Shayan Dodge

PhD Researcher in Computational Electromagnetics and Scientific Machine Learning

Pisa, Italy

dodgeshayan@gmail.com shayan.dodge@ing.unipi.it shayan.dodge@phd.unipi.it

ORCID Google Scholar LinkedIn Website GitHub

Research Profile

PhD researcher in Scientific Machine Learning and Computational Electromagnetics with experience applying AI to electromagnetic simulation, power and energy systems, bioelectromagnetics, inverse problems, and scientific computing. Developed physics-informed neural networks, neural operators, generative AI models, and deep learning frameworks for solving PDEs, surrogate modeling, signal analysis, optimization, and simulation acceleration.

Research Highlights

- 14 peer-reviewed publications: 12 journal articles and 2 conference papers.
- 5 first-author journal publications.
- Research experience in Scientific Machine Learning, PINNs, Neural Operators, Computational Electromagnetics, and AI for Physics.
- Student Editorial Assistant, *IEEE Journal on Multiscale and Multiphysics Computational Techniques*.
- Reviewer for 7 international journals.
- Winner of research grant: "Application of Machine Learning to Electromagnetism Problems", University of Pisa, 2024.

Education

Ph.D. in Electrical Engineering Sep 2024 – Present
University of Pisa (DESTEC), Italy

M.Sc. in Plasma Physics Sep 2017 – Feb 2020
Shahid Beheshti University, Laser and Plasma Research Institute, Iran
GPA: 18.27/20 (WES evaluated as U.S. GPA 3.87/4.00)

B.Sc. in Physics Oct 2013 – Jun 2017
Kharazmi University, Department of Physics, Iran
GPA: 18.46/20 (WES evaluated as U.S. GPA 3.98/4.00)

Research Experience

Research Fellow – University of Pisa (DESTEC) Jan 2024 – Jan 2026

Worked on AI-driven computational electromagnetics projects within the PRIN-funded *FELINES* and *STEM-DEEP* research programs.

Research Interests

- Scientific Machine Learning and AI for Physics.
- Physics-Informed Neural Networks and Variational PINNs.
- Neural Operators, DeepONet, and Surrogate Modeling.
- Computational and Applied Electromagnetics.

- Inverse Problems and Optimization.
- Power and Energy Systems.
- Bioelectromagnetics, TMS, SAR, MRI, and EIT.
- High-Performance Scientific Computing.

Selected Projects

Physics-Informed Neural Networks for Electromagnetic PDEs

- Developed *hybrid BEM–PINN* frameworks integrating classical Boundary Element Methods (BEM) with physics-informed neural networks for improved electromagnetic PDE solving accuracy and stability.
- Developed *STAR-PINN* architectures using stacked adaptive residual learning to improve convergence and nonlinear modeling capability in electromagnetic simulations.
- Developed *variational PINN* formulations inspired by finite element methods (FEM) to enhance numerical robustness for complex multiphysics and inverse electromagnetic problems.
- Implemented models using PyTorch, TensorFlow and JAX.
- Investigated neural operators and surrogate models for accelerated simulation.

Deep Learning for Lightning Localization

- Developed *deep learning systems* for lightning location estimation and overvoltage prediction.
- Processed transient electromagnetic signals for inverse analysis tasks.

GPU-Accelerated Electromagnetic Simulation

- Developed *CUDA-accelerated FDTD* simulation workflows.
- Optimized electromagnetic simulations using GPU acceleration and parallel computing.

AI for Bioelectromagnetics

- Developed *Generative AI* models for transcranial magnetic stimulation (TMS), using physician-defined stimulation targets as prompts for variational autoencoder (VAE)-based electric field map generation, followed by CNN-based prediction of optimal magnetic coil positioning.
- Developed deep learning surrogate models for *SAR hot-spot* prediction in wearable electromagnetic antenna devices, enabling fast estimation of localized electromagnetic energy absorption in biological tissues for safety and exposure analysis.

