James Roggeveen

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EDUCATION

Princeton University, Princeton, NJ   September 2019 – Present
    Doctor of Philosophy, Mechanical Engineering   expected May 2024
        Thesis: "Asymmetric and rough boundary surface effects on fluid flows"
    Master of Arts, Mechanical Engineering   May 2021

University of Cambridge. Cambridge, United Kingdom   October 2018 – July 2019
    Master of Advanced Study, Applied Mathematics   July 2019
        Thesis: "Gravity currents passing over cavities"
        Result: Passed with Distinction

Massachusetts Institute of Technology, Cambridge, MA   September 2014 – June 2018
    Bachelor of Science, Mechanical Engineering   June 2018
        Thesis: "Self-propulsion of floating objects"
        GPA: 5.0

RESEARCH EXPERIENCE

Complex Fluids Group, Princeton   September 2019 – Present
PhD Candidate
Adviser: Prof. Howard Stone
Topic: Low-Reynolds number flows, particle motion, fluid-structure interactions

– Developed quantitative applied mathematical theories to describe and discover emergent phenomena in fluid mechanics

– Validated theories using numerical and experimental data; developed code to automate data filtering, segmenting, and analysis in a controlled way

– Proved that particles in 2D can only adopt two possible motions when placed in a shear flow at low Reynolds numbers. Demonstrated that the second class of motions typically happens at high particle asymmetry and derived a quantitative condition on the particle's shape to achieve this class of trajectory

– Derived correction to diffusion tensor for passive tracers advected in channels with rough or topographically varied surfaces by applying asymptotic methods and local averaging techniques

– Demonstrated that in the limit of small surface amplitudes the leading order correction is linear in the wavenumbers present in the surface roughness and quantified the effects on particle drift and dispersion for simple and random surfaces

– Validated asymptotic theory by comparison to direct numerical simulation

– Developed non-linear model of micropipette aspiration to enable reduction of three-dimensional physics into one experimentally measurable quantity with no fitting or calibration parameters

- Wrote Python scripts to automate segmentation of experimental data, determine data consistency with model assumptions, and fit non-linear model to extract quantitative material information
- Validated automated pipeline and model using fluids of known material properties, successfully demonstrating novel ability of our model to quantify multiple rheological properties with one experiment
- Explored the evolution of complex dynamical systems by numerical investigation of Poincaré maps, including automated fixed point identification and deployment of Python multiprocessing to efficiently simulate long-time system behavior

Fluid Dynamics Laboratory, DAMTP, Cambridge January 2019 – May 2019
Part III Essay
Adviser: Prof. Stuart Dalziel
Topic: Gravity current interaction with cavities

- Reviewed literature on gravity currents and their interactions with various obstacles, obstructions, and other fluids; reviewed possible instabilities that can lead to mixing and fluid transport for interfaces experiencing shear
- Developed simple theory to predict the removal of a dense fluid from a cavity by a gravity current passing overhead; theory depends on the ratio of the densities of the current, cavity, and background fluids
- Validated theoretical predictions using exhaustive laboratory experiments

Applied Math Lab, MIT January 2018 – June 2018
Undergraduate Thesis
Adviser: Prof. John Bush
Topic: Self-propulsion of floating objects through interfacial phenomena

- Reviewed literature on classical methods of driving interfacial motion used in nature, such as by water striders and other insects
- Investigated how the Faraday instability affects floating fluid lenses and can lead to symmetry breaking and spontaneous self propulsion
- Experimentally determined the phase space of possible lens shapes and motions as a function of forcing frequency and volume
- Demonstrated how these lenses can be engineered to generate straight-line motion of boats or rotary motion of gears

Bourouiba Group, MIT January 2016 – January 2017
Undergraduate Researcher
Adviser: Prof. Lydia Bourouiba

- Developed simple method for benchtop rheological measurement of viscoelastic relaxation time
- Calibrated methodology using fluids of known properties and comparing to measurements obtained by CABER
- Used CABER and bench top method to test how the rheological properties of human saliva change when removed from the body; tested various techniques for cooling saliva to maintain rheological properties

– Attempted to relate rheological properties of fluids to disease progression and spread

WORK EXPERIENCE

Samsung Electronics   Summer 2018
Global Technology Center Intern

– Developed software solutions to automate quality control and inspection in Galaxy phone production line

– Interfaced with external contractors to deploy software in prototype robotic quality control mechanisms

– Built tool using C to determine surface roughness of curved glass and developed Python code to locate microLEDs and identify manufacturing defects including missing or misaligned components

SpaceX   Summer 2017
Vehicle Engineering Intern

– Technician turnover led to many repeated small-scale issues when integrating and testing Falcon 9 rocket, such as torn tape, torn connectors, incorrectly torqued or wired bolts, etc.

