Christopher Moakler

Contact cmoakler@gmail.com

Profile & Research Interests

I work at the intersection of mathematics, physics, and computer science to further understand physical phenomena. My thesis work was aimed at understanding granular materials, which I studied by adapting and extending numerical methods from computational chemistry and, during my postdoc, I branched out into studying chemical and mechanical systems. I hope to return to my thesis work and explore the applications of it beyond just granular materials. I am also interested in applying numerical methods to physical systems more generally. My background and expertise in these areas makes me well suited to explore this fascinating interface.

Education

University of North Carolina at Chapel Hill, Chapel Hill, NC

Ph.D., Physics and Astronomy (Fall 2016 – Summer 2021)

M.S., Physics and Astronomy (Fall 2016 – Spring 2020)

Stevens Institute of Technology, Hoboken, NJ

M.S., Mathematics (Spring 2014 – Spring 2016)

B.S., Physics (Fall 2012 – Spring 2016)

Research Experience

Johns Hopkins University Applied Physics Laboratory

Force Projection Sector **September 2023 – Present**

- I work with engineers and analysts from varied groups at the Applied Physics Labs to develop tools and analysis techniques for intelligence, surveillance, and targeting applications.

University of Maryland, College Park

This research was funded by an Air Force Multi University Research Initiative (MURI) grant titled Analysis and Synthesis of Rare Events. Award number FA9550-20-1-0397.

Stochastic Nonlinear Oscillators **Fall 2022 – Summer 2023**

- Working with Professor Maria Cameron, I implemented a method to study stochastic nonlinear oscillators by determining the committor function associated with transitions between stable states. This is done by approximating the system as a discrete markov process and obtaining the transition matrix from numerical simulations.
- Implemented code to run multiple stochastic nonlinear oscillator simulations in parallel.

Hydrocarbon Pyrolysis Modeling **Summer 2021 – Fall 2022**

- Collaborated with Professors Cameron and Evan Reed to develop a new method of predicting the products of hydrocarbon pyrolosis. This method uses data from Molecular Dynamics (MD) simulations to approximate the hydrocarbons as realizations of a Random Graph. This method allows one to predict the size distribution of the products of hydrocarbon pyrolysis orders of magnitude faster than running MD simulations.
- Parsed and analyzed data from MD simulations to assist in devising a simplified model.

University of North Carolina at Chapel Hill

The Hydra String Method and Granular Dynamics **Fall 2017 – Spring 2021**

- Under the supervision of Professor Katherine Newhall, I implemented a novel means to explore and map the Potential Energy Landscape of granular materials. Using this novel method, the Hydra String Method (HSM), the local energy minima and first order saddle points are mapped on a connected bipartite graph with which we intend to predict the dynamics of granular materials undergoing slow shear.
- Implemented a novel computational method and optimized it to run on the university's parallel super-computing cluster.
- Devised numerical experiments to assist in executing and optimizing the HSM on any function.

Stevens Institute of Technology

Coagulation Equation **Fall 2014 – Spring 2016**

- Under the supervision of Professor Pavel Dubovski, I implemented a solver for the Smoluchowski and Safronov-Dubovski Coagulation Equations.

Teaching Experience

University of Maryland, College Park

Computational Methods **Spring 2022 – Present**

- Instructed senior undergraduate and graduate students in computational methods suitable for scientific or engineering applications.
- Overhauled the course to be project based to better assess students ability to implement the various methods presented in class.
- Assisted and advised students on independent projects to solve a problem of the student's choice using a computational method not presented in class.

Multivariable Calculus **Fall 2021**

- Instructed undergraduate students in introductory multivariable calculus.
- Created course material to convey the topics through illustrative examples and intuitive graphics.

University of North Carolina at Chapel Hill

Advanced Laboratory Teaching Assistant **Spring 2020**

- Instructed and advised senior undergraduate students in the execution and presentation of well-known modern physics experiments.
- Graded student reports and laboratory notebooks.
- Met with students outside of class to reinforce and mentor on tough concepts.

Electronics Laboratory Teaching Assistant **Fall 2017 – Spring 2020**

- Instructed and graded undergraduate students in intermediate electronic circuit design and troubleshooting.

Introductory Physics Teaching Assistant **Fall 2017 – Spring 2021**

- Utilized the studio format to instruct and guide introductory physics students in course material.
- Initiated, facilitated, and moderated classroom discussions.
- Graded student assignments and examinations.
- Evaluated and revised course content, materials, and methods of instruction.

