Matthew Leighton

Curriculum Vitae

Education

2020–Present **Ph.D. in Physics**, *Simon Fraser University*, Burnaby, Canada
- **Thesis:** *Stochastic Thermodynamics of Multi-Component Molecular Machines*, supervised by Prof. David Sivak.

2016–2020 **B.Sc. Honours in Physics and Mathematics**, *Dalhousie University*, Halifax, Canada
- **Honours Thesis:** *Modelling the Formation of Cross-Linked Collagen Fibrils*, supervised by Prof. Andrew Rutenberg.
- Middle-Distance Runner with the Varsity Track Team (2016-2018)
- Choral Scholar with the University of King's College Chapel Choir (2016-2020)

2019 **Exchange Program, Mathematics, Statistics, and Finance**, *Chalmers University of Technology*, Göteborg, Sweden

Experience

Research

2020–Present **Graduate Researcher**, *Sivak Group*, Simon Fraser University
Working under the supervision of professor David Sivak, analyzing biological molecular machines using the theory of nonequilibrium statistical mechanics. Projects include exploring performance trade-offs in collective motor-driven transport, and investigating internal energy and information transduction in multi-component stochastic systems.

2018–2020 **Undergraduate Researcher**, *Rutenberg Group*, Dalhousie University
Worked with professor Andrew Rutenberg on various research projects in theoretical biophysics using computational and mathematical methods. Projects included modelling stochastic effects in the process of host cell invation by *S. Typhimurium* bacteria, developing a theoretical model for the thermodynamics of *in vivo* Collagen fibril growth, and studying the mechanics of double-twist liquid crystal elastomer systems under deformation.

Teaching, Mentoring, and Service

Summer 2023 - Spring 2024 **Research Supervisor**, *Graham Rich*, Undergraduate Honours Thesis in the Sivak Group
- Formulated and supervised a project investigating free energy transduction between chemical and mechanical degrees of freedom in flashing ratchet models for molecular motors.

Fall 2022 **Teaching Assistant**, *PHYS 801: Grad Student Seminar*, Simon Fraser University
- Responsibilities included running peer review sessions and providing feedback on graduate student research presentations.

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Summer 2022 **Research Supervisor**, *Lilian Paty*, Summer Research Intern in the Sivak Group
- Formulated and supervised a project investigating comparisons between discrete and continuous models for molecular motors. A manuscript based on this project is currently in preparation.
- Now: MSc student, ESPCI Paris.

Spring 2022 **Organizer**, *Frontiers in Biophysics 2022*, Vancouver, Canada
- Member of the organizing committee for Frontiers in Biophysics 2022, a conference run by and for graduate students in biophysics and related areas in the Pacific Northwest.
- Conference was held in person in downtown Vancouver, with 85 attendees.

Fall 2021 **Teaching Assistant**, *PHYS 132: Physics Laboratory I*, Simon Fraser University
- Responsibilities included helping to run the lab sessions and grading lab reports.
- Received the Fall 2021 Physics TA Teaching Award for outstanding teaching efforts.
- *"Matt is a great physics TA. Although most of physics TAs are generally pretty boring, he is full of personality and was great to have in lab. No matter how silly the question, or how many times I asked, he always helped me and made sure I understood what I was doing in lab. Although I probably will not take another physics class in my undergraduate studies here at SFU, Matt has definitely set the bar high when it comes to my expectations of TAs in a lab class."*—Anonymous Student Evaluation

Fall 2021 **Teaching Assistant**, *PHYS 344: Thermal Physics*, Simon Fraser University
- Responsibilities included leading tutorials and grading assignments.
- *"The TA shows great interest in this subject. His knowledge and teaching style is excellent. I like that he waits for his students to think of an answer first. Usually profs just give you the answer. There is no weakness in my opinion. Matt is a great person and is very approachable."*—Anonymous Student Evaluation

Summer 2018,2019 **Science Outreach**, *Dalhousie University*, Halifax, Canada
- Led interactive physics experiment demonstrations as part of the Discovery Days outreach program for elementary and high school students.