Technical Skills

Machine Learning and AI
PyTorch, TensorFlow, JAX, Deep Learning, Neural Networks, PINNs, Neural Operators, DeepONet, Scientific Machine Learning, Surrogate Modeling

Scientific Computing
Computational Electromagnetics, FEM, FDTD, BEM, Inverse Problems, Numerical PDEs, Signal Processing

Programming
Python, MATLAB, C++, CUDA

High-Performance Computing
GPU Computing, CUDA Acceleration, Parallel Computing, Scientific Workflows

Simulation and Engineering Tools
ANSYS Maxwell, CST Studio Suite, FEniCS, Gmsh, SimNIBS

Software and Development
Git, Linux, Scientific Software Development

Selected Publications

1. **Dodge, S.**, Barmada, S., & Formisano, A. (2025). A STacked Adaptive Residual PINN (STAR-PINN) Approach to 2D Time-Domain Magnetic Diffusion in Nonlinear Materials. *IEEE Access*. [Paper] [GitHub] [LinkedIn]
2. **Dodge, S.**, Nicora, M., Barmada, S., et al. (2025). A deep learning based lightning location system. *Electric Power Systems Research*. [Paper] [GitHub] [LinkedIn]
3. Barmada, S., **Dodge, S.**, Tucci, M., et al. (2024). A Novel Hybrid Boundary Element–Physics Informed Neural Network Method for Numerical Solutions in Electromagnetics. *IEEE Access*. [Paper] [GitHub] [LinkedIn]
4. **Dodge, S.**, Fontana, N., Mognaschi, M. E., et al. (2025). A Deep Learning Based Prediction of Specific Absorption Rate Hot-Spots Induced by Broadband Electromagnetic Devices. *IET Science, Measurement & Technology*. [Paper] [GitHub]
5. Barmada, S., **Dodge, S.**, & Formisano, A. (2025). Weak Formulation for Physics-Informed Neural Networks in the Resolution of Analysis Problems in Electromagnetics. *IEEE Transactions on Magnetics*. [Paper]

Publication Summary

Peer-reviewed publications: 14
12 journal articles and 2 conference papers

Google Scholar metrics: h-index 5

Journal Articles

1. Barmada, S., **Dodge, S.**, Formisano, A., Di Barba, P., & Mognaschi, M. E. (2026). PINN-Based Resolution of Inverse Non-linear Magnetostatic Problems. *COMPEL*. [Link]
2. Codecasa, L., Zhu, X., Di Rienzo, L., Barmada, S., **Dodge, S.**, et al. (2026). Fast Model Order Reduction Based Approach for Transcranial Magnetic Stimulation with Varying Coil Positioning. *IEEE Access*. [Link]
3. Formisano, A., **Dodge, S.**, & Barmada, S. (2025). A Comparison of Machine Learning and Classical Numerical Approaches for the Resolution of Electromagnetics Problems. *IET Science, Measurement & Technology*, 19(1), e70034. [Link]
4. Barmada, S., **Dodge, S.**, & Formisano, A. (2025). Weak Formulation for Physics-Informed Neural Networks in the Resolution of Analysis Problems in Electromagnetics. *IEEE Transactions on Magnetics*. [Link]
5. Cosentino, G., Zaffina, C., Zoccola, C., Fresia, M., Merli, S., Mauramati, S., Bertino, G., Todisco, M., **Dodge, S.**, et al. (2025). Unilateral EMG-Guided Botulinum Toxin for Retrograde Cricopharyngeus Dysfunction. *Toxins*, 17(9), 458. [Link]
6. Barmada, S., **Dodge, S.**, Brignone, M., et al. (2025). Relating transmission line overvoltages and lightning location: a machine learning-based procedure. *COMPEL*. [Link]
7. **Dodge, S.**, Barmada, S., & Formisano, A. (2025). A STacked Adaptive Residual PINN Approach to 2D Time-Domain Magnetic Diffusion in Nonlinear Materials. *IEEE Access*. [Link]

8. **Dodge, S.**, Fontana, N., Mognaschi, M. E., et al. (2025). A Deep Learning Based Prediction of Specific Absorption Rate Hot-Spots Induced by Broadband Electromagnetic Devices. *IET Science, Measurement & Technology*, 19(1), e70009. [Link]

9. **Dodge, S.**, Nicora, M., Barmada, S., et al. (2025). A deep learning based lightning location system. *Electric Power Systems Research*, 242, 111437. [Link]

10. Sekehravani, E. A., **Dodge, S.**, Barmada, S., et al. (2025). Preliminary Breakdown Pulses: A review on available data and models. *Electric Power Systems Research*, 242, 111463. [Link]

11. Barmada, S., **Dodge, S.**, Tucci, M., et al. (2024). A Novel Hybrid Boundary Element–Physics Informed Neural Network Method for Numerical Solutions in Electromagnetics. *IEEE Access*. [Link]

12. Niknam, A. R., **Dodge, S.**, Hajian, M., et al. (2024). Characterization of microwave heating for hyperthermia cancer treatment. *Waves in Random and Complex Media*, 34(1), 211–225. [Link]

13. **Dodge, S.**, Shafiee, M., & Shokri, B. (2022). Application of GPU-accelerated FDTD method to electromagnetic wave propagation in plasma using MATLAB Parallel Processing Toolbox. *arXiv preprint*. [Link]

Journal Articles Under Review

1. **Dodge, S.**, Barmada, S., & Formisano, A. (2026). INI-VPINN: A Variational Physics-Informed Neural Network with Implicit Neumann and Interface Handling for Multi-Material Domains with Geometric Singularities. *Journal of Computational Physics*. Major revision submitted.

