

# Ivan Zanardi

AEROSPACE ENGINEER · COMPUTATIONAL PHYSICIST

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## SUMMARY

PhD candidate in Aerospace Engineering applying machine learning and model reduction techniques to multiphysics, multiscale numerical simulations. Passionate about developing fast, accurate, and physics-aware simulation tools for real-world engineering challenges.

- 4+ years experience in machine learning and optimization
- 4+ years experience in surrogate and reduced-order modeling
- 4+ years experience in numerical methods for partial differential equations
- 5+ years experience in high-speed and reactive flows modeling
- 5+ years experience in hypersonics and aerothermodynamics

## EDUCATION



**University of Illinois Urbana-Champaign**

Urbana, IL, USA

**Ph.D. in Aerospace Engineering - GPA 4/4**

Jan. 2021 - Sep. 2025

- **Dissertation:** "Physics-aware thermochemical surrogates for next-generation aerothermal modeling"
- **Mentor:** Prof. Marco Panesi
- **Major:** Aerodynamics, Fluid Mechanics, Combustion and Propulsion (AFMCP)
- **Elective coursework:** Machine Learning · Numerical Methods for PDEs · Uncertainty Quantification · Spectral Element Methods · Computational Plasma Physics · Plasma Waves · Advanced Gas Dynamics
- **Activities and Societies:** Member of Center for Hypersonics and Entry Systems Studies (CHESS) · Member of American Institute of Aeronautics and Astronautics (AIAA) · Member of Society for Industrial and Applied Mathematics (SIAM)



**Politecnico di Milano**

Milan, Italy

**M.S. in Aeronautical Engineering - Grade 110/110**

Sep. 2017 - Apr. 2020

- **Dissertation:** "Effects of non-equilibrium oxygen dissociation and vibrational relaxation in hypersonic flows"
- **Mentor:** Prof. Federico Piscaglia
- **Major:** Combustion and Propulsion



**Politecnico di Milano**

Milan, Italy

**B.S. in Aerospace Engineering - Grade 110/110**

Oct. 2014 - Sep. 2017

## EXPERIENCE



**University of Illinois Urbana-Champaign**

Urbana, IL, USA

**Graduate Research Assistant - Aerospace Engineering Department**

Jan. 2021 - Sep. 2025

*Applying reduced-order modeling and physics-informed operator learning to improve accuracy and efficiency in multiphysics and multiscale simulations of high-speed reactive plasma flows.*

- Mentored by Prof. Marco Panesi.
- Reduced-order models (ROMs):
  - Developed ROMs for thermochemical nonequilibrium systems, achieving up to 700x speedup with 1% error.
  - Applied ROMs to multidimensional CFD simulations, ensuring stable and accurate performance in complex plasma flow environments.
- Physics-informed neural operators (PINOs):
  - Designed physics-constrained and physics-inspired neural operator architectures to surrogate thermochemical operators in reactive flow simulations, achieving over 100x speedup with 1% error.
  - Created and actively developing PyCOMET, a modular TensorFlow-based library for physics-informed machine learning for scientific computing and operator discovery.
  - Integrated TensorFlow C-based models with in-house Fortran CFD code for high-speed flow simulations.
- Research conducted at the Center for Hypersonics and Entry Systems Studies (CHESS) under the Vannevar Bush Faculty Fellowship, in collaboration with the Computational Aerosciences Lab at the University of Michigan.
- Presented research findings to senior scientists and program managers from NASA (Dr. Michael Wright, Dr. Aaron Brandis) and the Department of Defense (Dr. Jean-Luc Cambier).



**University of Illinois Urbana-Champaign**  
**Teaching Assistant - Aerospace Engineering Department**

Urbana, IL, USA  
 Aug. 2024 - Dec. 2024

Assisted in the course AE512 - Molecular gas dynamics.

- Conducted weekly office hours, supporting over 40 students.
- Developed and prepared assignments and exam materials.
- Managed and updated course materials through online learning platforms.



**Lawrence Livermore National Laboratory**  
**Data Science Researcher - Data Science Summer Institute (DSSI)**

Livermore, CA, USA  
 May 2024 - Aug. 2024

Developing data-driven nonlinear-manifold reduced order models with domain decomposition for partial differential equations.

- Mentored by Dr. Youngsoo Choi.
- Contributed to the development of an object-oriented Python library for constructing nonlinear-manifold reduced-order models using domain decomposition and deterministic autoencoders, with a focus on applications to the nonlinear Burgers' equation.
- Recognized as one of the top presenters in the DSSI Summer Slam competition, where projects from all DSSI scholars were evaluated.
- Work presented at the Machine Learning for Physical Sciences (ML4PS) workshop at NeurIPS 2024.



**Lawrence Livermore National Laboratory**  
**Machine Learning Researcher - Physics Division**

Livermore, CA, USA  
 May 2023 - Aug. 2023

Designed a novel quantum hydrodynamics formulation for DFT-based Born-Oppenheimer molecular dynamics (BOMD) using adjoint-based ML.

- Mentored by Dr. Amit Samanta.
- Developed PyDeFT, an object-oriented PyTorch-based library for constructing new PDE formulations for the DFT-BOMD method, featuring:
  - PDE-constrained optimization via the adjoint method.
  - PDE solver supporting implicit/explicit time integrators and a hybrid FD/FV method for space discretization.
  - Flexible deep neural network models for integration into the framework.