– Generating individualized work orders for repairing these problems were creating massive engineering overhead and production bottlenecks

– Worked with Falcon 9 stakeholders in avionics, propulsion, and structures to develop standard procedures to address common assembly defects in Falcon 9 Octaweb without generating individual issue tickets

– Implemented standard procedures within existing work order framework to empower technicians to address common defects while still ensuring engineering oversight and sign-off before shipping assembly

– Improved work order process saved Falcon 9 Vehicle Integration and Test team over 40 engineering hours per booster, freeing engineering resources to develop manufacturing procedures for Block 5 boosters

NASA Jet Propulsion Laboratory   Summer 2016
Summer Undergraduate Research Fellow
Adviser: Adrian Stoica, PhD

– Developed mission proposal for NASA Innovative Advanced Concepts "WindBots" as an autonomous robotic explorer of Jupiter's atmosphere

– Researched and analyzed various in-situ power generation schemes for potential robots depending on robot shape and flight functionality

– Led construction of bench-top wind tunnel for testing WindBot architectures

PUBLICATIONS

1. **J. V. Roggeveen**, H. Wang, Z. Shi and H. A. Stone, "A calibration-free model of micropipette aspiration for measuring properties of protein condensates." *Biophysical Journal*, 2023.

2. **J. V. Roggeveen**, H. A. Stone and C. Kurzthaler, "Transport of a passive scalar in wide channels with surface topography: An asymptotic theory." *Journal of Physics: Condensed Matter*, 2023.

3. **J. V. Roggeveen** and H. A. Stone, "Motion of asymmetric bodies in two-dimensional shear flow." *Journal of Fluid Mechanics*, 2022.

4. **J. V. Roggeveen**, A. Stoica and M. Dolci, "Analysis of alternative energy harvesting methods to power atmospheric robotic explorers on Jupiter." In proceedings of IEEE Aerospace Conference, 2017.

CONFRENCES AND INVITED TALKS

1. J. V. Roggeveen and H. A. Stone, Purcell's elastic swimmer: Drift of elastic hinges in oscillatory shear flows, *76th Annual Meeting of the APS Division of Fluid Dynamics*, Washington D.C., 2023.

2. J. V. Roggeveen, Multiphase flows at low Reynolds numbers: From condensate rheology to fluid-structure interactions, *Center for Computational Biology Group Meeting*, Invited Talk, Flatiron Institute, New York, 2023.

3. J. V. Roggeveen, H. Wang, Z. Shi and H. A. Stone, Modeling micropipette aspiration for use in material characterization of biological condensates, *XIXth International Congress on Rheology*, Athens, Greece, 2023.

4. J. V. Roggeveen, Measuring condensate rheology with micropipette aspiration & fluid-structure interactions at low Reynolds number, *LadHyX Seminar*, Invited Talk, École polytechnique, Paris, France, 2023.

5. J. V. Roggeveen, H. Wang, Z. Shi and H. A. Stone, Material characterization of condensates using micropipette aspiration, *Phase Group Seminar*, Invited Talk, Princeton, 2022.

6. J. V. Roggeveen, H. A. Stone and C. Kurzthaler, Transport of a passive scalar in wide channels with surface topography, *75th Annual Meeting of the APS Division of Fluid Dynamics*, Indianapolis, 2022.

7. J.V. Roggeveen and H. A. Stone, Motion of asymmetric bodies in shear flow, *74th Annual Meeting of the APS Division of Fluid Dynamics*, Phoenix, 2021.

8. J.V. Roggeveen and H. A. Stone, Motion of asymmetric bodies in shear flow, *Soft Materials Coffee Hour*, Invited Talk, Princeton, 2021.

