

# Opal Issan

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## EDUCATION

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### University of California San Diego

Ph.D. in Mechanical and Aerospace Engineering  
*Specialization in Plasma Physics and Numerical Methods*  
GPA: 4.0/4.0

La Jolla, CA  
Sept. 2021 – Present

### San Diego State University

B.S. in Applied Mathematics  
*Specialization in Computational Science*  
Major GPA: 4.0/4.0

San Diego, CA  
Aug. 2017 – May 2021

## RESEARCH EXPERIENCE

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### Graduate Research Assistant

*Department of Mechanical and Aerospace Engineering, University of California San Diego*  
Advisor: Prof. Boris Kramer

La Jolla, CA  
Sept. 2021 – Present

- Developed a reduced-order model that predicts the ambient solar wind 30% faster than MAS, with comparable accuracy [7].
- Performed variance-based global sensitivity analysis and Bayesian inference of the ambient solar wind parameters via ACE observations [6].

### Graduate Student Researcher

*T-5 Plasma Physics Theoretical Division, Los Alamos National Laboratory*  
Advisors: Dr. Gian Luca Delzanno, Dr. Salomon Janhunen, and Dr. Vadim Roytershteyn (Space Science Institute)

Remote Work  
April 2024 – Present

- 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.

### Heliophysics Researcher

*Frontiers Development Lab*  
Advisors: Dr. Mike Heyns (Imperial College London)

Remote Work  
June 2024 – Aug. 2024

- 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

*T-5 Plasma Physics Theoretical Division, Los Alamos National Laboratory*  
Advisors: Dr. Gian Luca Delzanno, Dr. Oleksandr Koshkarov, and Dr. Federico Halpern (General Atomics)

Los Alamos, NM  
June 2023 – July 2023

- 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

*Department of Mathematics and Statistics, San Diego State University*  
Advisor: Prof. Christopher Curtis

San Diego, CA  
May 2020 – Aug. 2021

- 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 [8].

### Solar Physics Intern

*Predictive Science Inc.*  
Advisors: Dr. Pete Riley and Dr. Cooper Downs

San Diego, CA  
Dec. 2019 – July 2021

- 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 [9–10].
- Developed *mesh-generator*, a Python package, for a spherical mesh generator that increased the accuracy of simulating coronal mass ejections.

## AWARDS AND FELLOWSHIPS

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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 Los Alamos National Laboratory 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 Los Alamos National Laboratory **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 doctoral students at UCSD, which provides three years of funding during graduate school; total of 120,000\$ for three years.

## JOURNAL PUBLICATIONS

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- [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, **Issan O**, Pogudin G, Kramer B (2023). *Exact and Optimal Quadraticization of Nonlinear Finite-Dimensional Non-autonomous Dynamical Systems*. *SIAM Journal on Applied Dynamical Systems*, 23:982-1016. doi: 10.1137/23M1561129
- [6] **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
- [7] **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
- [8] 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
- [9] **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
- [10] 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

## CONFERENCE PRESENTATIONS AND POSTERS

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1. (★ 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<sup>th</sup> International Symposium for Space Simulations (ISSS) and 16<sup>th</sup> 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<sup>th</sup> 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

*Department of Mathematics, San Diego State University*

*Taught by Lecturer Corey Manchester*

San Diego, CA

Aug. 2018 – Dec. 2018

- 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

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### UCSD Undergraduate Research Mentor

*Department of Mechanical and Aerospace Engineering, University of California San Diego*

La Jolla, CA

June 2022 – Oct. 2023

- Mentored undergraduate researchers Emily Deboer and Hannah Haider.
- Managed 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

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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).

## RELEVANT COURSEWORK

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- 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

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