# LAUREL A. KROO, PH.D.

◇ Research Scientist ◇ Detail-Oriented Engineer ◇ Patented Inventor ◇ Experienced Instructor ◇
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## EDUCATION

**Massachusetts Institute of Technology** *2022 - Present*
Postdoctoral Associate in the Department of Mechanical Engineering
Non-Newtonian Fluids Laboratory
Research Advisor: **Professor Gareth H. McKinley, F.R.S., Ph.D.**

**Stanford University** *2017 - 2022*
Doctor of Philosophy (Ph.D.) in Mechanical Engineering
Doctoral Thesis titled *Adaptive and Sensory Machines: Active Foam and Swimming Rheometers*
Graduate Research Fellow of the National Science Foundation (NSF GRFP)
Primary Thesis Advisor: **Professor Manu Prakash, Ph.D.**
Research Co-Advisor: **Professor Eric S.G. Shaqfeh, Ph.D.**

**Stanford University** *2014-2017*
Masters of Science in Mechanical Engineering (Degree granted in 2017; standalone program from PhD)
Coursework in precision engineering, soft materials, microfluidics, optics and applied mathematics.

**Franklin W. Olin College of Engineering** *2010-2014*
Bachelors of Science in Mechanical Engineering
Specializing in Fluid Transport, Mechanics, Robotics and Computational Modelling. Overall GPA 3.82

## AWARDS, GRANTS AND NOMINATIONS

[⋆] = Notable distinction

⋆ **2022 Caltech Young Investigator** (Selected as the 2022 awardee for the Mechanical and Civil Engineering Department).

**2023 University of Pennsylvania MRSEC Travel Grant** for the Aspen Center of Physics Winter Conference on Active Matter

**2021 Division of Fluid Dynamics Travel Grant** from the American Physical Society

**2021 Stanford BioX Travel Grant** from the Stanford Biophysics Program

⋆ **2019 Stanford Diversifying Academia, Recruiting Excellence (DARE)** Doctoral Fellowship Alternate Award

⋆ **2019 Complex and Adaptive Systems Gordon Research Seminar** Speaker Invitation (one of 10 selected from approximately 100 abstracts, with awarded funding for conference)

**2018 APS Gallery of Fluid Motion**, Placed 11th out of $\approx 100$ entrants, (video link here).

⋆ **2016 National Science Foundation GRFP Fellowship Awardee** (Tenured 2016 - Aug 2019)

**2015 National Science Foundation GRFP Fellowship Honorable Mention**

**2014 Berkeley Fellowship** for Graduate Study. (Cross-department merit-based competitive 5-year fellowship award). Selected for award, but I regretfully declined.

⋆ **2014 Hertz Foundation Finalist** (50 chosen total in the USA out of about 1000 applicants involving multiple in-person interviews)

**APS Travel Grant for Division of Fluid Dynamics** Conference in November, 2013 (Merit-Based, 5 awarded in total for all undergraduates)

**Olin College Student Academic Grant** (Research, Merit-based) for 2012 ASME International Mechanical Engineering Congress presentation.

## ACADEMIC PUBLICATIONS

[⋆] = Widely Recognized or Key Works

*Rapidly Accelerating Early-Career Researcher with 44 citations, h-index 4. Papers are hyperlinked below.*

### Peer-Reviewed and Published

⋆ 1. **L.A. Kroo**, Matthew Bull and Manu Prakash. "Active Foam: The Adaptive Mechanics of 2D Air-Liquid Foam under Cyclic Inflation" (*ArXiv posted April 04, 2022, Accepted to Soft Matter (Royal Society of Chemistry) February 2023*.

⋆ 2. **L.A. Kroo***, Jeremy Binagia*, Noah Eckman, Manu Prakash and Eric Shaqfeh. "Self-propulsion of a freely-suspended, rotationally-symmetric swimmer enabled by viscoelastic normal stresses" *Journal of Fluid Mechanics, June 2022*. (Arxiv posted Nov 2021) *Equal Contribution

⋆ 3. **L.A. Kroo**, et al. "Pneumask: Modified Full-Face Snorkel Masks as Reusable Personal Protective Equipment for Hospital Personnel." In Print, PlosOne (2020).

### Submitted, In-Review, or Online on ArxiV

4. Grace Zhong, **L.A. Kroo**, Manu Prakash. "Thermotaxis in an apolar, non-neuronal animal", 2022 (submitted to Journal of the Royal Society: Interface)

⋆ 5. Bull, Matthew S., **L.A. Kroo**, and Manu Prakash. "Excitable mechanics embodied in a walking cilium." arXiv preprint arXiv:2107.02930 (2021).

