Shayan Dodge

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Research Profile

PhD candidate in Electrical Engineering working at the intersection of computational electromagnetics and artificial intelligence. Research focuses on integrating high-fidelity numerical solvers (FEM, FDTD, BEM) with physics-informed neural networks to develop scalable, physics-consistent surrogate models for electromagnetic systems.

Research interests include next-generation machine learning frameworks for real-time electromagnetic analysis and design optimization in complex multiphysics environments.

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
Overall GPA: 18.27/20 (WES evaluated as U.S. GPA 3.87/4.00).
Selected courses: Electrodynamics (18/20), Numerical Electrodynamics (19/20).

B.Sc. in Physics Oct 2013 – Jun 2017
Kharazmi University (Department of Physics), Iran
Overall GPA: 18.46/20 (WES evaluated as U.S. GPA 3.98/4.00).
Selected courses: Electromagnetics II (19/20), Optics (19.25/20).

Research Experience

Research Fellow Jan 2024 – Jan 2026
University of Pisa (DESTEC), Italy
Contributed to PRIN 2022 funded projects *FELINES* and *STEM-DEEP*.

Developed machine learning frameworks for lightning precursor detection and induced overvoltage prediction in power systems. Designed deep learning models for inverse electromagnetic field reconstruction in personalized transcranial magnetic stimulation (TMS).

Research Interests

- **Computational and Applied Electromagnetics:** Multiphysics modeling, numerical EM solvers (FDTD, FEM, BEM), lightning and power-system electromagnetic phenomena.
- **AI for Electromagnetics:** Physics-informed neural networks (PINNs), ML-based inverse modeling, neural operators (DeepONet).
- **Bioelectromagnetics:** Computational modeling of transcranial magnetic stimulation (TMS), microwave hyperthermia, Specific Absorption Rate (SAR) estimation in biological tissues, and medical imaging techniques (MRI and Electrical Impedance Tomography).

Honors and Awards

- Winner, Research Grant: "Application of Machine Learning to Electromagnetism Problems", DESTEC, University of Pisa (2024).
- Ranked 1st among Plasma Physics graduates at 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 (2013).

Technical Skills

- **Computational Electromagnetics:** FEM (ANSYS Maxwell, Onelab, FEniCS) with mesh generation (Gmsh), FDTD (CST Studio Suite), Brain Stimulation Modeling (TMS: SimNIBS).
- **Scientific Programming:** Python, MATLAB, C++; CUDA-based acceleration.
- **Machine Learning:** PINNs, Neural Operators (DeepONet), TensorFlow, PyTorch, JAX.
- **High Performance Computing:** GPU acceleration and parallel processing (CUDA, MATLAB Parallel Computing Toolbox).

Languages

- English (C1)
- Persian (Native)

Professional Membership

- IEEE Member
- IEEE Antennas & Propagation Society

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

Publications

Peer-Reviewed Publications: 17 (13 Journal Articles, 4 Conference Papers)

Publication Metrics (Google Scholar, Feb 2026): h-index: 4

Journal Articles (Published)

1. Barmada, S., **Dodge, S.**, Formisano, A., Di Barba, P., & Mognaschi, M. E. (2026). PINN-Based Resolution of Inverse Non-linear Magnetostatic Problems. *COMPEL: The International Journal for Computation and Mathematics in Electrical and Electronic Engineering*. Accepted.

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: A Prospective Clinical and Neurophysiological Study. *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 – The International Journal for Computation and Mathematics in Electrical and Electronic Engineering*. [Link]

7. **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*. [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] [GitHub]

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

10. Sekehravani, E. A., **Dodge, S.**, Barmada, S., et al. (2025). Preliminary Breakdown Pulses (PBP): 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* arXiv:2211.05647. [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*. Under review (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 (Published)

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. In *2025 IEEE International Conference on Environment and Electrical Engineering and 2025*

IEEE Industrial and Commercial Power Systems Europe (EEEIC/I&CPS Europe) (pp. 1–5). IEEE. [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. In *2025 International Symposium on Lightning Protection (XVIII SIPDA)*. [Link]

3. **Dodge, S.**, Shafiee, M., & Shokri, B. (2021). 1-D numerical characterization of the electromagnetic wave propagation in plasma using the kinetic theory of discharge and finite difference time domain method. *Proceedings of the 8th Conference on Engineering and Physics of Plasma*. [Link]

4. **Dodge, S.**, Shafiee, M., Akbaripoor, M., & Shokri, B. (2019). Comparison of electromagnetic wave propagation with 1D-FDTD in the modeled plasma by Maxwellian and Druyvesteyn electron distribution function at the initial moment. *Proceedings of the 7th Conference on Engineering and Physics of Plasma*. [Link]

Conference Papers (Under Review)

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. *IEEE Conference on Electromagnetic Field Computation (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. *IEEE Conference on Electromagnetic Field Computation (CEFC) 2026*. Under review (poster).

3. Barmada, S., **Dodge, S.**, & Formisano, A. (2026). Isoparametric mapped weak-form PINNs for arbitrary quadrilateral elements (IsoMap-WPINN). *IEEE Conference on Electromagnetic Field Computation (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. *IEEE Conference on Electromagnetic Field Computation (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. *Applied Computational Electromagnetics Society (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. *International Conference on Scientific Computing in Electrical Engineering (SCEE) 2026*. Accepted (poster).

Peer Review

- IEEE Transactions on Magnetics (3) — 2026
- Physics of Plasmas (8) — 2024–2026
- The Applied Computational Electromagnetics Society (2) — 2022–2025
- Waves in Random and Complex Media (2) — 2021
- Optics Express (2) — 2025
- Franklin Open (1) — 2025