

# MATTHEW T. FLAVIN, PH.D.

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Homepage: <https://flavinlab.io>

## EDUCATION

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**Massachusetts Institute of Technology** Cambridge, MA  
Ph.D. in Electrical Engineering 2021  
Committee: Jongyoon Han, Ph.D. (advisor) GPA: 5.00/5.00  
Charles Lissandrello, Ph.D.  
Polina Anikeeva, Ph.D.  
Dennis Freeman, Ph.D.

**Massachusetts Institute of Technology** Cambridge, MA  
Master of Science in Electrical Engineering 2017  
GPA: 5.00/5.00

**University of Illinois** Urbana–Champaign, IL  
Bachelor of Science in Electrical Engineering 2015  
Minor in Bioengineering GPA: 3.60/4.00  
James Scholar (academic honors)

## RESEARCH VISION

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My aim is to develop powerful peripheral neural interfaces and mechatronic wearables that leverage advanced sensors and intelligent systems to address important and unresolved challenges in patient care.

## RESEARCH POSITIONS

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**Georgia Institute of Technology** August 2024 – Present  
Assistant Professor  
Flavin Neuromachines Lab

**Northwestern University** December 2021 – July 2024  
Post-doctoral Researcher  
John Rogers Research Group

**Massachusetts Institute of Technology** June 2021 – December 2021  
Post-doctoral researcher  
Micro/nanofluidic and BioMEMS Research Group

**Massachusetts Institute of Technology** August 2015 – May 2021  
Doctoral researcher  
Micro/nanofluidic and BioMEMS Research Group

## GRANT ACTIVITY

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**Haptic Textiles for Patients with Motor and Sensory Disorders** 2024  
Status: under review  
Ralph E. Powe Junior Faculty Enhancement Award, Oak Ridge Associated Universities  
Role: Principle Investigator

**Brine Dispenser and Dilution Utilizing Novel Plunging Liquid Jet Reactor Incorporating Annular Riser** 2024  
Status: under review  
Research Sector, Kuwait University  
Role: Co-investigator

**Full Freedom-of-Motion Haptic Actuators and Their Use in a Wireless System for VR Environments** 2023  
Status: awarded  
Army (W911QY-20-R-0022)  
Role: Co-investigator

**Haptic neuro-prosthesis for spinocerebellar ataxia** 2023  
Status: awaiting site visit as a finalist  
Raynor Cerebellum Project  
Role: Co-investigator

**High-frequency Electrical and Thermal Stimulation for Pain Management** 2019  
Draper Internal Research and Development Grant  
*Principle Investigator:* Charles Lissandrello, Ph.D.  
*Role:* Co-investigator

**Focal Neuromodulation via Localized Ca<sup>2+</sup> and Mg<sup>2+</sup> depletion and enrichment** 2016  
BRAIN Initiative RFA-EY-16-001  
*Principle Investigator:* Jongyoon Han, Ph.D.

**Localized Modulation of Synaptic Activity Using Calcium Ion-selective Membrane Coated Electrodes** 2015  
Amar G. Bose research grant (MIT internal)  
*Principle Investigator:* Jongyoon Han, Ph.D.  
*Role:* Co-investigator

## FELLOWSHIPS AND AWARDS

**NIH Fellowship in Circadian and Sleep Research** October 2023 – July 2024  
Ruth L. Kirschstein Institutional National Research Service Award (T32)

**Draper Laboratory Fellowship** August 2015 – May 2021

**NIH Brain Initiative Course on Models and Neurobiology** July 2016

## PEER-REVIEWED JOURNAL ARTICLES

**M. Flavin**,\* K. Ha,\* Z. Guo,\* S. Li,\* J. Kim,\* T. Saxena, F. Al-Najjar, S. Bandapalli, C. Fan, D. Bai, Z. Zhang, J. Yoo, M. Park, J. Shin, A. Huang, H. Shin, Y. Huang, Z. Xie, H. Jiang, J. Rogers (\*equal contribution), "Bioelastic state recovery for haptic sensory substitution," conditionally accepted in *Nature* as of August 2024.