### In Preparation

⋆ 6. **L.A. Kroo**, Patrick Underhill, Reed Nicholson, Marissa Rizzi and G.H. McKinley. "Measuring Transient Extensional Properties in Complex Microstructured Fluids using a Composite Harmonic Exponential Waveform". Under Final Preparation. Anticipated July 2023; Invited Paper to Soft Matter (Royal Society of Chemistry).

7. **L.A. Kroo** et al. "High-Frequency Rheology of Complex Fluids for Droplet Printing". Under Preparation. Anticipated Dec 2023.

8. **L.A. Kroo** et al. "Quantifying Textural Stringiness and Higher-Order Transient Extensional Properties of Semi-Liquid Foodstuffs. Anticipated Submission to Nature Foods, Dec 2023.

9. **L.A. Kroo**, Matthew Bull and Manu Prakash, Self-Propulsion of bubble clusters under confinement via Sparse Multi-body Contractile Coordination: A Critical Complexity Analog to Purcells minimal linkage theorem. *Under Final Preparation*, 2023.

### Patents (including submitted applications)

10. **A Mechanical Swimmer that acts as a Rheometer**. Patent Application (Patent Docket S21-217) Inventors: **L.A. Kroo**, Jeremy Binagia, Manu Prakash and Eric Shaqfeh. August 6th 2021. Appl. No.: PCT/US2022/039724

11. **Optical Lens Fabrication**, Manu Prakash, **L.A. Kroo**, and Jim Cybulski. The Board Of Trustees Of The Leland Stanford Junior University, assignee.
Patent PCT/US2014/022652. Awarded 10 Mar. 2014.

12. **Efficient Low-Cost Wind Energy Using Passive Circulation Control**, **L.A. Kroo**, I. Kroo. Filed Feb 22nd, 2011. Application number: 13/032,545

## VIDEO PUBLICATIONS AND SCIENTIFIC OUTREACH

**L.A. Kroo**, et al. American Physical Society, Division of Fluid Dynamics, Gallery of Fluid Motion: "Self-propulsion of a freely-suspended, rotationally-symmetric swimmer enabled by viscoelastic normal stresses" *Submitted to the American Physical Society*. (Online Publication on November 20th, 2021)
DOI: `https://doi.org/10.1103/APS.DFD.2021.GFM.V0065`
Note: LA Kroo is also the soloist (flute) in the original audio track (Baroque classical).

**L.A. Kroo** and Manu Prakash. American Physical Society, Division of Fluid Dynamics, Gallery of Fluid Motion: Mechanics of Active Foam: Local Energy Injection in an Addressable 2D Foam,
DOI: `https://doi.org/10.1103/APS.DFD.2018.GFM.V0080`
Note: LA Kroo is composer of the Original audio track (classical piano).

## CONFERENCE PRESENTATIONS AND RESEARCH SEMINARS

[⋆] = Invited or Highly Selective

**Highlighted Recent Invited Talks**

- ⋆ **(1) Aspen Physics Winter Conference**: Oral presentation (Invited lightning talk) and Poster (contributed) at the 2023 "Active Matter in Complex Environments". January 2023. (Highly selective).
- ⋆ **(2) Caltech MCE Department Invited Seminar (1-hour Young Investigator Lecture)** "Adaptive and Sensory Machines: From Active Foam to Swimming Rheometers." May 5th 2022; selection via competitive application process).
- ⋆ **(3) 7th Annual Stanford Global Health Research Convening, 25 minute invited talk** L. Kroo (speaker) et al. January 2021, Talk title: "Modified Full-Face Snorkel Masks as Reusable Personal Protective Equipment for Hospital Personnel"

⋆ **(4)** *Upcoming!* Oral presentation at the XIXth International Congress on Rheology (ICR2023), in Athens, Greece, from July 29th to August 4th, 2023. Abstract selected for session on "Advances in rheometrical and rheophysical methods" (highly selective).

**(5)** *Upcoming!* Oral presentation at the International Symposium on Food Rheology and Structure (ISFRS), June 11-15 2023, Wageningen University Netherlands. Abtract in session on "Rheology and Structure methods".

**(6)** Poster at the Princeton Center for Theoretical Science. "Physics of Morphing Matter". Dec 12-14 2022.

**(7)** "Adaptive and Sensory Machines: From Active Foam to Swimming Rheometers." Soundbite Oral Presentation. Tuesday, September 23, 2022. 92nd New England Complex Fluids Conference. In-Person, hosted by Brandeis University.

**(8)** "Adaptive and Sensory Machines", Department of Mechanical Engineering Thesis Defense, Stanford CA. April 25th 2022.

