

Physics Department Senior Design Project Proposal

Project Mentor: Prof. Lincoln Carr, 303 273 3759, lcarr@mines.edu and John Scales, 303 273 3850, jscales@mines.edu
(Name, phone, email)

Project Title: Computational Physics: Anderson Localization of mm-waves in a 2D Hexagonal Lattice

Project Type: [] Team; Number of students _____ [] Honors

Objective

(What is the science and/or engineering in this project?)

To model Anderson localized modes of mm-waves to compare to experimental data in a 2D hexagonal lattice. The simulation tool is an open source code called MEEP which models Maxwell's equations with finite element methods. A possible extension to model Dirac quasi-particles in the same system will be available upon completion of the first project. Modeling in all cases will require physical analysis and some supporting analytical work.

Prior Background

(What is the history of your involvement with this topic, including previous student projects?)

We had a previous senior design project with 1 student (2006 – 2007) which led to a Physical Review B publication on Anderson Localization in 1D. This is the extension of that work to 2D. Preliminary use of code has already been prototyped by a summer REU student, so we now it works.

Student Expectations

(What are the deliverables (in addition to the lab notebook and reports) for the two-semester project?)

Transmission/Reflection/Absorption plots produced by MEEP of mm-waves incident on a hexagonal lattice. Analysis of these plots and comparison to experimental data. Sophisticated thinking about averaging over different ensembles of data, including rotation of the sample and different realizations of random defects in the lattice. Continued thinking about the nature of Anderson localization and how it will manifest in this system.

We expect at least one publication in a leading physics journal out of this work. The student will co-author.

The student will be required to attend theoretical physics seminar (PHGN401) and a one hour team meeting, for a total of two hours per week. The student will present his/her work in theoretical physics seminar once during the year.

This project is suitable for extension to an MS degree. Such an extension is not expected but is encouraged.

Supervision Plan

(Who will be directly interacting with the student(s), you, a post-doc, grad students, or others?)

Physics Department Senior Design Project Proposal

The student will work primarily with Prof. Carr, and interact with Prof. Scales on modeling of experimental data.

Resources

(What equipment, algorithms, and facilities are available, and what will be assembled as part of the project?)

Use of computers in physics. Also computing center in CTLM. Code is open source, and already available.

Technical References

(Identify a few key starting points for the student(s); journal citations, prior reports, instruction manuals, etc.)

1. <http://ab-initio.mit.edu/wiki/index.php/Meep>
2. Schwartz, T.; *et al.* (2007). "Transport and Anderson Localization in disordered two-dimensional Photonic Lattices". *Nature* **446**: 52–55.