J. Shin,\* J. Song,\* **M. Flavin**,\* S. Cho,\* S. Li,\* A. Huang, J. Trueb, A. Yang, M. Kim, K. Nguyen, W. Sunng, H. Wang, A. Banks, J.-K. Chang, A. Paller, Y. Huang, G. Ameer, J. Rogers (\*equal contribution), "An Approach for Continuous Monitoring of Molecular Flux Into and Out of The Skin," under first revision in *Nature* as of August 2024.

**M. Flavin et al.**, "Sensory substitution with a multimodal somatosensory interface," in preparation, submission planned Dec. 2024.

E. Flavin, S. Hwang, **M. Flavin**, "The effects of augmented reality use on mathematics achievement of K–12 students: A meta-analysis," under second revision in *International Journal of Science and Mathematics Education* as of August 2024.

E. Flavin, M. Chung, S. Hwang, **M. Flavin**, "Developing the area measurement reasoning of elementary students with augmented reality activities," under review in *Educational Technology Research and Development* as of August 2024.

E. Flavin, S. Hwang, **M. Flavin**, "Multi-dimensional engagement of Haitian immigrant parents in mathematics education," under review in *Educational Studies in Mathematics* as of August 2024.

E. Flavin, **M. Flavin**, "Developing augmented reality system for embodied mathematics learning," accepted in *Proceedings of the 46th Conference of the North American Chapter of the International Group for the Psychology of Mathematics Education (PME-NA)*, August 2024.

E. Flavin, **M. Flavin**, “Black feminist thought as a guide for ethical integration of artificial intelligence in mathematics classroom,” accepted in *Connections*, August 2024.

**M. Flavin**,\* J. Fernandes,\* R. AlQabandi, E. Adams, J. Han, B. Al-Anzi (\*equal contribution), “Numerical modeling of plunging jets of brine: mass transport and implications for desalination plant outfalls,” *Desalination*, vol. 568, 116996, Dec. 2023.

M. Park, J.-Y. Yoo, T. Yang, Y. Hwan Jung, A. Vázquez-Guardado, S. Li, J.-H. Kim, J. Shin, W.-Y. Maeng, G. Lee, S. Yoo, H. Luan, J.-T. Kim, H.-S. Shin, **M. Flavin**, H.-J. Yoon, N. Miljkovic, Y. Huang, W. King, and J. Rogers, “Skin-integrated systems for power efficient, programmable thermal sensations across large body areas,” in *Proceedings from the National Academy of Sciences of the United States of America*, vol. 120, no. 6, e2217828120, Jan. 2023.

**M. Flavin**, C. Lissandrello, J. Han, “Real-time, dynamic monitoring of selectively driven ion-concentration polarization,” in *Electrochimica Acta*, vol. 426, 140770, Sep. 2022.

**M. Flavin**, M. Paul, X. Lim, C. Lissandrello, R. Ajemian, S. Lin, J. Han, “Electrochemical modulation enhances the selectivity of peripheral neurostimulation in vivo,” in *Proceedings from the National Academy of Sciences of the United States of America*, vol. 119, no. 23, e2117764119, June 2022.

J. Yoon, **M. Flavin**, J. Han, “Current efficiency and selectivity reduction caused by co-ion leakage in electro-membrane processes,” in *Water Research*, vol. 201, 117351, Aug. 2021.

**M. Flavin**, M. Paul, X. Lim, S. Abdulhamed, C. Lissandrello, R. Ajemian, S. Lin, J. Han, “Rapid and low cost manufacturing of cuff electrodes,” in *Frontiers in Neuroscience*, vol. 16, 628778, Feb. 2021.

**M. Flavin**, D. Freeman, J. Han, “Interfacial ion transfer and current limiting in neutral-carrier ion-selective membranes: A detailed numerical model,” in *Journal of Membrane Science*, vol. 572, pp. 374-381, Feb. 2019.