**(9)** L. Kroo (Speaker), J. Binagia, M. Prakash, E.S.G. Shaqfeh, American Physical Society, Division of Fluid Dynamics, 2021. Phoenix, Arizona USA.

**(10)** November 2020, Talk at APS Division of Fluid Dynamics in Chicago IL (Online Session). Talk title: "Modified Full-Face Snorkel Masks as Reusable Personal Protective Equipment for Hospital Personnel" `https://youtu.be/kAZsYfrNEFM`

⋆ **(11)** Kroo, Laurel (Speaker), Matthew Bull and Manu Prakash. July 2020, EUFOAM 2020 in Wales, UK. Talk on: "The Structural Adaptation of Two-Dimensional Air-Liquid Foam to Cyclic Inflation and Deflation". *This session was online, due to circumstances with COVID-19*. EUFOAM is widely recognized as the leading conference in the world on the physics of foams and bubbles; all sessions are plenary (no parallel sessions) and participation is competitive.

**(12)** Kroo, Laurel (Speaker), Matthew Bull and Manu Prakash. March 2020, March Meeting. Session on "The Physics of Foams". American Physical Society

**(13)** Kroo, Laurel (Speaker), Matthew Bull and Manu Prakash. November 2019 Division of Fluid Dynamics, Seattle, American Physical Society (Talk)

⋆ **(14)** Kroo, Laurel (Poster Presenter), Matthew Bull and Manu Prakash. August 2019 Soft Condensed Matter Gordon Research Conference and Gordon Research Seminar

⋆ **(15)** Kroo, Laurel (Presenter), Matthew Bull and Manu Prakash. May 2019 Biohub Inter-lab Confab - Invited Poster, San Francisco, California

**(16)** Kroo, Laurel (Speaker), Matthew Bull and Manu Prakash. March 2019 American Physical Society March Meeting, Boston (Talk, Abstract X63.00012)

⋆ **(17)** Kroo, Laurel (Speaker), Matthew Bull and Manu Prakash. January 2019 Complex Systems: Gordon Research Seminar Invited talk

⋆ **(18)** Kroo, Laurel (Presenter), Matthew Bull and Manu Prakash. January 2019 Complex Systems: Gordon Research Conference (Poster)

**(19)** Kroo, Laurel (Speaker) and Manu Prakash. 2018 APS Division of Fluid Dynamics Conference in Atlanta (Talk, Abstract L08.00009, Active Foam Project)

⋆ **(20)** Kroo, Laurel (Speaker) et al. Foldscope Invited Keynote at the Global Shaper's "Less is More, Doing Science the Frugal Way" conference in Rome (October 4th, 2014)

⋆ **(21)** Kroo, Laurel (Presenter) et al. 2014 Electron, Ion, and Photon Beam Technology and Nanofabrication (EIPBN) Conference. 'Printed Aspherical Micro Lenses': Invited poster in Washington DC

⋆ **(22)** Kroo, Laurel (Presenter) et al. Foldscope Invited Poster at TED Medical 2014 in San Fransisco (September 2014)

**(23)** Kroo, Laurel (Speaker) et al. 2013 APS Division of Fluid Dynamics Conference Aperture-Embedded Polymer Microlenses for Ultra-Low-Cost Microscopy Platforms (Foldscope) (Abstract: L34.00002 )

**(24)** 2012 ASME International Mechanical Engineering Congress poster presentation: L. Kroo (presenter), Aaron Crenshaw (presenter), Brian Storey. "Characterizing the Significance of Power Plant Blowdown Pollution on Rivers."

## RESEARCH IMPACT HIGHLIGHTS (NEWS, PUBLICLY ATTENDED LECTURESHIPS, ETC.)

- During the **prestigious annual William R. Schowalter Lecture** in 2021, Professor Eric S.G. Shaqfeh prominently featured my work on torque-free robotic swimming rheometers to the American Institute of Chemical Engineers community ( meeting). (link)
- **Washington Post wrote an article on our COVID-19 research response efforts** in 2020. I am the scholar pictured in the associated photographs, developing the technology. Available here: link
- **Stanford Medicine's newspaper SCOPE, along with many others internationally** did features on our COVID work in 2020 (link to article here). Quote from this article:
  *"One of the senior PhD students, Laurel Kroo, was in the final stretches of completing her graduate work, and without hesitation, she dropped everything to work on this effort. That's just one example of the dedication my lab and our collaborators have shown to this project." - Prof. Manu Prakash*
- **Quanta Magazine 2022 Feature Article**:"This Animals Behavior Is Mechanically Programmed" (Link discusses work that I did with my friend and collaborator, Dr. Matthew Bull, in the Prakash lab on neuronal-like information processing with massively parallelized soft mechanical structures (publication 5 listed, Bull et al. 2020)).
- **The New Yorker**: 2015 article "through the looking glass" (link) briefly discusses our work on lens manufacturing (related to publication item no. 11, "Optical Lens Fabrication" patent).
- I gave an **Opening Keynote Address to Maker Faire Europe, to an amphitheatre of approximately 1,100 atendees**, on the topic of the Fifty-Thousand Microscope Project (by invitation of the organizing committee through my advisor, Prof. Manu Prakash). This was on October 2nd, 2014 in the Auditorium Parco Della Musica in Rome, Italy. Link to entire session is here (including fantastic other speakers in the opening ceremony, such as Astronaut Cristoforetti). In 2014, we wanted to reach 10,000 users; now in 2023, Foldscope has reached over 1.6 **million** users.