**Freelancer**  
**Python Code Developer**

Bergamo, Italy  
 Jul. 2020 - Dec. 2020

- Developed Python-based codes for data analysis and web scraping.



**Brembo**  
**3D Systems Designer - Systems Design Area**

Stezzano, Italy  
 Mar. 2020 - Jun. 2020

- Designed 3D parts and assemblies for supercars braking system.
- Tested and managed new CAD/PLM tools to optimize design activities.
- Worked on 2D and 3D parametric modeling and compiled related documentation.



**Politecnico di Milano**  
**Graduate Research Assistant - Aerospace Engineering Department**

Milan, Italy  
 Sep. 2019 - Feb. 2020

Validated and extended an open-source hypersonic CFD code written in the OpenFOAM C++ toolbox.

- Mentored by Prof. Federico Piscaglia.
- Implemented new thermochemical libraries for nonequilibrium processes.
- Designed practical testing codes for academic purposes.

## HONORS & AWARDS

Aug. 2024 **Top presenter - DSSI Summer Slam**, Lawrence Livermore National Laboratory  
 Jun. 2016 **Best student award - Merit project**, Politecnico di Milano

Livermore, CA, USA  
 Milan, Italy

## SELECTED PUBLICATIONS

- [1] **I. Zanardi**, S. Venturi, and M. Panesi. *Hybrid matrix exponential-based neural operator for stiff thermochemical kinetics*. In preparation. 2025.
- [2] **I. Zanardi**, A. Meini, A. Padovan, D. J. Bodony, and M. Panesi. *Petrov-Galerkin model reduction for collisional-radiative argon plasma*. June 2025. DOI: 10.48550/arXiv.2506.05483.
- [3] Y. Choi, S. W. Cheung, Y. Kim, P.-H. Tsai, A. N. Diaz, **I. Zanardi**, S. W. Chung, D. M. Copeland, C. Kendrick, W. Anderson, T. Iliescu, and M. Heinkenschloss. *Defining Foundation Models for Computational Science: A Call for Clarity and Rigor*. May 2025. DOI: 10.48550/arXiv.2505.22904.
- [4] **I. Zanardi**, A. Padovan, D. J. Bodony, and M. Panesi. "Petrov-Galerkin model reduction for thermochemical nonequilibrium gas mixtures". In: *Journal of Computational Physics* 533 (Apr. 2025), p. 113999. DOI: 10.1016/j.jcp.2025.113999.
- [5] **I. Zanardi**, A. N. Diaz, S. W. Chung, M. Panesi, and Y. Choi. *Scalable nonlinear manifold reduced order model for dynamical systems*. Nov. 2024. DOI: 10.48550/arXiv.2412.00507.

[6]

C. Jacobsen, **I. Zanardi**, S. Bhola, K. Duraisamy, and M. Panesi. “Information Theoretic Clustering for Coarse-grained Modeling of Non-equilibrium Gas Dynamics”. In: *Journal of Computational Physics* (Mar. 2024), p. 112977. doi: 10.1016/j.jcp.2024.112977.

[7]

**I. Zanardi**, S. Venturi, and M. Panesi. “Adaptive physics-informed neural operator for coarse-grained non-equilibrium flows”. In: *Scientific Reports* 13 (Sept. 2023), pp. 1–22. doi: 10.1038/s41598-023-41039-y.

[8]

M. S. Priyadarshini, S. Venturi, **I. Zanardi**, and M. Panesi. “Efficient quasi-classical trajectory calculations by means of neural operator architectures”. In: *Physical Chemistry Chemical Physics* 25 (May 2023), pp. 13902–13912. doi: 10.1039/D2CP05506F.

CONFERENCE PRESENTATIONS

NeurIPS 2024 - ML4PS Workshop

Poster Presenter

“Scalable nonlinear manifold reduced order model for dynamical systems”

Vancouver, BC, Canada

Dec. 2024

APS Division of Fluid Dynamics Annual Meeting 2024

Presenter

“Projection-based model reduction for thermo-chemical non-equilibrium gas mixtures”

Salt Lake City, UT, USA

Nov. 2024

AIAA SciTech Forum and Exposition

Paper Presenter

Talks: [2022] [2023] [2024] [2025]

SIAM Annual Meeting

Minisymposium Presenter

Talks: [2021] [2022]

ADDITIONAL SKILLS & COMPETENCES

Coding Languages	Python, C/C++, Fortran, MATLAB, Bash
Version Control Systems	Git
Machine Learning Libraries	TensorFlow, Keras, PyTorch, scikit-learn, JAX
Scientific and Data Libraries	NumPy, SciPy, SQL, Pandas, H5py, HDF5
CFD Softwares	OpenFOAM, CHESSE in-house codes
Scientific Visualization	ParaView, Matplotlib

REFERENCES

Marco Panesi, Professor and Director of CHESSE

Department of Aerospace Engineering, University of Illinois Urbana-Champaign

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Youngsoo Choi, Research Scientist Staff

Physics Division, Lawrence Livermore National Laboratory

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Amit Samanta, Research Staff

Physics Division, Lawrence Livermore National Laboratory

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Karthik Duraisamy, Professor and Director of MICDE and CASLAB

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Simone Venturi, Senior AI Engineer

Atomic Machines

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Federico Piscaglia, Associate Professor

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