K. I. Jang, H. U. Chung, S. Xu, C. H. Lee, H. Luan, J. Jeong, H. Cheng, G. T. Kim, S. Y. Han, J. W. Lee, J. Kim, M. Cho, F. Miao, Y. Yang, H. N. Jung, **M. Flavin**, H. Liu, G. W. Kong, K. J. Yu, S. I. Rhee, J. Chung, B. Kim, M. H. Yun, J. Y. Kim, Y. M. Song, U. Paik, Y. Zhang, Y. Huang, J. A. Rogers, “Soft network composite materials with deterministic, bio-Inspired designs,” in *Nature Communications*, vol. 18, no. 6, 6566, Mar. 2015.

S. Xu,\* Z. Yan,\* K. Jang, W. Huang, H. Fu, J. Kim, Z. Wei, **M. Flavin**, J. McCracken, R. Wang, A. Badea, H. Liu, D. Xiao, G. Zhou, J. Lee, H. U. Chung, H. Cheng, W. Ren, A. Banks, X. Li, U. Paik, R. G. Nuzzo, Y. Huang, Y. Zhang, J. A. Rogers, “Assembly of micro/nanomaterials into complex, three-dimensional architectures by compressive buckling,” in *Science*, vol. 347, no. 6218, pp. 154-159, Jan. 2015. (Cover Figure)

S. Xu,\* Y. Zhang,\* L. Jia,\* K. E. Mattewson,\* K. Jang, J. Kim, H. Fu, X. Huang, P. Chava, R. Wang, S. Bhole, L. Wang, Y. J. Na, Y. Guan, **M. Flavin**, Z. Han, Y. Huang, J. A. Rogers, “Soft microfluidic assemblies of sensors, circuits, and radios for the skin,” in *Science*, vol. 344, no. 6179, pp. 70-74, Apr. 2014.

## PATENTS

J. Han, D. Freeman, **M. Flavin**, U.S. Patent Application 17/741,921, “Architectures and Methods for Electrochemical Neuromodulation,” 2022.

## CLINICAL TRIALS

**Multimodal haptic feedback for plantar sensory substitution**

April 20 – Present

Northwestern IRB # STU00218277

<https://clinicaltrials.gov/study/NCT06232512>

Role: Investigator

**Evaluation of haptic feedback in a novel acoustomechanic device for behavioral scratch modification in atopic dermatitis**  
Northwestern IRB # STU0021480  
Role: Investigator

Feb. 6 – Present

## **CONFERENCE AND SEMINAR**

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E. Flavin, **M. Flavin**, “Developing an augmented reality system for embodied mathematics learning,” under review in the North American Chapter of the International Group for the Psychology of Mathematics Education, 2024, Cleveland, Ohio.

**M. Flavin**, K. Ha, Z. Guo, S. Li, J. Kim, Y. Huang, Z. Xie, H. Jiang, J. Rogers, “Neural mechatronics and mixed reality for patient healthcare,” presented (as a poster) at Gordon Robotics 2024, Ventura, California.

**M. Flavin**, J. Rogers, “Multimodal augmented reality,” presented (orally) at Sustainable Laboratory Showcase 2023, Chicago, Illinois.

**M. Flavin**, M. Paul, X. Lim, S. Abdulhamed, C. Lissandrello, R. Ajemian, S. Lin, J. Han. “Selective nerve conduction block via focal delivery of high-frequency alternating current from a radial electrode array,” presented (as a poster) at Gordon Bioelectronics 2019, Andover, New Hampshire.

**M. Flavin**, M. Paul, X. Lim, R. Ajemian, S. Lin, D. Freeman, J. Han, “Focal Manipulation of Neural Interstitial Ion Concentration Using Ion-Selective Membrane Electrodes,” presented (orally) at the Fall meeting of the Material Research Society, 2017, Boston, Massachusetts.

**M. Flavin**, D. Freeman, J. Han, “Electrochemical neuromodulation using cuff electrodes modified with ion-selective membrane electrodes,” presented (as a poster) at Neuroscience 2017, Washington D.C.