## PROFESSIONAL DEVELOPMENT TRAINING

- **2022 Path of Professorship** Conference (MIT): By-application-only, this selective conference is specifically for Postdoctoral and Graduate-level women in underrepresented academic fields to discuss topics related to preparing for professorial positions. Topics varied widely but included: structuring a research budget, grant-writing, tenure considerations and opportunities for (and challenges with) interfacing STEM labs with the general public. Also discussed at great length were sensitive topics related to combating bias/hostilities when operating in severely underrepresented work environments,

self-advocacy, strategies for work-life balance, and how to manage difficult situations along gender and racial dimensions in a leadership/PI position. 22 Postdoctoral Scholars were selected to attend, including all departments at MIT.

- **2019 Preparing for Academic Careers course** (Stanford): This quarter-long class trained a small number of graduate students and postdoctoral associates to think about curriculum design, synthesize a coherent vision for their lab, and focus on career paths in academia. Negotiation skills, some legal training, and academic contract training were also formally included in the course.

## PROFESSIONAL ORGANIZATION MEMBERSHIP

Member and Elected Chairwoman of the Committee on Professional Development: **Postdoctoral Association**, Massachusetts Institute of Technology

Member: **Society of Rheology**

Member: **American Physical Society**: Division of Soft Matter (DSOFT) and Division of Fluid Dynamics (DFD)

Member: **American Society of Mechanical Engineers** (ASME)

Member: **American Society of Chemical Engineers**

Member 2019-2022 of the **Music Teachers Association of California** (MTAC) (required transcripts of 2+ years of college-Level music performance education, record of music theory classes, and an active performance record)

## HIGHLIGHTED ABSTRACTS: RECENT ACADEMIC RESEARCH

**Quantifying "Stringiness" of Complex Fluids via Analysis of Unsteady Composite Flows** September 2022 - Present

*MIT, Postdoctoral Associate* *Cambridge, MA*

Imposing complex strain histories on a material microstructure can result in a specific sequence of stress states that accurately emulates entirely different modalities of loading. Specifically, it was suggested by Doshi and Dealy (1987) and later demonstrated by Kwan et al. (2001) that an exponential shear strain will move the microstructure of a polymeric liquid through a similar sequence of stress states as a planar extensional flow. Fundamentally, this is enabled by the mechanical coupling between the normal and shear stresses that develop in complex fluids at large strains. Here we develop a periodic version of this concept, to probe dynamic extensional properties of complex fluids, using a conventional shear rheometer. The strain history is given by the following composite function: $\gamma(t) = A(\sinh(\alpha\sin(\omega t))$, where A controls the maximum amplitude of the imposed strain and is normalized such that $A = \gamma_{max}/\sinh(\alpha)$, $\omega$ is the frequency of the cyclic deformation and the flow type parameter $\alpha$ effectively tunes the signal between a weak sinusoidal ($\alpha << 1$) deformation (e.g. SAOS with $\gamma_{max} << 1$, or LAOS for $\gamma_{max} > 1$) and a strong ($\alpha >> 1$) deformation with exponential character. A representative Composite Harmonic Exponential Waveform (or CHEW strain history), say for example for an $\alpha = 10$, appears as a continuous and fully-differentiable periodic exponential strain function.

The benefits of expanding such a protocol to the periodic domain are two-fold: First, we can study the time-evolution of both shear and extensional properties of a complex fluid analogous to the convergence of medium- or large-amplitude oscillatory deformations into a limit cycle over the course of cyclic loading. Second, by measuring the shear stress and normal stress difference simultaneously we can also extract time-averaged extensional properties without specialized rheometric hardware (e.g. CABER). We demonstrate this method experimentally on a viscous fluid with no elasticity, and a canonical viscoelastic fluid (3 percent wt PIB solution). Using CHEW and a standard torsional rheometer (Ares G2, TA Instruments), we compute an appropriate periodic extensional viscosity function ($\eta_{ext} = \Delta\sigma/(\alpha\omega)$) from the time-evolving principal normal stress difference.

