Frederick Law

Courant Institute of Mathematics – Department of Mathematics
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Research Interests

- Uncertainty Quantification, Sampling, Optimization, Scientific Computing, Model Reduction, Applied Mathematics, Plasma Physics.

Education

- **Courant Institute of Mathematical Sciences, New York University** 2018–present
  Ph.D Candidate in Mathematics, Specializing in Applied Math.
- **University of California, Berkeley** 2014–2018
  B.A. in Applied Mathematics (Concentration: Mathematical Biology), Highest Honors
  B.A. in Statistics.

Honors & Awards

- National Defense Science and Engineering Graduate (NDSEG) Fellow – Department of Defense, 2020-2023.
- Honorable Mention – Graduate Research Fellowship Program, National Science Foundation, 2020.
- Henry MacCracken Fellowship – New York University, 2018-2020.

Publications

- **F. Law**, A. Cerfon, B. Peherstorfer (2022) Accelerating the estimation of collisionless energetic particle confinement statistics in stellarators using multifidelity Monte Carlo, *Nucl. Fusion* **62** 076019

Talks and Presentations

- *Multifidelity Monte Carlo estimation of energetic particle confinement in stellarators*. Contributed Talk, Sherwood Fusion Theory Conference 2021.
- *Learning data-fit models for multi-fidelity Monte Carlo estimation of energetic particle loss in fusion reactors*. MS352 Minisymposium Talk, SIAM CSE 2021.
- *"Physiologically Based Pharmacokinetic (PBPK) Modeling for a Persistent Chlorinated Water Contaminant: 1,2,3-Trichloropropane"*, with Jolie Even and Lee Spence. MAA Undergraduate Student Poster Session at Joint Mathematics Meeting 2018, San Diego, CA.

Other projects

- **Generating zonal instabilities in Hasegawa-Mima equation** (2019). Developed a pseudo-spectral code to simulate Hasegawa-Mima(HM) dynamics to model plasma flows with fast time scales that demonstrate zonal jets. While the HM dynamics do not have an inherent instability, we implemented deterministic forcing arising from asymptotic analysis on a two-field model to generate instability. Also introduced a cheaper white noise forcing term. For high-resolution solves, both methods gave rise to long-time zonal jets emerging from drift wave turbulence which qualitatively agree with experimental results. Future plans include constructing methods for uncertainty propagation in such complex dynamics.
- **Numerical computation of conformal maps by Kerzman-Stein integral equation.** (2019). Final propject for a course in Numerical Methods II. Numerically computed Riemann maps for a variety of shapes by solving

a second kind Fredholm integral equation using GMRES and FMM. Also implemented an recursively structured endpoint corrected trapezoidal quadrature to accurately recover the map in areas of crowding.

- **Multifidelity cross-entropy estimation of rare events in steady heat conduction** (2019). Final propject for a course in Stochastic Modelling and Uncertainty Quantification. Implemented an MFCE code to estimate small probabilities in net heat flux for a given domain with boundary conditions. Were able to accurately estimate events on the order of 10^{-6} to 10^{-9}, with considerable speedup compared to CE and standard Monte Carlo.
- **Simulating cryo-EM: a case study of Amyloid β (1-42)** (2017). Final paper for a course in mathematical and computational methods in biology. Focused on 3D reconstruction of proteins from 2D cryo-EM images, specifically of Zika virus and Amyloid-β (1-42). Expository paper detailing the biological background, mathematical preliminaries, and parallelized code in NumPy.
- **A survey of the theory of matroids and its applications** (2017). Final paper for a mathematics course in optimization. Expository/survey paper discussing the basics of matroid theory and applications, focusing on tangible examples. Some topics covered include cryptomorphic axiomizations of matroids, duality, matroid minors, the greedy algorithm and extensions beyond matroids, and algorithms for matroid intersection problems.

Graduate Coursework

- Stochastic Modeling and UQ
- Inverse Problems
- Numerical Methods I, II
- High Performance Computing
- Finite Element Method
- UQ for Turbulent Dynamical Systems
- Mechanics
- Fluid Dynamics
- Functional Analysis
- Real Variables($*$)
- Monte Carlo Methods
- Applied Stochastic Analysis
- Convex and Nonsmooth Optimization
- Methods of Applied Mathematics
- Partial Differential Equations I($*$), II($*$), III
- Fast Solvers
- Climate Change
- Geophysical Fluid Dynamics
- Differentiable Dynamical Systems
- Theoretical Statistics I($*$)

($*$) graduate level courses were taken during undergraduate degree.

Activities and Service

- Berkeley Undergraduate Mathementoring Program (BUMP) Mentor, January 2018–May 2018.
- Facilitator at Julia Robinson Mathematics Festival, Berkeley, October 2017.
- Department of Mathematics Peer Adviser, University of California, Berkeley, August 2016–May 2017.
- Proctor at Berkeley Math Tournament, March 2017, November 2016, March 2016.

Computing skills

- **Programming Languages:** Experienced in MATLAB, Python. Proficient in: R, C/C++.
- **High Performance Computing:** Proficient using the NYU Greene cluster.