Opal Issan

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EDUCATION

University of California San Diego — La Jolla, CA
Ph.D. in Mechanical and Aerospace Engineering — Sept. 2021 – Present
Specialization in Plasma Physics and Numerical Methods
GPA: 4.0/4.0

San Diego State University — San Diego, CA
B.S. in Applied Mathematics — Aug. 2017 – May 2021
Specialization in Computational Science
Major GPA: 4.0/4.0

RESEARCH EXPERIENCE

Graduate Student Researcher — Remote Work
T–5 Plasma Physics Theoretical Division, Los Alamos National Laboratory — April 2024 – Present
Advisors: Dr. Gian Luca Delzanno, Dr. Salomon Janhunen, and Dr. Vadim Roytershteyn (Space Science Institute)

- Developed quasilinear theory to understand how cold electrons dampen whistler waves and how cold protons dampen electromagnetic ion cyclotron waves via a secondary drift-driven instability.
- Validated the quasilinear theory via comparison to nonlinear kinetic particle-in-cell and hybrid simulations.

Graduate Research Assistant — La Jolla, CA
Department of Mechanical and Aerospace Engineering, University of California San Diego — Sept. 2021 – Sept. 2024
Advisor: Prof. Boris Kramer

- Developed a reduced-order model that predicts the ambient solar wind in the heliospheric domain.
- Performed variance-based global sensitivity analysis and Bayesian inference of the ambient solar wind parameters via ACE observations.

Heliophysics Researcher — Remote Work
Frontiers Development Lab — June 2024 – Aug. 2024
Advisors: Dr. Mike Heyns (Imperial College London)

- Developed a Gaussian process spherical harmonic and spherical elementary currents interpolator with quantified uncertainty of global geomagnetic ground perturbations via nearly 600 magnetometer station measurements.

Space Weather Summer School Student — Los Alamos, NM
T–5 Plasma Physics Theoretical Division, Los Alamos National Laboratory — June 2023 – July 2023
Advisors: Dr. Gian Luca Delzanno, Dr. Oleksandr Koshkarov, and Dr. Federico Halpern (General Atomics)

- Formulated an anti-symmetric and positivity-preserving spectral discretization for the Vlasov-Poisson equations. This novel formulation is unconditionally stable, structure-preserving, and conserves the number of particles, which is important for long-term numerical simulations of plasma processes.

Undergraduate Research Assistant — San Diego, CA
Department of Mathematics and Statistics, San Diego State University — May 2020 – Aug. 2021
Advisor: Prof. Christopher Curtis

- Developed an autoencoder that finds a finite-dimensional approximation of the Koopman operator with Tensorflow 2.0. The encoder mapping transforms the nonlinear trajectories to a space where the dynamics are linear.

Solar Physics Intern — San Diego, CA
Predictive Science Inc. — Dec. 2019 – July 2021
Advisors: Dr. Pete Riley and Dr. Cooper Downs

- Developed a robust method for automatically tracking spatiotemporal properties of coronal holes as part of Coronal Hole Mapping and Analysis Pipeline (*CHMAP*) Python package.
- Refined the Heliospheric Upwind eXtrapolation (HUX) model, which maps solar wind proton velocity from the inner heliosphere to Earth via employing finite-difference flux-limiter higher-order schemes. The HUX model is tested on observational data from various spacecrafts, e.g., Parker Solar Probe, Ulysses, and Wind.
- Developed *mesh-generator*, a Python package, for a spherical mesh generator that increased the accuracy of simulating coronal mass ejections.

AWARDS AND FELLOWSHIPS

1. UCSD MAE **Outstanding PhD Student of the Year Award** (2025).
2. UCSD MAE **Outstanding PhD Teaching Assistant of the Year Award** (2024).
3. Center for Space and Earth Science **(CSES) Fellowship** (June 2024): This fellowship is given by the LANL on our proposal "Effect of cold plasma on whistler waves in the magnetosphere" (with co-PI Oleksandr Koshkarov), total of 210,000$ for three years.
4. Awardee of the LANL **Vela Fellowship** (July 2023): Funding for PhD students as part of the Space Weather Summer School, total of 14,000$.
5. Awardee of the 2023 **best presentation award** at the CaCAO (ChAos, Computation, Analysis, and Optimization) group led by Prof. Mattias Morzfeld at the Scripps Institution of Oceanography.
6. Strategic Enhancement of Excellence Through Diversity **(SEED) Fellowship** (Aug. 2021): This award is given to outstanding PhD students at UCSD, which provides three years of funding.