Additionally, to study the long-term adaptive effects (arising for example from thixotropic effects, or the Payne or Mullins effect in a complex fluid), we have constructed a nonlinear theoretical model to interpret the material response arising from CHEW. Finally, we use the CHEW protocol to measure the rheological response of multiphase semi-solid food materials and how they evolve with deformation time. *(This paper, Kroo et al. 2023, is currently in-prep for submission July 1st, 2023)*

**Mechanics and Control of Active Foam** January 2018 - Present

*Stanford University, PhD Dissertation Research* *Stanford, CA*

Foam is a canonical example of disordered soft matter where local force balance leads to the competition of many metastable configurations. We present an experimental and theoretical framework for "active foam" where an individual voxel inflates and deflates periodically. Local periodic activity leads to irreversible and reversible T1 transitions throughout the foam, eventually reaching a reversible limit cycle. Individual vertices displace outwards and subsequently return back to their approximate original radial position; this radial displacement follows an inverse law. Surprisingly, each return trajectory does not retrace its outbound path but encloses a finite area, with a clockwise (CW) or counterclockwise (CCW) direction, which we define as a local swirl. These swirls form coherent patterns spanning the scale of the material. Using a dynamical model, we demonstrate that swirl arises from disorder in the local micro-structure. We demonstrate that disorder and strain-rate control a crossover between cooperation and competition between swirls in adjacent vertices. Over $5-10$ cycles, the region around the active voxel structurally adapts from a higher-energy metastable state to a lower-energy state, locally ordering and stiffening the structure. The coherent domains of CW/CCW swirl become smaller as the system stabilizes, indicative of a process similar the Hall-Petch effect. Finally, we introduce a statistical model that evolves edge lengths with a set of rules to explore how this class of materials adapts as a function of initial structure. Adding activity to foam couples structural disorder and adaptive dynamics to encourage the development of a new class of abiotic, cellularized active matter.

This research was funded by the National Science Foundation (GRFP, 1453190), CZ Biohub and the Gordon and Betty Moore Foundation (grant no. 5762). (*Kroo et al. 2023 Published in Soft Matter, Royal Society of Chemistry)*

**A Portable Robotic Swimmer as a Rheometer for Complex Fluids** Feb 2021 - Present

*Stanford University, PhD Side-Project: Collaboration with the Shaqfeh Lab* *Stanford, CA*

Built and tested a small freely-suspended robot capable of propulsion when submerged in an elastic/complex fluid (but not in a Newtonian fluid), via "swirling". In collaboration with the Shaqfeh lab, we were able to show that observations of the propulsion speed and rotation of this two-sphere swimming robot under certain speed control protocols can predict the first and second normal stress coefficients of the elastic fluid. My personal contributions included: conceptualization of robot design, building the robot prototypes (including both mechanical design and circuit design), fabrication of the robot, programming the robot (C++), experimental data collection, image processing / data analysis, and figure generation/ paper writing. (*Kroo et al. 2022 Published in the Journal of Fluid Mechanics*)

**The Pneumask Project** February 2020 - June 2020

*Stanford University, PhD Side Project* *Stanford, CA*

During the COVID-19 pandemic in the spring of 2020, the Prakash Lab coordinated/led a large interdisciplinary team that focused on the modification and evaluation of a full-face snorkel mask for use as personal protective equipment (PPE) for health care workers, who lacked appropriate alternatives at the time. The design (referred to as Pneumask) consists of a custom snorkel-specific adapter that couples the snorkel-port of the mask to a rated filter (either a medical-grade ventilator inline filter or an industrial filter). The design was tested for the sealing capability of the mask, filter performance, CO2 buildup and clinical usability. These tests found the 'Pneumask' capable of forming a seal that exceeds the standards required for half-face respirators or N95 respirators. Filter testing indicated a range of options with varying performance depending on the quality of filter selected, but with typical filter performance exceeding or comparable to the N95 standard. CO2 buildup was found to be roughly equivalent to levels found in half-face elastomeric respirators in literature. Clinical usability tests indicated sufficient visibility and, while speaking was somewhat muffled, this was addressed via amplification (Bluetooth voice relay to cell phone speakers through an app) in noisy environments. The benefit of the Pneumask as PPE is that it is reusable for longer periods than typical disposable N95 respirators, as the snorkel mask can withstand rigorous decontamination protocols (that are standard to regular elastomeric respirators). Our conclusions on the performance and efficacy of Pneumask as an N95-alternative technology was cautiously optimistic. My contributions to the project were extensive, and involved the mechanical design of the adapter, experimental data on performance, analysis and the writing the paper (first author). Globally, many tens of thousands of Pneumasks have been manufactured and donated to hospitals in need by industry partners. *Kroo et al 2021. Published in PLOS One*

