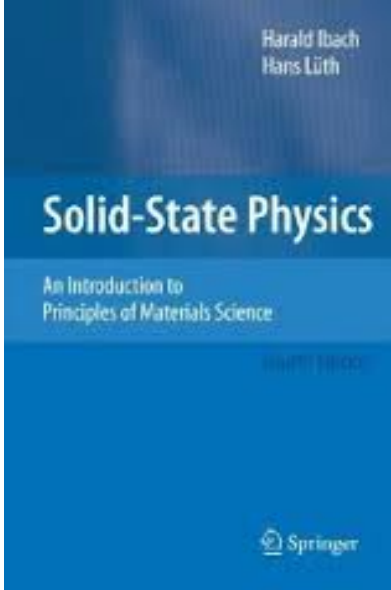
group. Originals must be turned in when you leave the group. *In the appendix there is a pretty extensive format for notebooks that is standard in laboratories across the world.*



**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 should complete the Carroll Group Curriculum.** The Carroll Group has its own expectations as to the course preparation of its students. Together with the completion of the required PhD coursework, each graduate student should make arrangements for the following:



- Graduate students must complete the graduate solid-state physics course offered by the Physics Department. (at the level of Ibach and Lüth)
- Graduate students must complete the courses on microscopy (Carter and Williams: Electron Microscopy) and nanomaterials (Roth and Carroll: One Dimensional Metals) offered at the NanoCenter. These are 1.5 credit hour special topics courses.
- Graduate Students should complete a self-study of Israelachvili Intermolecular & Surface Forces,

A complete working knowledge of the topics covered in these texts will be assumed at the end of the fourth year. Prof. Carroll will be available for discussions and help as you go.

Yes, this is a lot of additional work and is added to the classes you must take for the PhD. But, these topics are not typically covered in a basic physics curriculum. So to become a “specialist” in the area of nanoscale physics, you will need to supplement classwork. Remember that more than 70% of practicing physicists work in solid-state fields and a large number of those in nanoscopic physics. Your knowledge of the foundations makes you competitive.

Importantly, this doesn't substitute for reading current literature. You should develop the habit early on, to cover some aspect of recently published relevant work – each night. When you go for your first postdoc interview 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. So daily reading should be a part of your life from here on out.

## **Appendix:**

### ***How to submit a paper***

Publications are our primary product as a group. They are how the world first finds out about our work and they establish your (and the group's) reputation. So, care must be given to the preparation of every manuscript ~ remember it reflects the whole group.

There are a few rules that must be observed when submitting a paper from the Carroll Group.

- 1) Prof. Carroll must be consulted before the manuscript is constructed. Target journals, and a rough outline of the topical areas will be decided in this meeting.
- 2) Prof. Carroll is always to be the corresponding author.
- 3) Funding sources must always be listed.
- 4) All coauthors must be informed and have a chance to read the manuscript before it is submitted.
- 5) Prof. Carroll must give final approval for submission.

Unlike some research groups, you will be expected to write your own papers, either on your own or with the help of coauthors. However, in the Carroll Group we use a specific format for scientific writing. So how do we write a paper?

1. Outline the flow and points of the paper (this can be done in step one above). The paper must contain the following:
  - a. An introduction that ties the main thesis of this work into the larger community. It answers questions of why are we interested, what problem has been addressed and what did we do that was so important. A large number of references.
  - b. An experimental section that includes exact details of the experiments that were made, details as to precision and accuracy, error estimates, and isolated variables. (so details can be provided in an addendum). Fewer references.
  - c. Results and discussion section that examines raw data, converts this data into parameters that address what was sought, and explains the data. This section should also contain how this data justifies the overall purpose of the paper. Again fewer references.
  - d. A summary statement that reiterates the main points and summarizes the findings.
2. Check the target journal to see if they provide a template. If so, download this and use it to know where the pieces fit in. If there is no template available, write the paper in the order given above.
3. Once all references and data are in place, the format of the paper is correct, THEN submit to Prof. Carroll and Coauthors for review. Work on the introductory letter to the editor during this time.
4. After the paper is finished with all corrections and the letter is written and Prof. Carroll has agreed, then the paper should be submitted.
5. You are responsible for keeping up with its progress through the review process once it is at the editor.



Of course, writing style differs from person to person, and each person should choose their own style. To do this, choose several of the most important papers from the target journal and try to emulate the style as closely as possible. As a general rule, you should follow the following methods:

1. Avoid the use of idioms, humor, or repetition. The paper should be to the point as directly as possible. DON'T COPY! Even from your own previous work.
2. Use simple sentence structure, not long complex sentences. This allows for quicker reading and fewer misunderstandings.
3. Each figure should tell its own story. Each figure caption should add details to that story, each text surrounding the figure should further explain the figure. No figure should appear that isn't discussed in the text.
4. Each paragraph should tie in logically with the discussion before it. If there is a jump it should come only under a new heading.
5. References are heavy in the intro, light in the description of experiments, heavy in the discussion and conclusions.
6. The abstract should be short and a complete summation of the important findings of the work. It is not used to describe the problem or argue why it should be studied. It is also not used to define things, so avoid acronyms here.
7. If there is a theoretical part and we are leading the paper, the theory should be included in the results and discussion part of the paper.

### ***How to file Patent applications (if applicable)***

A second and important aspect of what we do is to file for patent protection on the technologies we develop. Patent applications must be cleared through Prof. Carroll before WFU is notified and approached and should be discussed with Prof. Carroll before they are prepared.

It is important to realize that the people listed on a patent (the inventors) is a legally defined thing. Inventorship determinations rely on whether a specific researcher can point to any claim within the claim set of the patent, as a thing that originated solely from them from its inception. This means inventorship lies with the person that had the idea (or some part of it), not the person making it happen. In the Carroll Group we take every opportunity to include students and postdocs on patents when it is possible. But the final outcome is determined through interviews and legal judgments. If you have questions please ask Prof. Carroll.

### ***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 Notebook Format***

1. 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 the notebook.
  
2. 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.
  
3. 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. 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.
  
4. 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

END