PREPRINTS

[1] **Issan O**, Roytershteyn V, Delzanno GL, Janhunen S (2025). *Understanding cold electron impact on parallel-propagating whistler chorus waves via moment-based quasilinear theory* (submitted). preprint doi: arXiv:2512.03269

JOURNAL PUBLICATIONS

[2] **Issan O**, Koshkarov O, Halpern F, Delzanno GL, Kramer B (2025). *Conservative data-driven model order reduction of a fluid-kinetic spectral solver.* Physics of Plasmas, 32:083907. doi: 10.1063/5.0275478

[3] **Issan O**, Chapurin O, Koshkarov O, Delzanno GL (2025). *Effects of Artificial Collisions, Filtering, and Nonlocal Closure Approaches on Hermite-based Vlasov-Poisson Simulations.* Physics of Plasmas, 32:033906. doi: 10.1063/5.0252456

[4] **Issan O**, Koshkarov O, Halpern F, Kramer B, Delzanno GL (2025). *Conservative Closures of the Vlasov-Poisson Equations Discretized with a Symmetrically Weighted Hermite Spectral Expansion in Velocity.* Journal of Computational Physics, 524:113741. doi: 10.1016/j.jcp.2025.113741

[5] **Issan O**, Koshkarov O, Halpern F, Kramer B, Delzanno GL (2024). *Anti-symmetric and Positivity Preserving Formulation of a Spectral Method for Vlasov-Poisson Equations.* Journal of Computational Physics, 514:113263. doi: 10.1016/j.jcp.2024.113263

[6] Bychkov A, **Issan O**, Pogudin G, Kramer B (2023). *Exact and Optimal Quadratization of Nonlinear Finite-Dimensional Non-autonomous Dynamical Systems.* SIAM Journal on Applied Dynamical Systems, 23:982-1016. doi: 10.1137/23M1561129

[7] **Issan O**, Riley P, Camporeale E, Kramer B (2023). *Bayesian Inference and Global Sensitivity Analysis for Ambient Solar Wind Prediction.* Space Weather, 21, e2023SW003555. doi: 10.1029/2023SW003555

[8] **Issan O** and Kramer B (2022). *Predicting Solar Wind Streams from the Inner-Heliosphere to Earth via Shifted Operator Inference.* Journal of Computational Physics, 473:111689. doi: 10.1016/j.jcp.2022.111689

[9] Alford-Lago D, Curtis C, Ihler A, and **Issan O** (2022). *Deep Learning Enhanced Dynamic Mode Decomposition.* Chaos, 32(3):033116. doi: 10.1063/5.0073893

[10] **Issan O** and Riley P (2022). *Theoretical Refinements to the Heliospheric Upwind eXtrapolation Technique and Application to in-situ Measurements.* Frontiers in Astronomy and Space Sciences, 8:795323. doi: 10.3389/fspas.2021.795323

[11] Riley P and **Issan O** (2021). *Using a Heliospheric Upwinding eXtrapolation Technique to Magnetically Connect Different Regions of the Heliosphere.* Frontiers in Physics, 9:679497. doi: 10.3389/fphy.2021.679497

NEWS BLOG

1. Issan O and Kramer B (2023). *Speeding Up Solar Wind Forecasts with Reduced-order Modeling*. Society for Industrial and Applied Mathematics News Blog.

CONFERENCE PRESENTATIONS AND POSTERS

1. ($\star$ invited) **Issan O**, Riley P, Camporeale E, Kramer B (Sept. 2025). *Bayesian Inference and Global Sensitivity Analysis for Ambient Solar Wind Prediction.* Machine Learning in Heliophysics (ML–Helio), Madrid, Spain. (presentation)

2. **Issan O**, Delzanno GL, Roytershteyn V, Janhunen S (Aug. 2025). *Cold electron impact on parallel–propagating whistler chorus waves.* Computational Physics School for Fusion Research (CPS–FR), Cambridge, MA. (poster)

3. **Issan O**, Delzanno GL, Roytershteyn V, Janhunen S (June 2025). *Cold electron impact on parallel–propagating whistler chorus waves.* Geospace Environment Modeling (GEM), Des Moines, Iowa. (poster)

4. **Issan O**, Chapurin O, Koshkarov O, Delzanno GL (Nov. 2024). *Effects of Artificial Collisions, Filtering, and Nonlocal Closure Approaches on Hermite-based Vlasov-Poisson Simulations.* 2024 Fusion Energy and Pulsed Power Workshop, San Diego, CA. (poster)

5. **Issan O**, Koshkarov O, Halpern F, Delzanno GL, Kramer B (Sept. 2024). *Conservative reduced order modeling of the plasma kinetic equations.* Model Reduction and Surrogate Modeling (MORe), San Diego, CA. (poster)