**Excitable Mechanics of Walking Cilia** January 2018 - October 2021
*Stanford University, PhD Side Project* *Stanford, CA*

Worked with the lead author, Dr. Matthew Bull, and Professor Manu Prakash, on a project modelling the curious mechanical characteristics of how cilia exhibit sensitive yet stable dynamics when periodically in contact with a sticky substrate. We demonstrate how this flexible structure when coupled with activity (excitable mechanics) can serve as a fundamental computational unit, where tissue height and activity map to many neuron-like nonlinearities. My contributions to the project included approximately weekly meetings/ feedback on the two theoretical models developed, contributions to some of the imaging of the cilia, and editting/review of the paper.
*(Manuscript is available on Arxiv, Submitted.)*

**Low-cost Microlens Fabrication using Ultra-Fast Polymeric Curing** 2014 - 2018
*Stanford University, Graduate Research Assistant* *Stanford, CA*

The Prakash Lab at Stanford University invented the Foldscope, a high-resolution, high-magnification origami microscope for less than 1 USD, for clinical pathology diagnosis in the third world. However, these microscopes are limited in field-of-view and suffer from substantial spherical aberration due to the use of ball lenses. I invented a optical manufacturing technique, where a UV-curable polymer droplet is injected into an aperture hole, the droplet is then driven into a high-frequency dynamical mode (through acoustic pressure), which changes its surface shape and optical properties. The drop is then subsequently "frozen" through a high-power curing process using ultraviolet light. The phase change is ultra-fast, occurring on the order of under 10 milliseconds, enabling a huge variety of ultra-smooth (8 nanometer RMS), self-assembled, aspherical lens shapes. This work has been awarded/assigned a patent by the US Patent Office. *This research was funded by NSF Career Grant no.1453190.

**Particle Tracking and Environmental Modeling** 2012 - 2013
*Olin College Research: Undergraduate Researcher* *Needham, MA*

I worked on developing lab tools for particle tracking velocimetry in microfluidic networks and environmental modelling in Professor Brian Storey's lab.

## TEACHING EXPERIENCE

**Macromolecular Hydrodynamics (2.341)** March 2023
*Guest Lecturer / Instructor at MIT* *Cambridge, MA*

2022-2023 Spring guest lecturer in Prof. Gareth McKinley's advanced graduate course on complex fluids.

**Classical Performance Flute** 2018-2022
*Private Instructor* *Stanford, CA*

Ran a personal studio, teaching talented high school music students on Saturday mornings classical performance. Focus on tone, technique, breathing/posture, repertoire and performance. Personal recordings may be found here. Member of the Music Teacher's Association of CA.

**Statistical Mechanics of Macromolecules** Jan-Mar 2017
*Teaching Assistant at Stanford University* *Stanford, CA*

BIOE41 was a 50-seat undergraduate course focused on the statistical mechanics and physics of micro-biological systems. I wrote problem sets, wrote exams, gave weekly lectures, graded psets, held office hours and provided creative curricular design support to Prof Manu Prakash.

**Principles of Engineering** Aug 2011 - May 2013
*Teaching Assistant at Olin College* *Needham, MA*

I was a teaching assistant for 3 semesters of this upper-level mechatronics/robotics course, teaching a sophomore/upperclassman project-based course focused on design, micro-controller implementation and prototyping. I was involved with grading, holding office hours and helping students with technical difficulties during lab periods. Check out some of the final projects from past semesters: `http://poe.olin.edu/`

**Introduction to Analog Circuits** Aug 2011 - May 2013
*Teaching Assistant at Olin College* *Needham, MA*

Formally titled "Modeling and Control (MODCON)" in the registrar list, this was a freshman course focused on analog circuit design and basics of control theory. The labs included PID control, signal filtering, sensor design and op-amp/transistor introductions. I gave biweekly lectures, graded labs and held office hours.

