Troy C. Messina

CONTACT

messinat@berea.edu
859.985.3326
www.themessinas.net/p/teaching.html

Scholarship

I have obtained three grants since arriving at Berea College. The first grant from the NASA-KY Space Grant Consortium is for $3000. The first grant funded travel and a materials budget to attend workshops for updating our experimental physics curriculum. Although this is a curricular update, I detail in this document the connection between the curricular update and scholarship. With the grant funds I attended two workshops (ALPhA Immersions, an acronym for Advanced Laboratory Physics Association) over the summer and have begun implementing the activities through student research projects in our advanced laboratory course. The second grant ($500) from the Kentucky Academy of Sciences (KAS) funds the design and construction of an existing commercial instrument that currently costs $30-100k. The purpose of the grant work is to create a low-cost version (less than $1000) and distribute the design as open-source for institutions to construct and use for student research projects. The third grant ($5075) is from the Jonathan F. Reichert Foundation, which is follow-on funding for the implementation of the NASA grant described above. The grant proposals and award letters are included in Appendix 5.

As a part of the Advanced General Laboratory course (PHY341) two students are working on projects related to the grants. A project related to the ALPhA Immersion workshops is underway and will eventually become a student laboratory in our Modern Physics or Quantum Mechanics course. The project related to the KAS is constructing what is known as an atomic force microscope (AFM). This instrument will be used for my research in materials science. An atomic force microscope is capable of measuring features on surfaces at nearly atomic resolution. It is used to characterize materials in the form of films, where nanometer-scale variations may be important for the material characteristics. The AFM can also be used to characterize biological and chemical systems. Therefore, it may find application in collaborative work with Nick Marshall and Matthew Saderholm in Chemistry or Dawn Anderson in Biology.

Another student project in Advanced General Laboratory is the construction of a system for depositing high quality, high purity thin films. One area of materials physics is the study of material properties at the nanoscale, where quantum mechanical effects can dominate. This research is relevant as computer integrated circuits become smaller and higher density. The deposition system, atomic force microscope, and existing instrumentation in the physics program such as an x-ray diffractometer and magnetometer make a nice set of characterization tools for a very high quality materials physics lab. For the processes and measurements I cannot make, I have an established collaboration with a colleague at Rochester Institute of Technology, who has a complementary set of tools. Either we can make exchanges of work, or students can go to Rochester during summer research to work in my collaborator's lab.

Several of the research projects I am overseeing in advanced lab will eventually turn into publishable research results. I have applied to the URCPP program for summer 2016 with the hopes of continuing these lines of research as a mentor of Berea students. Students will have the opportunity to present their work at a regional or national meeting or both. For example, the student working on the AFM presented at the Kentucky Academy of Sciences meeting in November. A faculty from Northern Kentucky University stopped at his poster presentation. Her research uses routine AFM analysis. She was impressed enough with his work that she informally offered him a summer research position in the summer of 2016.

In parallel with these student research projects, I am wrapping up a molecular dynamics computer simulation project that appears it will produce publishable results. I am currently at the mercy of the simulation software, as it must run until it finishes, and this has no concrete end. The work consists of four separate simulations, and three have completed. I foresee the fourth completing in the next 6 months, and (with cross-fingers) a paper submitted by the end of next summer (2016).

My work in computer simulations of biological systems has garnered some external interest. Below I detail a manuscript that was solicited from a journal. I also recently submitted a book chapter for Springer Publishing to appear in a book titled “Methods in Molecular Biology”.

Finally, I am talking with Matthew Saderholm to see if there are collaborative overlaps in our expertise. I believe we may develop a collaborative research project over the next year or two that will involve students at the intersection of biology, chemistry, and physics.

Pedagogical Scholarship

I have submitted two journal publications since arriving at Berea College. One was an invited publication from Biochemistry and Molecular Biology Education (BaMBEd), which has been accepted for publication and should appear in print in January 2016. The manuscript describes teaching students the basics of a computer programming technique that is used broadly in physics, chemistry, and biology known as molecular dynamics. It goes on to introduce students to professional-grade, freely-available molecular dynamics software. They perform simulations and analyze their results in the context of various known laws of physics. This provides them with a deeper understanding of very complex molecular systems such as DNA, proteins, enzymes, etc. through application of Newton’s Laws. The second paper has also been accepted by BIOSCENE. It is a pedagogical module for improving student understanding of diffusion, a mode of motion that most chemical and biological systems use. The paper details lab activities and an assessment tool. The coauthors and I have used the assessment tool at four institutions and shown that students’ scores double after the activities. This is a large improvement over previous methods that have been published. Both manuscripts are included in Appendix 6.

Book Chapter

I was solicited to submit a book chapter for Springer’s Methods in Molecular Biology Series titled *In Vitro Mutagenesis: Methods and Protocols*. The chapter as submitted on December 31. It details experimental methods related to the molecular dynamics simulations described

above. The audience for this book is practitioners of molecular methods in biophysical chemistry. A draft of the chapter is included in Appendix 6.