Opal Issan

Email: oissan@ucsd.edu | LinkedIn: opal-issan | Website: opaliss.github.io/opalissan/

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

- Reduced-Order Modeling of Ambient Solar Wind Models: Developed a reduced-order model, *shifted operator inference*, to predict the ambient solar wind in the heliospheric domain. The proposed method can be extended to a wide class of advection-dominated systems described on a periodic domain [7].
- Bayesian Inference and Global Sensitivity Analysis of Ambient Solar Wind Models: Performed variance-based global sensitivity analysis of the uncertain parameters in a solar wind model chain, and learned the posterior distribution of the influential parameters via Bayesian inference [6].

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)

- Cold Plasma (below 100eV) Impact on Magnetospheric Electromagnetic Waves: 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. The quasilinear theory is validated via comparison to nonlinear kinetic particle-in-cell and hybrid simulations.

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

- SuperMAG with Quantified Uncertainties: 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)

- Spectral Plasma Solver: 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 [1–4].

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

- Deep Learning Dynamic Mode Decomposition: 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. This method is useful for estimating, predicting, and controlling nonlinear dynamical systems [8].

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

- Coronal Hole Mapping and Analysis Pipeline (CHMAP): Developed a robust method for automatically tracking spatiotemporal properties of coronal holes as part of the CHMAP Python package.
- Heliospheric Upwind eXtrapolation (HUX): Refined the 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 [9-10].
- Mesh Generation Software: Developed *mesh-generator*, a Python package, for a spherical mesh generator that increased the efficiency of simulating coronal mass ejections by adjusting the mesh resolution in areas of the Sun's active region.

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.

MENTORSHIP

UCSD Undergraduate Research Mentor   La Jolla, CA
Department of Mechanical and Aerospace Engineering, University of California San Diego   June 2022 – Oct. 2023

- Mentored undergraduate researchers Emily Deboer and Hannah Haider under the supervision of Prof. Boris Kramer. I worked with Emily on structure-preserving non-intrusive model order reduction and with Hannah on a stable discretization of a three-dimensional hydrodynamic model of the solar wind.

OUTREACH

Hosted a "Space Research" booth with Prof. Boris Kramer's laboratory, the Rocket Propulsion Laboratory, and Students for the Exploration and Development of Space, at Southeast San Diego Science and Art Expo (Aug. 2022), Barrio Logan Science and Art Expo (April 2022/2023), and Comienza con un Sueño / It Begins with a Dream (March 2023). These events are a great opportunity to communicate our research to the San Diego community and engage with future scientists early on.

JOURNAL PUBLICATIONS

[1] 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

[2] 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

[3] 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

[4] 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

[5] Bychkov A, <u>Issan O</u>, 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

[6] <u>Issan O</u>, 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

[7] <u>Issan O</u> 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

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

[9] <u>Issan O</u> 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

[10] Riley P and <u>Issan O</u> (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

CONFERENCE PRESENTATIONS AND POSTERS

1. ($\star$ invited) <u>Issan O</u>, 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. <u>Issan O</u>, 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. <u>Issan O</u>, 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. <u>Issan O</u>, 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. <u>Issan O</u>, 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. <u>Issan O</u>, 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$^{\text{th}}$ International Symposium for Space Simulations (ISSS) and 16$^{\text{th}}$ International Workshop on the Interrelationship between Plasma Experiments in the Laboratory and in Space (IPELS), Garching, Germany. (poster)

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

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

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

FELLOWSHIPS

1. Center for Space and Earth Science (CSES) Fellowship (June 2024): This fellowship is given by the Los Alamos National Laboratory on our proposal "Effect of cold plasma on whistler waves in the magnetosphere" (with co-PI Oleksandr Koshkarov, LANL T–5), total of $210,000$ for <u>three years</u> (of which $135,000$ goes towards my graduate school tuition and funding).
2. Strategic Enhancement of Excellence Through Diversity (SEED) Fellowship (Aug. 2021): This award is given to outstanding doctoral students at UCSD, which provides <u>three years</u> of funding during graduate school.

AWARDS AND DISTINCTIONS

1. UCSD Mechanical and Aerospace Engineering **Outstanding PhD Student of the Year Award** (2025)
2. UCSD Mechanical and Aerospace Engineering **Outstanding PhD Teaching Assistant of the Year Award** (2024)
3. Awardee of the Los Alamos National Laboratory Vela Fellowship (July 2023): Funding for PhD students as part of the Space Weather Summer School.
4. 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.
5. Travel Awards:

   - Machine Learning in Heliophysics Workshop (ML–Helio) (Sept. 2025).
   - Computational Physics School for Fusion Research (CPS–FR 2025) (Aug. 2025).
   - Geospace Environment Modeling (GEM) (June 2025).
   - Model Reduction and Surrogate Modeling (Sept. 2024).
   - CRC International Summer School 2024 on Data Assimilation (Sept. 2024).
   - Solar Heliospheric and INterplanetary Environment (SHINE) (Aug. 2024).
   - 15th International Symposium for Space Simulations (ISSS) (Aug. 2024).
   - 16th Interrelationship between Plasma Experiments in the Laboratory and in Space (IPELS) (Aug. 2024).
   - 10th International Congress on Industrial and Applied Mathematics (ICIAM) (Aug. 2023).
   - Geospace Environment Modeling (GEM) (June 2023).
   - Space Weather Quantified Uncertainties (SWQU) Spring Meeting (March 2023).
   - Society for Industrial and Applied Mathematics Conference on Mathematics of Data Science (SIAM–MDS) (Sept. 2022).

COMPUTER SKILLS

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