Introductory Astronomy Teaching Assistant **Fall 2016 – Spring 2017**

- Instructed students in basic astronomy concepts and assisted them in utilizing remote research-grade telescopes to obtain and analyze their own images of astronomical objects.

Stevens Institute of Technology

Peer Tutor **Spring 2013 – Spring 2016**

- One-on-one tutoring of undergraduates in a variety of undergraduate courses.

Review Instructor **Fall 2014 – Spring 2016**

- Created and presented review materials for Physics I and Calculus II in a large recitation format with 200+ students.

Teaching Assistant **Fall 2014 – Spring 2016**

- Supervised and instructed undergraduate students in the design and construction of electronic circuits in a laboratory setting.

Service & Mentoring

University of Maryland, College Park

Graduate Student Mentoring **Spring 2023 – Present**

- Perrin Ruth: Perrin is a graduate student in the Applied Mathematics & Statistics, and Scientific Computation program whom I am helping to mentor. He is working on the hydrocarbon pyrolysis modeling project. In particular, he wants to further apply graph theory to the study of these chemical systems. He believes that more physical features of the hydrocarbons can be understand as a direct consequence of their graph structure.

University of North Carolina at Chapel Hill

Physics Graduate Student Association President **Fall 2020 – Spring 2021**

- Represented the physics graduate students to the physics faculty and coordinated the Physics GSA committees.

Graduate Studies and Affairs Committee Member **Fall 2018 – Spring 2021**

- Represented the physics graduate students on the physics faculty Graduate Studies and Affairs Committee.
- Assisted in the overhaul of the first-year graduate curriculum.
- Assisted in revamping the quantum and astronomy graduate curricula.

Physical Applied Mathematics Seminar Coordinator **Fall 2020 – Spring 2021**

- Coordinated the speakers at a weekly seminar that brought together people from various fields who were connected by their use of applied mathematics.

Publications

Journal Papers

[1] Dufour-Decieux, V., **Moakler, C.**, Cameron, M., Reed, E.J. "Predicting Molecule Size Distribution in Hydrocarbon Pyrolysis using Random Graph Theory". *J. Chem. Phys.* 158, 024101 (2023); **https://doi.org/10.1063/5.0133641**

[2] **Moakler, C.** and Newhall, K. A. "The Hydra String Method: A Novel Means to Explore Potential Energy Surfaces and its Application to Granular Materials". *Granular Matter* **24**, 24 (2022). **https://doi.org/10.1007/s10035-021-01184-5**

Dissertation Work

[3] **Moakler, C.** "'The Hydra String Method and its Application to High Dimensional Potential Energy Surfaces Arising from Granular Systemsa". *University of North Carolina at Chapel Hill Dissertation*. Chapel Hill, NC 2021.

[4] **Moakler, C.** "Granular Material Dynamics and the Hydra". *University of North Carolina at Chapel Hill Thesis Prospectus*. Chapel Hill, NC 2020.

Master's Thesis

[5] **Moakler, C.** "A Snaking Method for Saddle Point Search in Granular Materials" *University of North Carolina at Chapel Hill Master's Thesis*. Chapel Hill, NC 2020.

Talks and Presentations

[6] "Predicting molecule size distribution in hydrocarbon pyrolysis using random graph theory". *Rare Events: Analysis, Numerics, and Applications Workshop* College Park, MD 2023

[7] "The Hydra String Method and its Application to High Dimensional Potential Energy Surfaces Arising from Granular Systems". *University of Maryland, College Park Statistical Physics Seminar* College Park, MD 2022

[8] "The Hydra String Method and its Application to High Dimensional Potential Energy Surfaces Arising from Granular Systems". *American Physical Society March Meeting* Virtual 2021

[9] "The Hydra String Method and its Application to High Dimensional Potential Energy Surfaces Arising from Granular Systems". *University of North Carolina at Chapel Hill Thesis Defense* Chapel Hill, NC 2021

[10] "Granular Material Dynamics and the Hydra". *University of North Carolina at Chapel Hill Thesis Proposal Presentation* Chapel Hill, NC 2020

[11] "Granular Material Dynamics and Hydras". *Physical Applied Mathematics Lunch Seminar* Chapel Hill, NC 2020

[12] "Granular Material Dynamics and Hydras". *North Carolina State University Research Group Talk* Durham, NC 2020

[13] "A Snaking Method for Saddle Point Search in Granular Materials". *University of North Carolina at Chapel Hill Master's Defense* Chapel Hill, NC 2020