6. **Issan O**, Koshkarov O, Halpern F, Kramer B, Delzanno GL (Aug. 2024). *Anti–symmetric and Positivity Preserving Formulation of a Spectral Method for Vlasov–Poisson Equations.* 15^{th} International Symposium for Space Simulations (ISSS) and 16^{th} International Workshop on the Interrelationship between Plasma Experiments in the Laboratory and in Space (IPELS), Garching, Germany. (poster)

7. **Issan O**, Koshkarov O, Halpern F, Kramer B, Delzanno GL (Aug. 2024). *Anti–symmetric and Positivity Preserving Formulation of a Spectral Method for Vlasov–Poisson Equations.* Solar Heliospheric and INterplanetary Environment (SHINE), Juneau, Alaska. (poster)

8. **Issan O**, Riley P, Camporeale E, Kramer B (Aug. 2023). *Bayesian Inference and Global Sensitivity Analysis for Ambient Solar Wind Prediction.* 10^{th} International Congress on Industrial and Applied Mathematics (ICIAM), Tokyo, Japan. (presentation)

9. **Issan O**, Koshkarov O, Halpern F, Delzanno GL (July 2023). *Anti–symmetric and Positivity Preserving Formulation of the Spectral Plasma Solver.* Los Alamos National Laboratory Space Weather Summer School Seminar (LANL–SWSS), Los Alamos, NM. (presentation)

10. **Issan O**, Riley P, Camporeale E, Kramer B (June 2023). *Bayesian Inference and Global Sensitivity Analysis for Ambient Solar Wind Prediction.* Geospace Environment Modeling (GEM) Workshop, San Diego, CA. (poster)

11. **Issan O** and Kramer B (April 2023). *Predicting Solar Wind Streams from the Inner–Heliosphere to Earth via Shifted Operator Inference.* U.S. Association for Computational Mechanics (USACM) Workshop on Establishing Benchmarks for Data-Driven Modeling of Physical Systems, Los Angeles, CA. (presentation)

12. **Issan O**, Camporeale E, Kramer B (March 2023). *Parameter Estimation of Ambient Solar Wind Models using ACE Observations.* Space Weather with Quantified Uncertainties Spring Meeting, Cambridge, MA. (poster)

13. **Issan O** and Kramer B (Sept. 2022). *Predicting Solar Wind Streams from the Inner–Heliosphere to Earth via Shifted Operator Inference.* Society for Industrial and Applied Mathematics Conference on Mathematics of Data Science (SIAM–MDS), San Diego, CA. (presentation)

14. **Issan O** and Kramer B (June–July 2022). *Predicting Solar Wind Streams from the Inner–Heliosphere to Earth via Shifted Operator Inference.* Geospace Environment Modeling (GEM) and Solar Heliospheric and INterplanetary Environment (SHINE) Workshop, Waikiki, HI. (poster)

15. **Issan O** and Kramer B (May 2022). *Predicting Solar Wind Streams from the Inner–Heliosphere to Earth via Shifted Operator Inference.* Southern California Applied Mathematics Symposium (SOCAMS) Conference, Los Angeles, CA. (presentation)

16. **Issan O** and Curtis C (July 2021). *Enhancing Dynamic Mode Decomposition using Autoencoder Networks.* Society of Applied and Industrial Mathematics Annual Meeting (SIAM–AM), virtual. (presentation)

TEACHING

Teaching Assistant, Signals and Systems San Diego, CA
Department of Mechanical and Aerospace Engineering, University of California San Diego Jan. 2024 – March 2024
Taught by Prof. Boris Kramer

- Led recitation sessions to 190+ MAE students teaching the material covered in course lectures.
- Held weekly office hours to help students with the course material/concepts and homework problems.

Course Grader, Introduction to Linear Algebra Course San Diego, CA
Department of Mathematics, San Diego State University Jan. 2019 – May 2020
Taught by Prof. Peter Blomgren

- Graded midterm and final exams for the 'Introduction to Linear Algebra' undergraduate course.

Teaching Assistant, Precalculus San Diego, CA
Department of Mathematics, San Diego State University Aug. 2018 – Dec. 2018
Taught by Lecturer Corey Manchester

- Led tutoring sessions to over 40 precalculus students, teaching the material covered in course lectures.
- Held weekly office hours to help students with coursework in the San Diego State University Math Learning Center.

RELEVANT COURSEWORK

• Astrophysical Fluid Dynamics • Probabilistic Reasoning & Learning • Model Reduction • Hydrodynamic Instability
• Potential Flow • Computational Fluid Dynamics • Uncertainty Quantification • Numerical Methods
• Fluid Dynamics • Geophysical Data Analysis • Applied Mathematics • Plasma Physics • Turbulence

COMPUTER SKILLS

• Programming languages: Python, Matlab, Maple, Julia, C/C++. • Version control tools: Git, Bitbucket.
• Operating systems: MacOS, Windows, Linux.