Business and Finance

2021-2022 **Co-Founder**, OnDeck Fisheries AI Inc.
- Co-founded a tech startup with the mission of bringing modern computer vision technology to bear on longstanding problems in the fisheries monitoring industry.
- Led efforts to raise more than $200,000 in non-dilutive funding in the company's first year of incorporation.

2017–2018 **Business Analyst**, *Inetco Systems LTD*, Vancouver, Canada
- Led the planning process for the release of a major new cloud SaaS product; wrote and presented the business plan at a quarterly board meeting for board approval.
- Performed financial modelling and analysis, managed marketing campaigns, and communicated requirements to the software team.
- Started as a summer co-op student, hired to stay on as a part-time consultant over the next year.

Publications and Manuscripts

peer reviewed: 6, first author: 6, h-index: 5, total citations: 38 **[Google Scholar]**

6. **M.P. Leighton,** D.A. Sivak, "Inferring Subsystem Efficiencies in Bipartite Molecular Machines", *Physical Review Letters*, **130**:178401, 2023.
   ★ Featured in **Physics Magazine**.
5. **M.P. Leighton,** D.A. Sivak, "Dynamic and Thermodynamic Bounds for Collective Motor-Driven Transport", *Physical Review Letters,* **129**:118102, 2022.
   ★ Selected for award: top student paper of 2022, Biophysical Society of Canada.

4. **M.P. Leighton,** D.A. Sivak, "Performance Scaling and Trade-offs in Collective Motor-Driven Transport", *New Journal of Physics*, **24**:013009, 2022.
3. **M.P. Leighton,** A.D. Rutenberg, and L. Kreplak, "D-Band Strain Underestimates Fibril Strain for Twisted Collagen Fibrils at Low Strains", *Journal of the Mechanical Behavior of Biomedical Materials*, **124**:104854, 2021.
2. **M.P. Leighton,** L. Kreplak, and A.D. Rutenberg, "Chiral Phase-Coexistence in Compressed Double-Twist Elastomers", *Soft Matter*, **17**:5018, 2021.
1. **M.P. Leighton,** L. Kreplak, and A.D. Rutenberg, "Nonequilibrium Growth and Twist of Cross-Linked Collagen Fibrils", *Soft Matter*, **17**:1415, 2021.

Under Review

M.P. Leighton, and D.A. Sivak, "Jensen Bound for the Entropy Production Rate in Stochastic Thermodynamics", *arXiv:2305.11287*, 2023.

M.P. Leighton, L. Kreplak, and A.D. Rutenberg, "Torsion and Bistability of Double-Twist Elastomers", *arXiv:2304.14349*, 2023.

In Preparation

M.P. Leighton*, J. Ehrich*, and D.A. Sivak, "Information Arbitrage in Bipartite Heat Engines".

*: These authors contributed equally

Selected Talks and Posters

Talks

May 2023 **Free Energy Transduction within Molecular Machines**, Biophysical Society of Canada Annual Meeting, *Invited*

May 2023 **Stochastic Thermodynamics of Multi-Component Molecular Machines**, Aidan Brown Group Meeting, Toronto Metropolitan University, *Invited*

March 2023 **Inferring Subsystem Efficiencies in Bipartite Molecular Machines**, American Physical Society March Meeting

November 2022 **A Guided Tour of the Nanoscale Machines that keep Us Alive**, Guest Lecture for SFU PHYS344, *Invited*

November 2022 **Dynamic and Thermodynamic Bounds on the Performance of Multi-Component Molecular Machines**, Physics of Life: Students and Postdocs Edition Symposium at the *Center for the Physics of Biological Function*

June 2022 **Dynamic and Thermodynamic Bounds for Collective Motor-Driven Transport**, Frontiers in Biophysics 2022

May 2022 **Dynamic and Thermodynamic Bounds for Collective Motor-Driven Transport**, Workshop on Stochastic Thermodynamics III

June 2021 **Scaling Laws and Performance Trade-offs for Collective Transport**, Frontiers in Biophysics 2021

November 2020 **Structural Phase Transitions in Double-Twist Elastomers**, Collagen Cafe II

July 2020 **Nonequilibrium Growth of Cross-Linked Collagen Fibrils**, Collagen Cafe I

June 2020 **Elastomeric Properties of Double-Twist Collagen Fibrils**, Soft Matter Canada Symposium

March 2020 **Modelling Cross-Linking in Collagen Fibrils**, APS March Meeting (via DSOFT Virtual Meeting)

January 2020 **Coarse-Grained Structure of Double-Twist Liquid Crystals**, Atlantic Undergraduate Physics Conference
Selected for award – top theory talk.