2. **Dodge, S.**, Mestriner, D., Nicora, M., Barmada, S., Brignone, M., Formisano, A., & Procopio, R. (2026). Prediction of lightning flashover on overhead distribution lines from preliminary breakdown voltages based on deep learning. *Electric Power Systems Research*. Under review.

3. Toghranegar, S., **Dodge, S.**, Barmada, S., Kazmi, H., Deconinck, G., & Sabariego, R. (2026). Physics-Informed Deep Operator Networks for Parametric Modelling of Electromagnetic Devices: Magnetostatics to Magnetoquasistatics. *IEEE Transactions on Magnetics*. Under review.

Conference Papers

1. Barmada, S., Bonfiglio, A., Brignone, M., **Dodge, S.**, Formisano, A., Procopio, R., & Akbari Sekehavani, E. (2025). A Survey of Measurements and Analyses of Preliminary Breakdown Pulses in Lightning Flashes. *EEEIC/I&CPS Europe*. [Link]

2. Nicora, M., Procopio, R., Brignone, M., **Dodge, S.**, et al. (2025). A Deep Learning Model for Lightning Location and Peak Current Estimation from Induced Overvoltages. *SIPDA*. [Link]

Conference Papers Accepted

1. **Dodge, S.**, Fontana, N., Tucci, M., Barmada, S., Codecasa, L., Di Rienzo, L., Cosentino, G., Pichecchio, A., Antoniazzi, E., & Mognaschi, M. E. (2026). A deep learning approach for electric field reconstruction for transcranial magnetic stimulation. *CEFC 2026*. Under review, oral presentation.

2. Barmada, S., **Dodge, S.**, & Formisano, A. (2026). A variational physics-informed neural network framework for magnetostatic problems in strongly non-homogeneous domains. *CEFC 2026*. Under review, poster.

3. Barmada, S., **Dodge, S.**, & Formisano, A. (2026). Isoparametric mapped weak-form PINNs for arbitrary quadrilateral elements. *CEFC 2026*. Under review, oral presentation.

4. Barmada, S., **Dodge, S.**, Hajian, M., & Fontana, N. (2026). Fast parametric prediction of coil coupling in wireless power transfer systems using physics-informed DeepONet. *CEFC 2026*. Under review, poster.

5. **Dodge, S.**, Hajian, M., & Barmada, S. (2026). A non-conforming domain-decomposed variational physics-informed neural network for electromagnetic problems in complex geometries. *ACES Conference 2026.* Accepted, oral presentation.
6. **Dodge, S.**, Toghranegar, S., Barmada, S., Kazmi, H., Deconinck, G., & Sabariego, R. V. (2026). PI-FNO: A physics-informed Fourier neural operator for parametric magnetostatic simulations. *SCEE 2026.* Accepted, poster.

Academic Service

- Student Editorial Assistant, *IEEE Journal on Multiscale and Multiphysics Computational Techniques* (2026–Present).
- Reviewer for:
  - *IEEE Transactions on Magnetics*
  - *IEEE Journal on Multiscale and Multiphysics Computational Techniques*
  - *COMPEL: The International Journal for Computation and Mathematics in Electrical and Electronic Engineering*
  - *Applied Computational Electromagnetics Society Journal*
  - *Physics of Plasmas*
  - *Optics Express*
  - *Waves in Random and Complex Media*

Honors and Awards

- Winner, Research Grant: "Application of Machine Learning to Electromagnetism Problems", DESTEC, University of Pisa, 2024.
- Ranked 1st among Plasma Physics graduates, Shahid Beheshti University, 2020.
- Ranked 1st among all undergraduates of the Physics Department, Kharazmi University, 2017.
- Top 1.5% in Iran's BSc National Entrance Exam among 251,000 participants, 2013.

Professional Memberships

- IEEE Member
- IEEE Antennas and Propagation Society

Languages

- Persian: Native
- English: Professional working proficiency