**M. Flavin**, D. Freeman, J. Han, “Mathematical Modeling of Ion Selective Membrane Systems Subject to Electrical Polarization,” presented (orally) at the 232nd Electrochemical Society Meeting, 2017, New Orleans, Louisiana.

## **PROFESSIONAL AND EDITORIAL SERVICE**

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### **IEEE-EMBS BSN 2024**

October 2024

Publications Co-chair, Organizing committee,

### **Kellog-Q residency**

February 2024 – July 2024

Mentoring two MBA students

### **PNAS Journal Club Panelist**

October 2022 – July 2024

Contributed to selections for PNAS’s journal club segment  
See: <https://www.pnas.org/journal-club/journal-club-panelists>

### **Peer review**

June 2022 – Present

Reviewed articles for *npj Digital Medicine* and *Science Advances*

### **Ph.D. advisor (Georgia Institute of Technology)**

August 2024 – Present

Led and trained two current students

### **Undergraduate student mentor (Georgia Institute of Technology)**

August 2024 – Present

Led and trained three current students

### **Undergraduate student mentor (Northwestern University)**

December 2021 – July 2024

Led and trained six undergraduate students

### **Undergraduate student mentor (MIT)**

August 2015 – May 2021

Hired, trained, and mentored two undergraduate students

## TEACHING ACTIVITY

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### Northwestern Teaching Assistant

Bioelectronics Lab (BME 354)

Spring 2024

### Outreach

Fairview Elementary Third Grade Class (<https://twitter.com/dist57/status/1722418763155263993>)

Nov. 8, 2023

STEM for ALL Brockton Math education program

Spring 2023

### Guest Lecturer (Northwestern)

Designing Product Interactions (DSGN 495-21)

Evanston, IL

Wearable Electronics (COMP\_ENG 395, 495)

Fall 2022

Spring 2023

### MIT Teaching Assistant

Biological Systems Modeling (20.334)

Cambridge, MA

Cellular Neurophysiology and Computing (9.21)

Fall 2021

Biological Systems Modeling (20.334)

Fall 2020

Fall 2017

### MIT BE Data Lab

Fellow

Cambridge, MA

March 2020 – May 2021

## TECHNICAL SKILLS

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- Clean-room fabrication: photolithography, thin-film deposition, reactive-ion and wet etching
- Electrochemical characterization: electrochemical impedance spectroscopy (EIS), cyclic voltammetry (CV), ion-selective electrode (ISE) potentiometry, inductively-coupled plasma atomic emission spectroscopy (ICP-AES)
- Fluorescence microscopy: widefield, confocal, two-photon, fluorescence lifetime imaging microscopy (FLIM)
- Biological wet-lab: microarray fabrication, cell culturing, EDC/NHS protein functionalization, plasmid amplification and transfection
- Rapid prototyping: CNC milling, 3D printing (FDM and SLA)
- Animal preparations: *ex vivo* bullfrog sciatic nerve, acute *in vivo* rat sciatic nerve, rat hippocampal neuron culture, rat dorsal root ganglion culture
- Embedded electronics design: fPCB design and fabrication, Bluetooth Low-energy (BLE) embedded software, mobile integration
- Numerical simulation: COMSOL Multiphysics, NEURON
- Programming languages (see <https://github.com/mflav>): Python, C, C++, Java, SystemVerilog, Haskell, Julia, Swift
- Mathematical packages: Mathematica, Matlab
- DAQ control: Labview, TDT RPvdsEx/Synapse
- CAD: SolidWorks, AutoCAD, Adobe Illustrator, EAGLE, Blender, Unity
- Other: fabrication and operation of microfluidic devices, GNU/Linux software development, statistical/machine learning

## ADDITIONAL INFORMATION

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**Google scholar:** <https://scholar.google.com/citations?user=3VgPQZoAAAAJ>

**LinkedIn:** <https://www.linkedin.com/in/matthew-flavin-a6b52250/>

**Github:** <https://github.com/mflav>

**ORCID:** <https://orcid.org/0000-0001-6636-0445>

**Homepage:** <https://flavinlab.io>

## REFERENCES

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References available upon request