November 2019 **Modelling Cross-Linking in Collagen Fibrils**, Canadian Undergraduate Physics Conference

August 2018 **Stochastic Modelling of Cellular *Salmonella* Infection**, Dalhousie Bioblast Symposium

Posters

June 2023 **Dynamic and Thermodynamic Performance Bounds for Multi-Component Molecular Machines**, Beg Rohu Summer School

May 2023 **Thermodynamic Performance Bounds for Multi-Component Molecular Machines**, Biophysical Society of Canada Annual Meeting

March 2023 **Inferring Subsystem Efficiencies in Bipartite Molecular Machines**, SFU Physics Department Poster Session

January 2023 **Dynamic and Thermodynamic Performance Bounds for Multi-Component Molecular Machines**, Gordon Research Conference on Stochastic Physics in Biology

January 2023 **Dynamic and Thermodynamic Performance Bounds for Multi-Component Molecular Machines**, Berkeley Stat Mech Meeting

April 2022 **Dynamic and Thermodynamic Bounds for Collective Motor-Driven Transport**, SFU Physics Department Poster Session

May 2021 **Scaling Laws and Performance Trade-offs for Collective Transport**, Biophysical Society of Canada Annual Meeting
Selected for poster award.

February 2021 **Performance Trade-offs in Cooperative Intracellular Transport**, SFU Physics Department Poster Session

Selected Awards

Research Fellowships and Awards

2022-2025 **NSERC CGS-D**, *Simon Fraser University*

2024 **Graduate Travel and Research Award**, *Simon Fraser University*

2023 **Graduate Travel and Research Award**, *Simon Fraser University*

2020–2021 **NSERC CGS-M**, *Simon Fraser University*

2020 **NSERC USRA**, *Dalhousie University*

2018 **NSERC USRA**, *Dalhousie University*

Service, Presentation, and Paper Awards

2023 **Trainee Paper Award**, *Biophysical Society of Canada*

2021 **TA Teaching Award (PHYS 132)**, *SFU Physics*

2021 **Poster Award**, *Canadian Biophysical Society*

2020 **Top Theory Talk**, *Atlantic Undergraduate Physics Conference*

2016–2020 **Helen Roby Choral Scholarship**, *University of King's College*

Academic Scholarships

2022 **Hargreaves Scholarship**, *Simon Fraser University*
2022 **Howard Malm Graduate Scholarship**, *Simon Fraser University*
2021 **Kirk H. Michaelian Graduate Scholarship**, *Simon Fraser University*
2020–2021 **BC Graduate Scholarship**, *Simon Fraser University*
2016–2020 **Chancellor's Scholarship**, *Dalhousie University*
2017–2018 **USports Academic All-Canadian**, *Dalhousie University*
2016–2017 **USports Academic All-Canadian**, *Dalhousie University*
2017 **Archibald Physics Prize**, *Dalhousie University*
2016–2020 **Dean's List**, *Dalhousie University*

Languages and Technical Skills

- **Languages:** English (Native), French (Fluent)
- Extensive experience with scientific programming and numerical optimization in Python
- Experienced in the use of Compute Canada computing clusters
- Working knowledge of MATLAB, Mathematica, Maple, and HTML

Miscellaneous Qualifications

Grade 8 Piano, Advanced Music Theory, *Royal Conservatory of Music*
DELF B2, *French language Certification*
CSIA Level 1 Ski Instructor, *Canadian Ski Instructors Alliance*
AST 1 Avalanche Skills, *Avalanche Canada*
Emergency First Aid, CPR-C, and Bronze Cross, *Canadian Lifesaving Society*
Cansail 4, *Sail Canada*