TEACHING AND MENTORING

– **Princeton University:**
  – MAE 305, Mathematics in Engineering I, Fall 2023
  – MAE 552, Viscous Flows and Boundary Layers, Assistant in Instruction, Spring 2023
  – MAE 501, Mathematical Methods of Engineering Analysis I, Assistant in Instruction, Fall 2022
  – MAE 563, Instabilities in Fluids: Linear and Non-Linear Analysis of Waves and Patterns in the Environment, Assistant in Instruction, Spring 2022
  – EGR 156, Multivariable Calculus, Assistant in Instruction, Fall 2021
    * Worked with instructional staff to rewrite course curriculum, assignments, and exams from scratch

* Increased course evaluations nearly 20% when compared to average of past several years
* Incorporated real-world engineering and physics examples into curriculum

- **Massachusetts Institute of Technology:**
  - MIT Global Teaching Labs South Korea, Instructor, Spring 2018
    * Designed and taught workshops on robotics and stem to low-income middle and high school students in Seoul, South Korea; included instruction in Korean and Chinese
  - 2.05, Thermodynamics, Teaching Assistant, Fall 2017
  - 2.005, Thermal-Fluids Engineering I, Teaching Assistant, Spring 2017
  - 2.007, Design and Manufacturing I, Undergraduate Assistant, Spring 2017
    * Provided in-lab assistance to sophomore mechanical engineering students. Included design consultation and machine operation
  - 7.012 Introductory Biology, Tutor, Fall 2015
  - China Education and Technology Initiative, Instructor, Summer 2015
    * Worked with a team of three in China to teach workshops focused on math, science, and technology to Chinese middle school, high school, and university students in Xi'an, Guangzhou, and Fuzhou

LEADERSHIP AND VOLUNTEERING

Graduate Student Council, Princeton MAE   September 2019 - Present
Chair

- Chaired committee tasked with acting as a liaison between the faculty and the graduate student body
- Advocated on behalf of graduate students to faculty on departmental policies and degree requirements
- Organized Research Day and visiting days for approx. 30 admitted students per year with departmental staff

MIT Engineering Advisory Board   October 2019 - Present
Senior Reviewer

- Evaluated around 50 Engineering portfolios per year on the basis of technical skill, creativity, and potential impact for MIT Admission Committee as primary and secondary reviewer
- Handle second round reviewing of applicants to help benchmark new reviewers

Mathey College, Princeton University   September 2021 - May 2022
Resident Graduate Student

- Provided live-in residential support to 50 first-year undergraduate students at Mathey College
- Organized and led study breaks and group cooking sessions to help relieve stress, discuss current issues, and build camaraderie amongst new students

- Advised students on course selection and career progression, especially for those interested in graduate studies
- Assisted Mathey College staff with planning and execution of College-wide events

MIT 2.009 Product Engineering Process Yellow Team   September 2017 - December 2017
Firmware Lead

- Led firmware team for search and rescue tracking product prototype development
- Product consisted of three tiers of device and included integrating GPS and radio modules with onboard tracking and display functions
- Designed and implemented system API to control passage of information between modules and over the radio
- Website: `http://designed.mit.edu/new/view.html?year=2017&team=yellow`

MIT Asian Dance Team   September 2014 - May 2018
Captain, Director of Logistics

- Served as Captain for a dance team of 270 students producing a semester showcase, with responsibilities including overseeing booking space, managing finances, overseeing training and recruitment of choreographers, and selling out 700 open seats at showcase
- Maintained culture of inclusivity and welcomed all interested dancers regardless of ability or experience
- One of the largest student organizations on campus and largest performing student organization on campus
- As Director of Logistics handled stage manager duties as well as coordinating lighting; used experience from theater productions to rewrite handbook on how to setup stage

MIT Next Haunt   August 2015 - December 2015
Build Director

- Led construction team for Next Haunt, a two-story standalone escape room puzzle game built in the basement of Next House, a dorm on campus
- Organized construction shifts and had main responsibility for completing the build of the house exterior and interior elements on time
- Responsible for ensuring safety and compliance with MIT EHS and Cambridge Fire regulations

AWARDS AND HONORS

- GradFutures Professional Development Grant, Princeton University, 2023
- SEAS Travel Grant, Princeton University, 2023
- Dean's Fund for Scholarly Travel, Princeton University, 2023
- Graduate School Teaching Award, Princeton University, 2022
- Guggenheim Second Year Fellowship, Princeton University, 2020
- Sayre Award for Academic Excellence, Princeton University, 2020
- Upton Fellowship, Princeton University, 2019

- Trinity College External Research Studentship, University of Cambridge, 2018
- Phi Beta Kappa, 2018
- Whitelaw Award for Originality of Design, MIT, 2016
- Nantucket Scholar, 2014
- Eagle Scout, 2014