## ANONYMOUS INDIVIDUAL COURSE REVIEW FEEDBACK (Stanford undergraduate students, quoted verbatim)

- *"Helpful and Patient"*
- *"[Laurel taught me] how to think about macrostates and microstates, how to think about fermi problem questions.."*
- *"solid understanding of material"*
- *"Laurel has greatly helped my understanding of the ideas/topics discussed in this course, specifically those relevant to the problem set questions which in turn fostered my ability to show my thinking."*
- *"Laurel was the most enthusiastic about our learning/understanding and the one that demonstrated the most how much she cared about our growth by working with the students to translate our concerns and inquiries to Manu. I can tell she was the most devoted towards supporting this course, which I very much appreciate. "*
- *"Laurels Piazza responses to student questions were thorough and guided students in the correct direction of thinking, which was critical towards our understanding/completion of the ideas asked of us in the problem sets. "*
- *"She helped me think critically about the problem at hand and reflect on my own answers."*
- *"Laurel was the only aspect of this class that was somewhat organized. She was always very responsive to emails and helpful. She was also passionate about the content and us learning, which is really nice and makes the class more enjoyable. "*
- *"Was most accessible of the TA's to answer questions"*
- *"I learned about combinatorics and stat mech (from Laurel)"*
- *"For grading our PSETS Laurel went above and beyond making a graph for every problem for each student showing how their estimations compared to their peers. This level of dedication and attention to detail meant a lot. "*
- *"Laurel was good at explaining stat mech concepts during TA office hours"*
- *"During office hours and on piazza Laurel was the best TA for answering PSET questions."*
- *"Generally willing and able to assist. Only really useful TA. Thanks for your good work Laurel."*
- *"Out of all our TAs, Laurel was definitely the most hardworking and reachable."*
- *"She was the best lecturer for TA sections out of all the TAs."*
- *"Laurel was well prepared for sections and seemed to handle questions regarding the class, course material, and psets very well "*
- *"I learned how to improve my approaches to open problems and estimation problems. "*
- *"Super responsive on piazza and office hours "*
- *"Happy to set up time to meet outside of class "*
- *"She was always happy to answer questions "*

## MENTORSHIP/ RESEARCH LEADERSHIP EXPERIENCE

*Student's Names Respectfully Omitted for Privacy.*
*Available only upon reasonable request (contingent on students' permission).*

- (Upcoming!) **2023 Undergraduate Summer Research Student at MIT in Mechanical Engineering** in Prof. Gareth McKinley's lab.
- **2023 Visiting Industry Scientist (post-Masters) at MIT** in Mechanical Engineering in Prof. Gareth McKinley's Lab.
- **Stanford Prakash Lab: mentored a research team of 4 Olin College undergraduate students** who were contributing to in the space of COVID-19 emergency response from March 2020 to August of 2020. The undergraduate team successfully developed a software package capable of transmitting audio through specialized masks for hospital personnel, in a manner that only required use of commercial off-the-shelf Bluetooth earbuds(with built-in mics). I met with them met each week as a sub-team on the project as their primary advisor, and their work was peer-reviewed/published as part of the larger project (including all as authors). The code package we developed was open-sourced and is linked in here in our publication.
- **2020-2021 Chemical Engineering Rotating First-Year Graduate Student at Stanford**: Research Mentor in Prof. Eric Shaqfeh's lab. Student helped develop a second version of our image analysis code for our work on swimming

rheometers, that took advantage of color channels in the images to improve the signal to noise ratio of our data. Also showed him how to set up Schlieren imaging (which he had not done before) for a submission to APS DFD's Gallery of Fluid Motion, and was a regular resource to him. He was included on our publication, Kroo et al. 2022, in the Journal of Fluid Mechanics.

- **2018-2021 Long-term private instructor for high school music students studying classical flute** (For students of intermediate to advanced performance level). Included on this list because of the (many!) translation mentorship skills.

## ACADEMIC SERVICE

**MIT Postdoctoral Association** 2022 - Present
*Chairwoman of the Committee on Professional Development*
*and member of the DEI Committee* *Cambridge, MA*

I currently serve as the 2022-2023 Professional Development Committee chair, organizing events and providing career support for over 1500 postdoctoral trainees appointed in 50 departments at MIT. The Committee on Professional Development is one of 9 active committees in the association, and committee chairs are elected annually. The MIT Postdoctoral Association is structured according to the guidelines provided by the National Postdoctoral Association (NPA) and is financially supported by the MIT Office of the Vice President for Research (VPR).

**Prakash Lab Shop, Stanford University** 2014-2017
*Machine Shop Manager* *Stanford, CA*

Served as shop manager for 2.5 years in my lab's machine shop. Duties included training labmembers (and users from other labs) on the epilog laser cutter, bandsaw, drill-press, vinyl cutter, 3D printer (Form 2), PCB mill and electronics prototyping (soldering station). Maintained a clean, safe environment; no serious incidents were reported while I was manager, despite heavy shop usage.

