# Jack Coughlin

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## **Professional Experience**

Research Scientist Theory and Modeling Intern *Zap Energy* 

- Performed MHD and multi-fluid simulations in validation of Zap's sheared flow-stabilized Z pinch fusion concept.
- Using JAX, developed a differentiable multi-fluid solver in cylindrical geometry for detailed investigation of stability in shear flow Z pinches.
- Developed robust shock-handling methods for high-order discontinuous Galerkin fluid solvers.
- Analyzed and improved performance of fluid solvers on HPC systems.

Graduate Research Intern, T-5 Applied Mathematics and Plasma Physics Group Los Alamos National Laboratory

- Using Julia, developed numerical methods for the efficient solution of plasma kinetic equations.

#### Senior Software Engineer, Payments

Square, Inc.

- Led the technical transition of Square's production accounting system from nightly payouts to stored balance features.
   We maintained continuity of service while replacing the guts of a system that moves hundreds of millions of dollars per day to customer bank accounts.
- Designed and implemented public APIs for money movement and accounting as part of Square's Marketplaces initiative.
- Contributed to the development of an automatic reconciliation engine for Square's payment and settlement systems.
- As a member of the Data Infrastructure team, developed and maintained Square's core data infrastructure primitives such as Kafka and Hadoop on behalf of machine learning practitioners and data analysts.

#### Consulting Cloud Engineer

Freewire, Inc.

- Designed an ingestion pipeline and query API for MQTT telemetrics from a fleet of mobile EV chargers.

#### Member of Technical Staff

University of Washington

Inscriptive, Inc.

- Developed a standalone anomaly detection service for server monitoring, backed by a new anomaly detection algorithm
  for time series data, combining Discrete Wavelet analysis with Kernel Density Estimation.
- Created a high-performance microservices application framework in Java, using gRPC and Kubernetes.

#### Education

Ph.D. in Applied Mathematics	
University of Washington	2019–2024
Thesis: Asymptotic and non-asymptotic model reduction for kinetic descriptions of plasma. [PDF]	
Advised by:	
Professor Jingwei Hu	Applied Mathematics
Professor Uri Shumlak	Aerospace and Energetics Research Program
B.S. in Mathematics	

2008–2013

2023, 2024-2025

2013-2016, 2018-2019

2022

2018

2016-2018

#### **Publications**

- [1] COUGHLIN, J., HU, J., AND SHUMLAK, U. Robust and conservative dynamical low-rank methods for the Vlasov equation via a novel macro-micro decomposition. *Journal of Computational Physics 509* (July 2024), 113055.
   [DOI] [arXiv]
- [2] COUGHLIN, J., AND HU, J. Efficient dynamical low-rank approximation for the Vlasov-Ampère-Fokker-Planck system. *Journal of Computational Physics* (Sept. 2022), 111590 [DOI] [arXiv]
- [3] COUGHLIN, J., AND PERRONE, G. Multi-scale Anomaly Detection with Wavelets. In Proceedings of the International Conference on Big Data and Internet of Thing - BDIOT2017 (London, United Kingdom, 2017), ACM Press, pp. 102–108

## Preprints

[4] COUGHLIN, J., HU, J., AND SHUMLAK, U. Asymptotic perpendicular transport in low-beta collisionless plasma, Aug. 2024. [arXiv]

### **Talks and Posters**

- [5] *Robust flux limiting of the Runge-Kutta Discontinuous Galerkin method for advection-dominated multiphysics plasma simulations.* Poster at APS DPP, October 2023. [abstract]
- [6] A Conservative Dynamical Low-rank Method for the Vlasov Equation. Invited talk at SIAM-NNP 2023.
- [7] Towards Efficient Dynamical Low-Rank Approximation of Collisional Kinetic Equations. Invited talk at SIAM CSE23.
   [abstract]
- [8] *Dynamical low-rank methods for capturing kinetic effects in the collisional transition regime.* Poster at APS DPP, October 2022. [abstract]
- [9] Low-rank decomposition of plasma kinetic distributions in the collisional transition regime. Poster at IEEE ICOPS, May 2022. [abstract]
- [10] *Asymptotic-preserving dynamical low-rank discretization of kinetic plasma models*. Presentation at Isaac Newton Institute, March 2022. [slides]
- [11] A Data-Driven Analysis of Non-Equilibrium Transport in the Magnetized Kelvin-Helmholtz Instability. Poster at APS DPP 2021. [abstract]

#### Patents

[12] PERRONE, G., LEDUC, M., COUGHLIN, J., AND KUMAR, A. Determining recommendations from buyer information, Sept. 2017. US Patent 9,767,471