**Microcosmos Website Co-Manager/Co-Developer/Co-Founder, Stanford University** 2015-2016
*Volunteer Developer* *Stanford, CA*

Developed and maintenanced the Prakash Lab's original microcosmos.foldscope.com online platform with my colleague, Dr. George Herring. Microcosmos an online, open-source microscopy community and now the largest amateur microscopy community in the world. Originally it was developed to share findings of the Foldscope (a one-dollar origami paper microscope originally developed by the Prakash Lab), that has reached over 1.6 million users. I personally helped develop the original infrastructure for the first prototype of the website, and I personally wrote/contributed a software package that allowed the entire contents of the website to be downloaded and viewed locally (e.g. on a USB drive) – so that the site could be shared with communities in the world without robust access to high speed internet.

## INDUSTRY EXPERIENCE

**Diffract Technology, Inc.** September 2021 - Present
*Member of the Scientific Advisory Board* *Menlo Park, CA*

I serve as a Scientific Technical Advisor for an NSF-funded optical metrology and display technology start-up, specifically for my prior expertise in precision manufacturing (their primary commercial application). Diffract Technology is developing new techniques in non-linear optics and holography to advance the field precision measurement.

**Harley Davidson Motorcycles** September 2013 - May 2014
*Technical Team Lead,Olin Senior Capstone Team* *Needham, MA and Milwaukee, WI*

I worked with a team of students for Harley-Davidson Motorcycles on the development of a novel thermoelectric generator to supply a small amount of additional power at idle RPMs. Final design took advantage of both the energy stored in vibration and that stored in heat gradients, using pyroelectric materials.

**Apple Inc.** May 2011 - Aug 2011
*Mechanical Engineering Intern* *Sunnyvale, CA*

Was on the advanced manufacturing engineering team working on Apple laptop platforms. This experience involved many weeks of international travel, exposure to consumer electronics design, assembly line processes, tolerance stack up analysis, process capability and computational statistical analysis of precision manufacturing techniques.

**Desktop Aeronautics Inc.: Novel Wind Turbine Rotor Design** May 2011 - Aug 2011
*Environmental Engineering Intern* *Mountain View CA*

Designed a wind turbine blade modification that increases turbine efficiency over a range of speeds, tested a simplified prototype, and wrote a program that predicts how this modification affects turbine performance. Project leader, primary inventor and IP rights/application owner

**Zee.Aero (formerly KittyHawk, Wisk): Rotor Design for Acoustics** May 2010 - Aug 2010
*Mechanical Engineering Intern* *Mountain View CA*

Assessed different vertical lift fan rotor designs for acoustic performance. Identified key parameters that contributed to a quiet vertical take-off design.

**National Aeronautics and Space Administration (NASA)** June 2009 - Aug 2009
*Simulation Intern on Rocket Orion Team* *Ames Research Center, Mountain View CA*

Worked on the simulation team for the Rocket Orion escape pod. ITAR classified; Wrote several visualization modules for assessment of multi-objective optimization tools. (MATLAB)

## TECHNICAL STRENGTHS

| | |
|---|---|
| **Physical Modelling** | Analytical modelling and low-dimensional simulation of complex and dynamical systems. Nonlinear modelling of viscoelastic and micro-structured fluids |
| **Computer Languages** | MATLAB, Python, Java, C, Javascript, Scheme/Lisp |
| **Computational Modeling Tools** | SolidWorks, Finite Element Analysis/Modelling, CFD (overgrid, CFL3D), COMSOL, ZEMAX, CODEV, In-house numerical tools written from scratch for Foam dynamics modelling |
| **Electronics design** | PCB layout, power control, analog signal processing, digital signal processing, embedded programming |
| **Mechanical design** | Geometric Dimensioning and Tolerancing (GDT), tolerance stack up analysis, metrology (CMM experience), Design for manufacturing (DFM; particularly for CNC), |
| **Hobbies** | Downhill Skiing, Classical Flute Performance, recreational soccer, half-marathons, motorcycling, HAM radio, and classical music composition |

## REFERENCES

**Prof. Gareth H. McKinley, F.R.S., Ph.D.**
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**Prof. Eric S.G. Shaqfeh, Ph.D.**
Lester Levi Carter Professor of Chemical Engineering at Stanford University (endowed chair)
Former Dept. Chair of Chemical Engineering
Stanford University
Research Project Co-advisor / collaborator
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**Prof. Brian Storey, Ph.D.**
Founding Faculty Member of Olin College of Engineering and Faculty of Mechanical Engineering
Currently the Director of Accelerated Materials Design and Discovery Program at Toyota Research Institute
Email: brian.storey@olin.edu

**3-5 additional references available, upon request.**

*Reference phone numbers available only upon request.*
*(Email Contact Preferred, unless phone appointment scheduled)*